The prosody of rhetorical questions[*]

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1. Introduction

The present paper deals with the prosody of rhetorical questions as compared to information-seeking questions in three related languages: English, German and Icelandic. The study includes two question types: polar questions (*Does anyone like liver?*) and *wh*-questions (*Who likes liver?*). The focus of the prosodic analysis is on their intonational characteristics, as well as on the phonetic parameter of duration.

1.1 Information-seeking and rhetorical questions

Prototypical questions (i.e., information-seeking questions, henceforth ISQs) perform the directive speech act of requesting information. Polar questions "request an answer that specifies whether the proposition expressed by their sentence radical holds or does not hold" (Krifka 2011:1747), i.e. the expected answer may be "yes" or "no" (Groenendijk and Stokhof 1984, Karttunen 1977). Semantically, polar questions hence denote the set of possible answers (or resolutions) {p, ¬p}; but see Biezma and Rawlins (2012). *Wh*-questions, on the other hand, "create an open proposition by leaving parts of the description of the proposition unspecified" (Krifka 2011:1744). In English, the open parameter is represented by a *wh*-pronoun (e.g. *who*), correspondingly in German by a *w*-pronoun (e.g., *wer* 'who') and in Icelandic by a *hv*-pronoun (e.g., *hver* 'who'). The expected answer is one that provides information about the open parameter. Semantically, a *wh*-question is either represented as a set of propositions that would constitute felicitous answers (Groenendijk

and Stokhof 1984, Hamblin 1973, Karttunen 1977) or as an incomplete expression (e.g., Hausser and Zaefferer 1979, von Stechow and Zimmermann 1984).

Rhetorical questions (henceforth RQs) are formally (i.e., surface-syntactically) interrogatives, but differ from ISQs in discourse function. In particular, according to Biezma and Rawlins (2017) and based on much previous literature, they have the following three characteristics: (i) RQs do not expect an answer (Banuazizi and Creswell 1999, Hudson 1975, Ilie 1995, Quirk et al. 1985, Wilson and Sperber 1988), (ii) RQs have the feel of an assertion (Gutiérrez Rexach 1998, Han 2002, Quirk et al. 1985, Rohde 2006, Sadock 1971), and (iii) RQs do not have to but can optionally be answered (Caponigro and Sprouse 2007, Rohde 2006). These characteristics are related: if RQs have the force (or the feel) of assertions, then the speaker does not request an answer; however since RQs are formally questions, an answer is still possible. While for ISQs there is a high degree of uncertainty as to the answer on the part of the speaker, for RQs there is no uncertainty. Instead, the answer is in the common ground and obvious to all interlocutors (Biezma and Rawlins 2017, Caponigro and Sprouse 2007, Rohde 2006) or is intended to be added to the common ground (Biezma and Rawlins 2017). Biezma and Rawlins (2017:307) further argue that for a question to be interpreted as an RQ, it "must conventionally indicate the speaker's attitude [...] that the question they are asking is non-inquisitive in context".

Cues to rhetorical meaning include world knowledge (*Is the Pope catholic?*; example from Han 2002:216), syntactic means such as negative polarity items (*What has John ever done for Sam?*; Han 2002:202), and lexical means such as particles in German (*Wer zahlt schon gerne Steuern?* lit: Who pays PART gladly taxes, 'Who likes paying taxes?'; Bayer and Obenauer 2011:454). However, not all RQs are cued by extra means; instead, ISQs and RQs may be identical surface-syntactically, and some particles, such as German *denn*, occur in both ISQs and RQs (Thurmair 1991). It is a common assumption that prosodic parameters help cue the interpretation of a given interrogative as ISQ or RQ (e.g., (Biezma and Rawlins 2017, Gutiérrez Rexach 1998). However, the exact difference in the prosody of ISQs vs. RQs often remains unspecified; prosodic parameters have been said to be "hard to pin down" (Biezma and Rawlins, 2017:306, 313) and compared to the prosody of ISQs, the prosody of RQs is understudied.

The present paper presents a study that investigates the prosodic characteristics of polar and *wh*-RQs and ISQs in English, German and Icelandic, and discusses theoretical implications of the results. The remainder of this section introduces the reader to the intonation of ISQs and RQs as described in previous literature, followed by hypotheses for the current study. Section 2 reports on a production experiment carried out with parallel materials in the three languages. Section 3 discusses the results, making an important contribution to our knowledge about question intonation and the prosodic means to mark illocution type in interrogatives (ISQ vs. RQ). Section 4 is a conclusion.

1.2   The intonation of information-seeking and rhetorical questions

1.2.1   The intonation of information-seeking questions
According to previous studies, English polar ISQs are predominantly realized with a low rise, i.e. L* H-H% in autosegmental-metrical phonology (Bartels 1999, Hedberg and Sosa 2002, Hedberg et al. 2010, Pierrehumbert and Hirschberg 1990, Schubiger 1958).

Moreover, the high rise (H* H-H%) frequently occurs with polar ISQs in English (e.g., Bartels 1999, Hedberg et al. 2017).

Polar ISQs in German have also been described as ending in a final rise by von Essen (1964) and Féry (1993), but falling polar questions have also been reported in the literature; see e.g. Selting (1995) for North-West German speakers, and Kügler (2003) for Upper Saxon German speakers. Analyzing the intonational terminus in questions in German appointment-making dialogues, Kohler (2004) found that polar questions were predominantly rising (70%; high rise: 40%, low rise 30%), but also that a considerable proportion (21% of the polar questions) was falling. Kügler (2003) considers the possibility that falling polar questions are more frequent in spontaneous than in read speech.

Unlike in English and German, the default intonational contour of polar questions in Icelandic ends in a low boundary tone L% (Árnason 1998, 2005, 2011, Dehé 2018). The typical nuclear pitch accent in Icelandic polar questions is a rise from a low target on the accented syllable (late rise; L*+H), the peak being reached after the end of the nuclear syllable (Árnason 2011). Combined with the low boundary tone, the typical nuclear contour is thus a rising-falling one (L*+H L%).

Wh-ISQs are generally assumed to be falling to L% in all three languages. In English, they are typically assumed to be produced with a nuclear high fall, i.e. H* L-L% (Bartels 1999, Hedberg and Sosa 2002, Hedberg et al. 2010, Pierrehumbert and Hirschberg 1990, Schubiger 1958). Hedberg and Sosa (2002) also find that the *wh*-word almost always has a prenuclear accent, which in their data is typically L*+H. In German, *wh*-ISQs are also typically falling (e.g., Féry 1993, Grice et al. 2005, Isačenko and Schädlich 1966, Oppenrieder 1988, Pheby 1969, von Essen 1964), although in his study, Kohler (2004) finds rising *wh*-questions (34% of the *wh*-questions in his data set) along with falling ones (57%). In Icelandic, the typical contour of a *wh*-ISQ starts high, has an optional high peak (H*) prenuclear accent associated with the *wh*-word, followed by a H* nuclear accent, and is then falling towards L% (Árnason 2005:476-477). Note that for Icelandic it has been argued that it is the nuclear accent rather than the boundary tone that distinguishes between illocution types. Specifically, the early rise (L+H*) is found in statements (Árnason 2011:322-323, Dehé 2010), the late rise (L*+H) in polar questions (Árnason 2011:322-323), and the high peak accent (H*) in *wh*-questions (Árnason 2005:476-477). Nuclear accents are followed by a fall to L% in all three utterance types unless special connotations demand otherwise.

1.2.2   The intonation of rhetorical questions
Previous literature on the intonation of RQs is essentially limited to English. It seems to be uncontroversial that the semantic-pragmatic differences between (string-identical) ISQs and RQs are cued by prosody. The exact phonological and phonetic features of RQs, however, are not so clear and are conflicting at times, and a systematic comparison between the intonation of ISQs and RQs is as yet missing in the literature.

Quirk et al. (1985:826) maintain that polar RQs "have the normal rising intonation of a yes-no question, and are distinguished chiefly by the range of pitch movement", although they do not provide actual prosodic data or say whether RQs have a wider or narrower pitch range than ISQs. Based on her assumption that RQs have the illocutionary force of an assertion, and likewise without providing empirical evidence, Han (2002) assumes the opposite. Specifically, she maintains that polar RQs have the intonational contour of an

assertion, and are thus realized with falling intonation, like declaratives expressing assertions, but unlike polar ISQs. Banuazizi and Creswell (1999) investigated the intonation of polar questions based on data taken from the Switchboard corpus of telephone conversations. They analyzed a total of 102 polar RQs and 2106 polar ISQs. Of the 102 RQs, 45 (44.1%) were falls and 57 (55.9%) were rises, compared with 89.7% of rises for polar ISQs. Banuazizi and Creswell (1999) link the default intonational rise in "genuine" polar questions to the sincerity conditions that they must meet. RQs, they argue, violate these conditions. In particular, in the speaker's mind, the answer to an RQ is "either perfectly obvious or perfectly obviously knowable". An answer is therefore not required or expected to an RQ, and there is therefore no need for an intonational rise. This explains the higher frequency of final falls with polar RQs than with polar ISQs in their corpus data (44.1% vs. 10.3%), but it does not explain the high percentage of rises found in RQs (55.9%). According to Bartels (1999:ch. 8.2), whose study is mostly based on fictive data, polar RQs may be rising or falling, depending on polarity (positive vs. negative sentence radical) and speaker commitment to the proposition. Specifically, in her examples, H-H% cues "the speaker's commitment to the polar opposite of [the surface] proposition" (Bartels 1999:255), whereas L-L% cues assertiveness.

Rhetorical *wh*-RQs have been claimed to be realized with a rise-fall, "less commonly a simple falling tone" (Quirk et al. 1985:826). In her theoretical study, Han (2002) assumes for *wh*-questions "that the intonational contour serves as a cue that a *wh*-question is a rhetorical question that expresses an assertion" (Han 2002:217), but does not specify exactly how this is done. Since assertions typically have falling intonation, we may infer that Han assumes *wh*-RQs to have falling intonation, too. However, since *wh*-ISQs are also falling, this would not distinguish *wh*-ISQs from *wh*-RQs. So while Han seems to advocate an intonational distinction between (assertive) RQs and (non-assertive) ISQ, for *wh*-questions it is not clear what this difference would be. According to Bartels (1999:ch. 8.2), *wh*-RQs, like polar RQs, may have either rising or falling intonation, but the reasoning is different for the two question types. For *wh*-questions, she argues, non-tonal cues (e.g., the context) are responsible for interrogative utterances to be interpreted as questions or statements, i.e. in *wh*-questions (unlike in polar questions) "L- does *not* necessarily indicate non-questionhood" (Bartels 1999:257; italics in original). Factors affecting the intonation of *wh*-questions according to Bartels include politeness strategies (see also Banuazizi and Creswell 1999) and didactic stratagems.

1.2.3   Intonation: Summary
The intonational patterns of ISQs and RQs as outlined above are summarized in (1) for all three languages. Note that the contours provided for ISQs are based on experimental and corpus work, whereas the contours for RQs are mostly based on theoretical work and introspective data, i.e. they do not rest on actual prosodic evidence. Stylized intonation contours are provided for illustration.

(1)   *Typical nuclear contours of ISQs and RQs in English, German and Icelandic, as described in previous literature (n/a: no information available in literature)*

		English	German	Icelandic
Polar	ISQ	Rise: L* H-H%, H* H-H%	Rise: L* H-^H%	Rise-fall: L*+H L L%
	RQ	Rise or fall	n/a	n/a
Wh	ISQ	Fall: H* L-L%	Fall: H* L-%	Fall: H* L L%
	RQ	Rise-fall, rise or fall	n/a	n/a

1.3   Hypotheses

Hypothesis H1 follows directly from the literature survey in Section 1.2. Several authors assume intonational differences between ISQs and RQs, although the specific parameters contributing to these differences have not previously been approached experimentally and remain unclear in previous literature. Hypothesis H2 goes beyond the assumptions in most of the literature. While some authors limit their discussion to final edge tones (e.g. Bartels 1999, Han 2002), the current study takes into account further intonational categories in earlier parts of the intonational contour, specifically prenuclear and nuclear pitch accents, to investigate the intonational differences between illocution types. Hypothesis H3 adds one phonetic parameter – duration – to the intonational ones. Hypothesis H4 relates to the assumption that certain differences between ISQs and RQs may be language-specific.

H1.   In production, ISQs and RQs generally differ in their intonational realization.
H2.   In intonation, boundary tones, nuclear and prenuclear pitch accents contribute to the overall different prosodic realization of ISQs and RQs.
H3.   Along with intonational parameters, phonetic parameters (e.g. duration) are responsible for the overall different prosodic realization of ISQs and RQs.
H4.   All languages investigated here make use of intonational categories to signal illocution type. The exact way of doing this may be language-specific.

2.   Production experiment

A production experiment was designed and carried out in English, German and Icelandic to test hypotheses H1 through H4.

2.1   Method

2.1.1   Materials
Eleven pairs of *wh*- and 11 pairs of polar interrogatives and accompanying contexts were constructed. Target interrogatives and contexts were originally constructed in German and

were translated into English and Icelandic as closely as possible by native speakers of the respective language. All German target interrogatives included the particle *denn*, which is known to appear in both polar and *wh*-questions (Thurmair 1991). The particle was removed in the translations. One question pair was removed in the English and Icelandic versions, leaving 21 pairs in these two languages. Each question was felicitous in an information-seeking context as well as a rhetorical one, resulting in 22/21 quadruples (examples in (2)-(3); German and Icelandic targets in (4) and (5), respectively).[1] In contexts triggering an ISQ reading of the target interrogative, the answer was obviously not known to the speaker and would thus have been highly informative. The description of the context situation was therefore followed by a sentence starting 'You would like to know' or similar (see left-hand columns in (2) and (3)). In contexts triggering an RQ reading of the target interrogative, there was no uncertainty about the answer. Instead, the answer to the RQ was obvious from the context, i.e. common ground in the given situation. This was achieved by the string 'It is well known that' or similar (see right-hand columns in (2) and (3)).

(2) *Contexts and target polar interrogatives*

Context for ISQ	Context for RQ
At a garden party, you offer canapés with Limburger cheese. You would like to know which of the guests eat this and whether they want some of it or not. You say to the guests:	Your friend offers his guests a cheese tray, including Limburger. However, it is well known that none of your friends like stinky cheese and therefore, nobody will touch it. You say to your friend:
Target: Does anyone eat Limburger?	

(3) *Contexts and target wh-interrogatives*

Context for ISQ	Context for RQ
At a garden party, you offer canapés with Limburger cheese. You would like to know which of the guests eat this and want some of it. You say to the guests:	Your friend offers his guests a cheese tray, including Limburger. However, it is well known that none of your friends like stinky cheese and therefore, nobody will touch it. You say to your friend:
Target: Who eats Limburger?	

(4) *German target interrogatives*   (5) *Icelandic target interrogatives*

a. Mag denn jemand Sellerie?   a. Borðar einhver límónur?
   Likes PART anyone celery   Eats   anyone limes
   'Does anyone like celery?'   'Does anyone eat limes?'

b. Wer mag denn Sellerie?   b. Hver borðar límónur?
   Who likes PART celery   Who eats   limes
   'Who likes celery?'   'Who eats limes?'

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[1] Note that unlike English, German and Icelandic do not have *do*-support in polar questions, thus the lexical verb is in initial position in German and Icelandic polar questions.

In addition to the target items, fillers were created in each language (28 German, 28 English, 34 Icelandic). They were mostly exclamatives (e.g. English: How crazy he is!; Has Benni grown!), and they, too, had appropriate contexts.

2.1.2 Procedure

Two basic experimental lists were constructed. Each list contained both questions types (polar and *wh*), and both illocution types (ISQ and RQ). In the English and Icelandic versions, the members of the quadruplets were distributed across the two lists such that one list contained 11 polar and 10 *wh*-questions, the other list contained 10 polar and 11 *wh*-questions. In the German version, each list contained the polar question for half of the question-pairs and the *wh*-question for the other half. Illocution type was thus manipulated within-subjects. The same polar or *wh*-question occurred twice in each list, one in an ISQ context, the other in an RQ context. For example, the items in (2) were members of list 1, the items in (3) appeared in list 2. The filler items were added to both lists. The participants were randomly assigned to one of the two lists. The lists were randomized for each participant separately in such a way that the two readings of a question were separated by at least four other trials. Each experiment started with four familiarization trials (three in the Icelandic version). These were followed by a short break, during which the participants were allowed to ask questions. The experiment was controlled using the experimental software Presentation (Neurobehavioral-Systems, 2000). Each trial started with the visual display of the context, which the participant had to read silently. After a button press, the target interrogative appeared on the same screen. The participants were instructed to read each context carefully and to utter the target and filler sentences as naturally as possible and in such a way that they were suitable in the given context. The recording started with the appearance of the target interrogative on the screen. The participants pressed a button to proceed to the next trial. The recording was stopped at this point. Participants were allowed to repeat the target in case of mistakes. The experiment was self-paced and lasted about 25 to 30 minutes. No feedback was provided during the experiment. The contexts were presented in black Calibri 40 font and the target sentences in blue Calibri 40 font, all on white background. Productions were recorded using a headset-microphone (Shure SM10A) and digitized directly onto a PC (44.1 kHz, 16Bit, stereo).

2.1.3 Participants

The participants entering the analysis were 21 native speakers of North American English from Canada (7 male, 14 female; average age = 22.5 years), 20 monolingual native speakers of German (15 female, 5 male; average age = 21.7 years) and 17 native speakers of Icelandic (6 male, 11 female, average age = 26.9 years). They were tested in sound-attenuated rooms at the University of Alberta, Canada, the University of Konstanz, Germany, and the University of Iceland, respectively. The participants were unaware of the purpose of the experiment. None of them reported any speaking or hearing disorders.

2.1.4 Data treatment and analysis

Overall, 918 English, 880 German, and 714 Icelandic target interrogatives were produced. Of these, all target interrogatives containing slips of the tongue, speech errors, omissions or inclusions of lexical material, or stammering or laughter on the part of the speaker were

removed from the analysis. In addition, two quadruples were completely removed from the Icelandic data set because they contained non-native object nouns (*Lambada, Bolognese*), which were produced with varying, often non-native placement of word stress. This procedure left 862 English (433 polar: 218 ISQs, 215 RQs; 429 *wh*: 213 ISQs, 216 RQs), 851 German (423 polar: 213 ISQs, 210 RQs; 428 *wh*: 213 ISQs, 215 RQs), and 645 Icelandic (313 polar: 156 ISQs, 157 RQs; 332 *wh*: 166 ISQs, 166 RQs) target interrogatives for analysis.

All target interrogatives were annotated in Praat (Boersma and Weenink 2017). The phonological analysis of the English and German data was done following ToBI (Beckman and Elam 1997, Beckman, Hirschberg, and Shattuck-Hufnagel 2005, Silverman et al. 1992) and GToBI (German ToBI; Grice and Baumann 2002, Grice et al. 2005), respectively. The phonological analysis of the Icelandic data was done following previous intonational analyses of Icelandic in the autosegmental-metrical framework (e.g., Dehé 2010, Dehé 2018). Boundary tones, nuclear accents and prenuclear accents were annotated in all languages. See (6) for an example from the Icelandic data set.[2]

(6)   *Annotated Icelandic target interrogative (polar RQ, female speaker vp28): CIt: beginning of onset consonant of target (stressed) syllable (σt); Vt: beginning of vowel of σt; CIf: beginning of onset consonant of syllable following σt; Vf: beginning of vowel of syllable following σt; ef: end of syllable following σt; '0' on the tonal tier indicates the absence of a prenuclear accent on the respective word.*
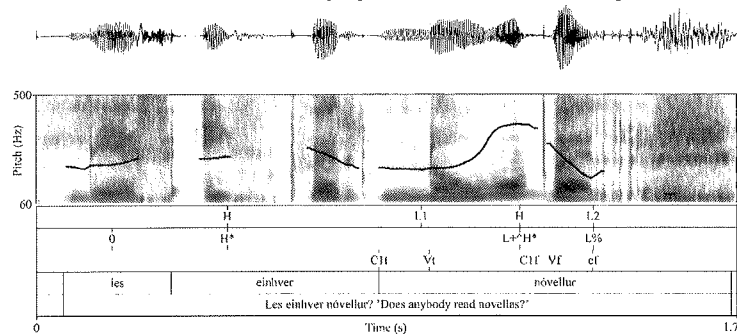
The duration of the relevant constituents was automatically extracted from the annotation. For the statistical analysis of accent types and boundary tones, logistic mixed effect regression models were run with illocution type (ISQ vs. RQ) as fixed factor and participants and items as crossed random factors (adjustment of intercepts). For dependent variables with more than two levels, one level was coded 1 and all other levels 0 (Agresti

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[2] Note some relevant notational differences between ToBI and GToBI. For example, ^ in GToBI marks the upstep of a tone in accents and at boundaries, i.e. ^H% marks a high boundary, which is higher than preceding peaks in the same utterance. H-^H%, H-% and L-% are labels according to GToBI, which are not identical to the original ToBI for English. H-^H% in GToBI corresponds to H-H% in ToBI, L-% in GToBI corresponds to L-L% in ToBI. Since a ToBI framework does not yet exist for Icelandic, the annotation of the Icelandic data generally follows the original ToBI, and borrows ^ for upstep from GToBI.

2002). For the statistical analysis of duration, linear mixed effect regression models were run with the same specifications and model fitting as described above. P-values were calculated using the Satterthwaite approximation of degrees-of-freedom. To avoid Type I errors, p-values were adjusted by means of the Benjamini-Hochberg correction (Benjamini and Hochberg 1995).

2.2   Results

This section reports the results of the phonological (intonational) and phonetic analyses, i.e. for boundary tones, nuclear and prenuclear accents, and duration. Within parameters, results are first reported for polar questions, followed by *wh*-questions. The focus is on the relevant differences between illocution types (ISQs vs. RQs) and languages (English, German, Icelandic).

2.2.1   Boundary tones

The results for boundary tones are summarized in (7) for the three languages. They show that in polar questions, English and German make use of the boundary tone to distinguish between ISQs and RQs, but Icelandic does not. In *wh*-questions, the boundary tone is relevant in German only.

(7)   *Distribution of final boundary tones across question types and illocution types; statistically significant differences are marked by asterisks; n.s.: not significant*

		English		German		Icelandic	
polar questions	ISQ	82% H-H% 9% H-L%	***	83% H-^H% 4% H-%	***	95.5% L%	n.s.
	RQ	46% H-H% 53% H-L%		27% H-^H% 62% H-%		100% L%	
wh-questions	ISQ	89% L-L%	n.s.	48% L-% 28% L-H% 20% H-^H%	***	88% L%	n.s.
	RQ	87% L-L%		95% L-%		100% L%	

In English polar questions, the steep rise to a high terminal (H-H%) was overall very frequent in both ISQs and RQs. However, it was significantly more frequent in polar ISQs than in polar RQs (ß=2.7, SE=0.8, z=3.4, p<0.0001, $p_{adjusted}$=0.0006). At the same time, RQs were comparatively more often realized with a mid-high final plateau (H-L%) in polar RQs than in polar ISQs (ß=5.0, SE=2.0, z=2.4, p<0.01, $p_{adjusted}$<0.02), i.e. RQs did not have as many steep rises as ISQs. A similar difference was found for German polar questions. High rises (H-^H%) were significantly more frequent in ISQs (ß=2.8, SE=0.3, z=10.1, p=$p_{adjusted}$<0.0001), while high plateaus (H-%) were significantly more frequent in RQs (ß=5.5, SE=1.5, z=3.8, p=0.0002, $p_{adjusted}$=0.0004). In Icelandic polar questions, however, L% was found in almost all ISQs and in all RQs.

In English *wh*-questions, the most frequent edge tone was L-L% in both ISQs and RQs, i.e. *wh*-questions were predominantly falling regardless of illocution type, thus there was no effect of illocution type on edge tone. The results are very similar for Icelandic *wh*-questions. For Icelandic, it was impossible to compare the distribution of L% boundary

tones statistically across illocution types because of 100% L% occurrence in RQs, but L% was most frequent in *wh*-ISQs, too. In German *wh*-questions, on the other hand, illocution type did have an effect on boundary tone. Specifically, while *wh*-RQs most often terminated in L-%, there was a lot more variation within ISQs, thus L-% was significantly more frequent in RQs (ß=4.1, SE=1.0, z=4.0, p<0.0001, $p_{adjusted}$=0.0002).

2.2.2 Nuclear pitch accents

Three characteristics of nuclear pitch accents contribute to the distinction between ISQs and RQs: (i) the 'type' of accent, specifically whether it is monotonal (e.g. L*, H*) or bitonal (e.g. rising L*+H, L+H*), (ii) the timing of the rise in L+H accents (early rise L+H* vs. late rise L*+H), and (iii) their position. However, not all characteristics are relevant in all three languages, or not in the same way. In particular, all three languages make use of the distinction between monotonal and bitonal pitch accents to signal illocution type, but while German does so in polar questions, English and Icelandic do so in *wh*-questions. The timing of the rise in L+H accents is relevant in Icelandic polar questions and in German *wh*-questions, but not in English. The position of the nuclear accent plays a role in English, but not in German or Icelandic. Taken together, both question types (polar and *wh*) make use of the pitch accent to distinguish between ISQs and RQs in all three languages, but in different ways. The specific results for each language are reported immediately below, beginning with polar questions. Examples for the three characteristics of pitch accents are given as we go along.

In English polar questions, the nuclear accent was most often realized on the object noun in both ISQs and RQs (ISQ: 93.6%; RQ: 71.2%). The most frequent accent type was L*, but there were significantly more L* accents in ISQs than in RQs (ß=2.8, SE=1.0, z=2.8, p=0.005, $p_{adjusted}$=0.02). There were more cases of unaccented objects in RQs (28.8%) than in ISQs (6.4%), a difference that was significant (ß=-8.0, SE=2.8, z=2.8, p=0.03, $p_{adjusted}$=0.04). When the object was unaccented, the nuclear accent was realized on the subject (*anyone*); typically this accent was L*+H. The position of the nuclear accent is illustrated in (8). The polar ISQ (left) has a prenuclear L*+H accent on the subject *anyone* and a nuclear L* accent on the object noun, followed by a rise to H-H%. In the polar RQ (right), the object noun is unaccented. Instead, the nuclear accent (L*+H) is realized on the subject *anyone*. The contour terminates in a mid-high plateau H-L%.

(8)   *Position of the nuclear pitch accent: English ISQ (left) with nuclear accent (L*) on object, and RQ (right) with nuclear accent (L*+H) on subject*
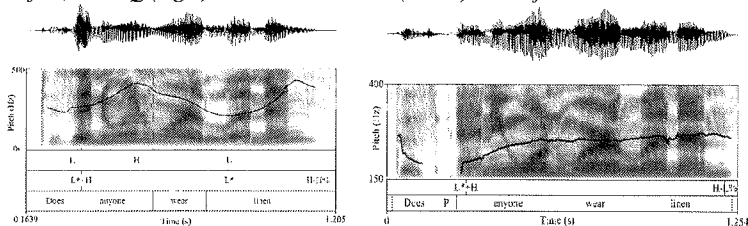
In Icelandic polar questions, the nuclear accent was realized on the object noun throughout. Both polar ISQs and polar RQs were typically realized with a rising bitonal nuclear pitch accent (L+H), but the rises in the two illocution types differed in timing. The most frequent nuclear pitch accent in polar ISQs was the late rise (L*+H and L*+^H, together 55.8%), followed in frequency by the early rise (L+H* and L+^H*, together 41%). In Icelandic polar RQs, the most frequent accent type was the early rise (L+H*, L+!H* and L+^H*), adding up to 68.2%). This was followed in frequency by late rises (L*+H, L*+!H L+^H*), together 28%). Late rises were significantly more frequent in ISQs than in RQs (β=1.9, SE=0.3, z=5.6, p<0.0001), while early rises were significantly more frequent in RQs than in ISQs (β=2.8, SE=0.5, z=6.3, p<0.0001).

The timing of the nuclear rise is illustrated in (9), using the Icelandic polar question *Les einhver nóvellur?* 'Does anyone read novellas?'. The polar ISQ (left) is realized with a late rise (L*+H), i.e. the low target is located in the vowel of the accented syllable, and the peak is reached outside the nuclear syllable, here within the geminate consonant /l.l/ at the boundary of the second and third syllables of the object noun *nóvellur*. The polar RQ (right) is realized with an early rise (L+H*). Both L and H are aligned in the nuclear syllable. The peak is reached within the vowel of the nuclear syllable (interval Vt to C1f).

(9)   *Timing of the rise: Late rise (ISQ; left) vs. early rise (RQ; right) in polar questions, zooming in to nuclear area; nuclear syllable <nó> marked by rectangle*
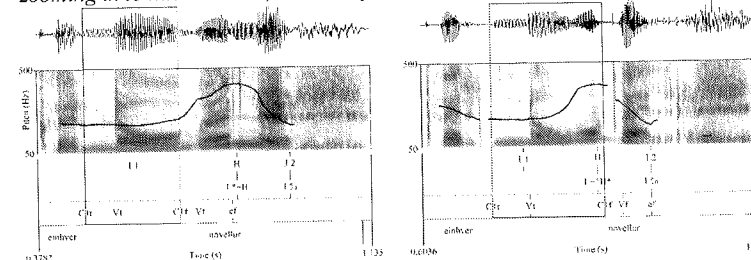

In German polar questions, the type of accent contributes to the distinction between ISQs and RQs. In polar ISQs, monotonal L* was the most frequent nuclear accent (80%). In polar RQs, on the other hand, the late rise (L*+H) was the most frequent nuclear accent (59%), followed by monotonal L* (27%). These distributional differences were confirmed by the statistical analysis. There were significantly more L* in polar ISQs than in polar RQs (ß=2.3, SE=0.8, z=2.8, p=0.005, $p_{adjusted}$=0.008), and significantly more L*+H in RQs than in ISQs (ß=4.0, SE=1.0, z=2.1, p=$p_{adjusted}$=0.04).

In *wh*-questions, the position of the nuclear accent was on the noun in all three languages, with very few exceptions. English and Icelandic make use of accent type (monotonal vs. bitonal) to distinguish between *wh*-ISQs and *wh*-RQs. In English *wh*-ISQs, the most frequent nuclear accent was !H* (41.8%). This accent occurred in only 26.9% of *wh*-RQs. Together with ^H* (2.3%) and H* (10.8%) in *wh*-ISQs (0% and 0.5% respectively in *wh*-RQs), the nuclear peak accent occurred in 55% of *wh*-ISQs. The results of the statistical analysis confirmed that the monotonal !H* or H* (combined category) is significantly more often realized in *wh*-ISQs than in *wh*-RQs (ß=1.4, SE=0.3, z=4.2,

p<0.001, $p_{adjusted}$=0.002). In English *wh*-RQs, the most frequent nuclear accent was the bitonal (early rise) L+!H* (59.3%), which in turn occurred in only 26.3% of *wh*-ISQs. The results of the statistical analysis showed significantly more nuclear L+!H* accents in RQs than in ISQs (ß=2.3, SE=0.5, z=4.6, p<0.001, $p_{adjusted}$=0.002). Like in English, the most frequent nuclear pitch accent in Icelandic *wh*-ISQs was the monotonal peak accent (H*, !H* and ^H*, together 60.2%). This was followed in frequency by the early rise (L+H*, L+!H* and L+^H*, together 36.7%). In Icelandic *wh*-RQs, early rises (L+H*, L+!H*, L+^H*) were typical (together 80.1%), while late rises (L*+H, L*+!H, L*+H) and monotonal accents were rare (6.6% and 13.2%, respectively). The results of the statistical analysis showed more monotonal accents in *wh*-ISQs than in *wh*-RQs (ß=3.6, SE=0.8, z=4.4, p<0.0001), more early rises in *wh*-RQs than in *wh*-ISQs (ß=2.0, SE=0.3, z=6.4, p<0.0001), and no difference in late rises (p>0.1).

The difference between monotonal and bitonal nuclear accents is illustrated in (10), using an English *wh*-question as an example. The ISQ (left) is realized with a monotonal nuclear peak accent (!H*) associated with *linen*. The RQ (right) has a bitonal nuclear accent (L+!H*) on *Limburger*.

(10)   *Type of nuclear pitch accent: Monotonal (ISQ; left) vs. bitonal (RQ; right) nuclear*
       accent in English wh-questions; nuclear accent associated with the object noun
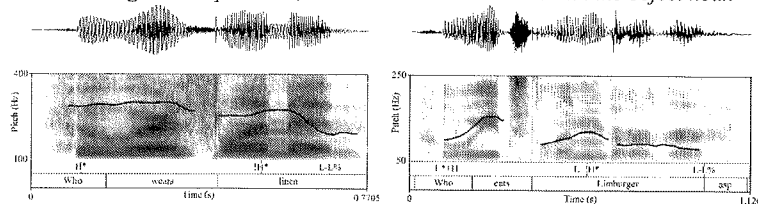
Unlike in English and Icelandic, bitonal (rising) pitch accents were most frequent in both illocution types (ISQ and RQ) in German *wh*-questions, but here the timing of the rise matters. The most frequent nuclear accent in *wh*-ISQs was the early rise (L+H*; 38%), followed by L* (24%), H+L* (18%), and L*+H (13%). In *wh*-RQs, on the other hand, L*+H was the most frequent nuclear accent (64%), while L+H* occurred in only 19% of cases. The results of the statistical analysis showed significantly more L+H* accents in *wh*-ISQs than in *wh*-RQs (ß=1.1, SE=0.2, z=4.5, p=$p_{adjusted}$<0.0001), and more L*+H accents in *wh*-RQs than in *wh*-ISQs (ß=3.7, SE=0.4, z=9.8, p=$p_{adjusted}$<0.0001).

2.2.3 Prenuclear pitch accents

The prenuclear region precedes the nuclear accent. If the nuclear accent is associated with the syntactic object, the prenuclear region comprises the auxiliary, the subject *anyone* and the lexical verb in polar questions, and the *wh*-word and lexical verb in *wh*-questions. In German, the particle *denn* is also part of the prenuclear region. If the nuclear accent is on the subject (specifically in English polar questions), the prenuclear region is limited to the (auxiliary) verb that precedes the subject. According to the present results, both the presence of a prenuclear accent on a given lexical item and the type of accent play a role. In English and Icelandic polar questions, the presence vs. absence of a prenuclear accent is

particularly relevant, with generally more prenuclear accents in RQs than in ISQs. In *wh*-questions, the type of accent matters most in English, and both features matter in Icelandic. In German polar questions, the accent type also plays a role. Unlike in English and Icelandic, the distribution of prenuclear accents contributes to the distinction between ISQs and RQs in German *wh*-questions, with more unaccented *wh*-pronouns but more accented verbs in RQs than in ISQs. The results are reported in more detail immediately below.

In English polar questions, the sentence-initial auxiliary (*does*) was unaccented almost across the board in both ISQs (98%) and RQs (99.3%). The lexical verb was mostly unaccented in ISQs (74.8%) than in RQs (55.8%), and the difference was statistically significant (ß=9.0, SE=3.4, z=2.6, p=0.008, $p_{adjusted}$=0.02). In Icelandic polar questions, the sentence-initial verb was mostly unaccented in ISQs (65.4%), but mostly accented in RQs (67.5%). The difference was statistically significant (ß=2.0, SE=0.5, z=4.1, p<0.0001). Within accented verbs in RQs, the most frequent accent type was L*+H, which occurred significantly more frequently in RQs than in ISQs (ß=3.5, SE=1.1, z=3.1, p=0.001). The subject in Icelandic polar questions was mostly unaccented in both illocution types, but significantly more so in ISQs than in RQs (ß=2.9, SE=0.6, z=4.6, p<0.0001). In German polar questions, both the modal particle *denn* and the subject *jemand* 'anyone' were typically unaccented. The verb was more often accented than unaccented, and if it was accented, it was most often realized with H* in both illocution types (ISQs: 52.1%; RQs: 45.7%). However, there were significantly more L*+H in RQs (30.0%) than in ISQs (20.7%) (ß=0.8, SE=0.3, z=2.8, p=0.005, $p_{adjusted}$=0.008).

In English *wh*-questions, there was no difference in frequency of prenuclear accent placement on the *wh*-word or the verb between ISQ and RQ. However, there was a difference in accent type. If accented, the *wh*-word was more often realized with an L*+H accent in RQs (70.4%) than in ISQs (46.9%), a difference that was statistically significant (ß=1.3, SE=0.2, z=5.4, p<0.0001, $p_{adjusted}$=0.0009). Conversely, there were significantly more H* accents in ISQs (34.7%) than in RQs (14.8%) (ß=1.4, SE=0.27, z=5.1, p<0.0001, $p_{adjusted}$=0.0009). This difference can be observed in (10) above. The *wh*-pronoun has a prenuclear monotonal peak accent (H*) in the ISQ (left), but it has a prenuclear bitonal L*+H accent in the RQ (right). In Icelandic *wh*-questions, approximately a third of the *wh*-words was unaccented (ISQ: 34.3%, RQ: 36.7%; difference not significant). Among the accented *wh*-words, L*+H was most frequent in RQs, and it was significantly more frequent in RQs than in ISQs (ß=2.6, SE=0.4, z=5.9, p<0.0001). Among the accented *wh*-words in ISQs, L* was most frequent (57.9%), and it was significantly more frequent in ISQs than in RQs (ß=1.0, SE=0.3, z=3.5, p=0.0004). Within accented *wh*-words, there were generally mostly monotonal accents in ISQs (H* and L* together 91.7%), while in RQs there were slightly more bitonal accents (53.3%). This effect of illocution type was significant such that there were more monotonal prenuclear accents on *wh*-words in ISQs than in RQs (ß=3.1, SE=0.5, z=5.9, p<0.0001). Also for Icelandic *wh*-questions, verbs were mostly unaccented (ISQ: 96.4%, RQ: 62.7%), although there were significantly more unaccented verbs in ISQs than in RQs (ß=3.1, SE=0.5, z=6.4, p<0.0001). The most frequent prenuclear accent on the verb in *wh*-RQs was H*.

In German *wh*-questions, the *wh*-pronoun was mostly unaccented in both illocution types, but significantly more so in RQs (ISQs: 61.9%; RQs: 75.1%; ß=0.8, SE=0.3, z=2.7, p=0.007, $p_{adjusted}$=0.008). There were significantly more unaccented verbs in ISQs (45.1%)

than in RQs (31.5%) (ß=0.9, SE=0.3, z=2.7, p=0.006, $p_{adjusted}$=0.009). The most frequent accent type on verbs in RQs was the monotonal H* (47.4%), which was significantly more frequent in RQs than in ISQs (38.6%) (ß=0.5, SE=0.2, z=2.0, p=$p_{adjusted}$=0.05). Finally, the particle *denn* was typically unaccented throughout.
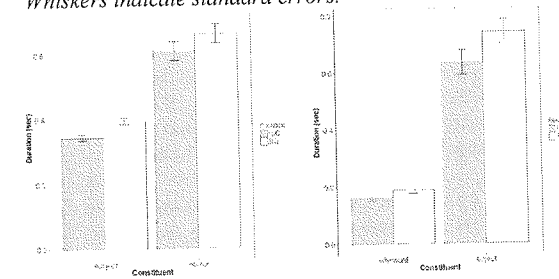
2.2.4 Duration

The results for duration show that in all three languages, utterance duration and the duration of individual constituents is generally longer in RQs than in ISQs. For reasons of space, examples are presented here only from English and Icelandic (but see Section 3 for German). The results reported on here are plotted in (11) and (12) for English and Icelandic, respectively. In English, we find longer durations for major syntactic constituents in both polar and *wh*-RQs. In polar questions, the subject (*anyone*) was on average 50 ms longer in RQs than in ISQs (ß=50.0, SE=8.1, t=21.0, p<0.01, $p_{adjusted}$<0.02). Likewise, the object was 57 ms longer in RQs than in ISQs (ß=56.9, SE=9.3, t=20.6, p<0.02, $p_{adjusted}$<0.03). In English *wh*-questions, the duration measures showed longer absolute durations of the *wh*-word and the object in RQs compared to ISQs. The *wh*-word was on average 28 ms longer in RQs than in ISQs (ß=28.4, SE=6.8, t=20.9, p<0.004, $p_{adjusted}$<0.007). The duration of the syntactic object was 104 ms longer in RQs than in ISQs (ß=104.2, SE=12.7, t=8.2, p<0.001, $p_{adjusted}$<0.002).

In Icelandic polar questions, the sentence-initial verb was on average 86.7 ms longer in RQs than in ISQs (ß=86.9, SE=0.01, df=16.7, t=6.4, p<0.01). In *wh*-questions, the *wh*-word was on average 58.4 ms longer in RQs than in ISQs (ß=60.7 SE=0.01, df=18.8, t=4.6, p<0.0005). There was also a significant effect of illocution-type on the duration of the nuclear syllable in both question types. The accented syllable was on average 62.9 ms longer in polar RQs than in polar ISQs (ß=62.7, SE=0.007, df=14.0, t=8.2, p<0.0001). In *wh*-questions, the accented syllable was on average 90.7 ms longer in RQs than in ISQs (ß=90.2, SE=0.008, df=18.3, t=11.4, p<0.0001). Within the nuclear syllable, the effect was due to lengthening of both the onset and the rhyme of the syllable; see (12).[3] The onset consonant was on average 29.7 ms longer in polar RQs than in polar ISQs (ß=30.3, SE=0.003, df=14.8, t=9.9, p<0.0001), and 44.9 ms longer in *wh*-RQs than in *wh*-ISQs (ß=43.3, SE=0.004, df=26.4, t=10.7, p<0.0001). The rhyme was on average 32.6 ms longer in polar RQs than in polar ISQs (ß=32.9, SE=0.005, df=19.4, t=7.3, p<0.001), and it was 50.2 ms longer in *wh*-RQs than in *wh*-ISQs (ß=50.6, SE=0.007, df=19.4, t=7.0, p<0.001).

[3] For the analysis of the duration of the onset consonant and the rhyme of the nuclear syllable, all items were excluded whose stressed syllable started with a vowel (e.g. innmat 'innards'), unless these vowels were preceded by a syllable-initial (onset) glottal stop. 543 items remained for analysis (272 wh: 136 ISQ, 136 RQ; 271 polar: 135 ISQ, 136 RQ).

(11) *Average durations of major syntactic constituents across illocution types in English; left-hand panel: polar questions; right-hand panel:* wh-*questions. Whiskers indicate standard errors.*

(12) *Duration of onset and rhyme in nuclear syllables in Icelandic; left: polar questions; right:* wh-*questions. Whiskers indicate standard errors.*
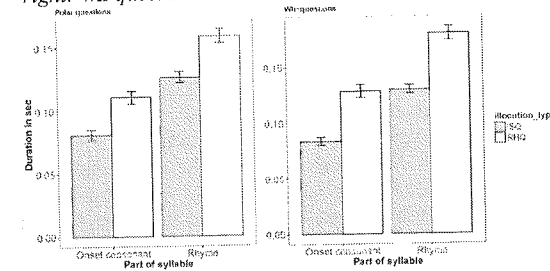
3. Discussion

This paper set out to identify prosodic differences between ISQs and RQs in three languages: English, German and Icelandic. Intonational and phonetic parameters were tested (boundary tones, nuclear and prenuclear pitch accents, duration). This section discusses the results and their implications. The hypotheses are repeated directly below.

H1. In production, ISQs and RQs generally differ in their intonational realization.

H2. In intonation, boundary tones, nuclear and prenuclear pitch accents contribute to the overall different prosodic realization of ISQs and RQs.

H3. Along with intonational parameters, phonetic parameters (e.g. duration) are responsible for the overall different prosodic realization of ISQs and RQs.

H4. All languages investigated here make use of intonational categories to signal illocution type. The exact way of doing this may be language-specific.

ISQs and RQs differ in their intonational realization in all three languages, confirming H1 as well as general assumptions in the literature. In line with H2, boundary tones, nuclear

and prenuclear pitch accents all contribute to the overall different prosodic realization of ISQs and RQs. Effects of illocution type were found for all intonational parameters. Along with intonation, duration is also used to convey illocution type, confirming H3. There were overall longer durations in RQs than in ISQs. Duration was reported in Section 2 for English and Icelandic only, but similar effects have been found for German. They were first reported in Wochner et al. (2015), who found overall longer utterance durations for RQs than for ISQs in both polar and *wh*-questions, as well as longer durations of the object noun, *wh*-word and verb in *wh*-RQs than *wh*-ISQs. The Icelandic duration results are interesting from a phonological perspective, because in the literature on Icelandic syllable structure, lengthening of a stressed syllable, e.g. due to emphasis, has been described as lengthening of the rhyme (V in open syllables, coda C in closed syllables; see Árnason 2011 and references given there). The current study shows that speakers lengthen the onset consonant, too, at least to indicate illocution type. In line with H4, all three languages make use of intonational categories to signal illocution type, but the exact way of doing so is indeed language-specific. In particular, the boundary tone has more impact in German than it has in English, and in English, it has in turn more impact than in Icelandic. In German the boundary tone contributes to the distinction between ISQs and RQs in both polar and *wh*-questions. In polar questions, the difference is between a frequent rise in ISQs and a frequent plateau in RQs. Within German *wh*-questions, RQs are mostly falling, but the boundary tone in ISQs is much more varied. In English, on the other hand, the boundary tone contributes to the difference between illocution types only in polar questions, such that ISQs mostly ended in steep rises, while RQs ended in plateaus (H-L%) in more than 50% of the cases. In English *wh*-questions, however, a fall of the intonational contour to L-L% is typical in both ISQs and RQs. In Icelandic, the boundary tone does not mark illocution type at all, because the contour falls to L% almost throughout. Note that the Icelandic tonal inventory does have H%, but H% seems reserved for special connotations and continuation rises (Árnason 1998, 2005, 2011, Dehé 2009).

It is particularly noteworthy that boundary tones do not distinguish between illocution types in all languages or question types. In previous literature, the intonational distinction has sometimes been put down to edge tones alone (Bartels 1999, Han 2002; see Section 2) without taking into account the rest of the utterance, i.e. without considering the intonational contour up to the terminus. The current study clearly shows that it is not enough to focus on the boundary tone, because nuclear and prenuclear pitch accents contribute to the distinction between illocution types, too. Moreover, the present study shows that in cases in which the boundary tone does play a role (German polar and *wh*-questions, English *wh*-questions), it is not enough to distinguish between falls and rises. Instead, a (mid-) high plateau is frequent in English and German polar RQs. One crucial difference between polar ISQs and polar RQs in both English and German is that a steep rise is typical of ISQs (English H-H%, German H-^H%), while we find more than 50% plateaus in RQs (English H-L%, German H-%). Roughly speaking, the result is then a threefold distinction between steep rise in polar ISQs, (mid-) high plateau in polar RQs, and fall (English L-L%, German L-%) in *wh*-questions and declaratives. It almost seems as if the plateau were ideal to terminate an RQ, i.e. an utterance that is interrogative in syntactic form, but but which has the feel of an assertion. Crucially, a fall to L% is not typical of English polar RQs, against Han (2002). The fact that Icelandic does not make use of the boundary tone to mark illocution type is in line with previous findings in the

literature that pitch accents rather than boundary tones signal illocution type (Árnason 2005, 2011).

All three languages investigated here make use of the nuclear pitch accent to distinguish between ISQs and RQs in both polar and *wh*-questions. It is interesting to note that the same characteristics of pitch accents play a role in different languages, but not in the same way. All three languages make use of the distinction between monotonal and bitonal pitch accents in signaling illocution type, but while German does so in polar questions, English and Icelandic do so in *wh*-questions. The timing of the rise in bitonal nuclear accents is relevant in Icelandic polar questions and in German *wh*-questions, but not in English. While Icelandic polar questions use mostly late rises in ISQs and mostly early rises in RQs, in German *wh*-questions we find the opposite. The position of the nuclear accent (placed on syntactic subject vs. object) contributes to the distinction between polar ISQs and polar RQs in English, but not in German or Icelandic.

Along with the nuclear accent, the prenuclear region contributes to the distinction between ISQs and RQs in all three languages in some way. Both the presence of a prenuclear accent on a particular item and the type of pitch accent play a role. It seems that in English and Icelandic polar questions, it is the presence vs. absence of a prenuclear accent that is particularly relevant, while in *wh*-questions it is the type of accent that matters in English and German, and both the presence vs. absence and the type of accent in Icelandic. We find similarities between Icelandic and English such that more and stronger (i.e., bitonal) prenuclear accents are found in RQs than in ISQs.

It follows from all this that the intonational parameters used to signal illocution type may be the same in different languages, but the ways they are employed are language-specific. Notice that the phonetic parameter of duration goes in the same direction in all three languages: RQs have longer durations than ISQs throughout. At the prosody-pragmatics interface, this study shows that intonation as well as duration are used by speakers to distinguish between illocution types, i.e. the results add to the evidence suggesting that prosody, along with other factors (such as the context), helps to distinguish between possible meanings of an utterance. Unlike other studies focusing on RQs, this study identifies a number of actual prosodic means speakers use to mark illocution type. Crucially, speakers employ a range of prosodic parameters, rather than the boundary tone, or the distinction between utterance-final rise or fall, alone, thus the course of the whole intonational contour, as well as its phonetic properties, is relevant, not just the terminus.

4.   Conclusion

The paper contributes to our knowledge about prosodic differences between ISQs and RQs in three Germanic languages: English, German and Icelandic. Crucially, all languages make use of intonational means to signal illocution type, but not all three of them do so in the same way. Given the focus on the terminus of the intonational contour (boundary tone, rise to H% vs. fall to L%) in previous literature, it is important to emphasize that the boundary tone does not contribute to the pragmatic meaning of an interrogative in all languages (here: not in Icelandic) and not in all question types (English: polar questions only). Moreover, three rather than two ways of terminating the contour seem relevant (rise, fall, plateau). Along with intonation, duration signals illocution type. Finally, while there is undoubtedly some variation in the intonational realization of both ISQs and RQs, there

are very clear, and easy-to-pin down prosodic differences between the two illocution types in all three languages under investigation here.

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