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Ambiguity resolution via the syntax-prosody interface: The case of *kya* ‘what’ in Urdu/Hindi

Abstract: This paper focuses on the prosodic realization of Urdu/Hindi *kya* ‘what’ in polar and wh-constituent questions. The wh-word *kya* ‘what’ is polyfunctional in that it is used in wh-constituent questions to mean ‘what’, but also serves as a marker of polar questions. The distribution of *kya* is relatively free in both types of questions, which can lead to syntactically (and therefore semantically) ambiguous structures involving *kya* ‘what’. We show that prosodic information is crucial for the disambiguation of such sentences. We report on a production experiment which establishes that the wh-constituent *kya* is prosodically focused while polar *kya* is accentless. Moreover, the nouns following wh-constituent *kya* have shorter duration as compared with the nouns following polar *kya*, which have longer duration and an LH contour. We show that speakers of Urdu/Hindi are perceptually sensitive to the prosodic properties of wh-constituent and polar *kya* and the following nouns. We take the information established about *kya* ‘what’ and show how the prosodic differences guide syntactic disambiguation at the prosody-syntax interface, which in turn results in the activation of the appropriate semantic information (polar vs. wh-constituent readings of *kya*). We model our analysis within Lexical-Functional Grammar (LFG) and work with Bögel’s framework of the prosody-syntax interface (Bögel 2015, this volume).

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1 Introduction

The study of the role of prosody in Urdu/Hindi¹ questions and how it interacts with the syntax and semantics of questions is in its infancy. Our contribution in this paper focuses on the role of prosodic realization of Urdu/Hindi *kya* ‘what’ in polar and *wh*-constituent questions.

Polar questions in Urdu/Hindi are string identical to declaratives, as shown in (1). The status of (1) as a declarative vs. a polar question is signaled exclusively via prosodic means (see Sect. 3 for details).

- (1) anu=ne uma=ko kitab d-i ?/.
 Anu.F=Erg Uma.F=Dat book.F.Sg.Nom give-Perf.F.Sg
 ‘Did Anu give a/the book to Uma?’ (Polar Question)
 ‘Anu gave a/the book to Uma.’ (Declarative)

In addition, Urdu/Hindi can optionally use *kya* ‘what’ in polar questions, as shown in (2). The literature reports that the default placement for this polar *kya* is the clause initial position (Platts 1884; Masica 1991; Montaut 2004) but Bhatt & Dayal (2020) show that it can in fact scramble among all the major constituents of a clause (see Sect. 3 for details).

- (2) (kya) anu=ne uma=ko kitab d-i?
 what Anu.F=Erg Uma.F=Dat book.F.Sg.Nom give-Perf.F.Sg
 ‘Did Anu give a/the book to Uma?’ (Polar Question)

This ability to appear in different positions in a clause taken together with similar scrambling possibilities for *wh*-constituents (see Sect. 4) leads to potential ambiguities with the *wh*-constituent question use of *kya*. A *wh*-constituent example is shown in (3), ambiguous cases are illustrated below.²

- (3) anu=ne uma=ko kya di-ya?
 Anu.F=Erg Uma.F=Dat what give-Perf.M.Sg
 ‘What did Anu give to Uma?’ (Wh-Constituent Question)

¹ Urdu and Hindi are structurally almost identical, but differ in terms of the writing system they employ. Our data is based on Urdu spoken in Pakistan. Where the data and insights apply to both Urdu and Hindi, we use Urdu/Hindi to refer to the language(s).

² There is (at least) a third use of *kya* that has been identified in the literature, namely as a scope marker in scope marking constructions (Dayal 1996, 2000).

Ambiguities arise particularly naturally in the preverbal position, which is a syntactic focus position and thus also the default/preferred position for the placement of *wh*-constituents.³ We therefore zeroed in on ambiguities in this position and conducted experiments investigating the production and perception of *kya* with regard to examples as in (4). This sentence can be interpreted either as a polar question (4a) or as a *wh*-constituent question (4b) where *kya* ‘what’ is part of an NP.

- (4) a. jahina=ne naz=ko kya [tohfa] di-ya?
 Shahina.F=Erg Naz.F=Dat what present.M.Sg.Nom give-Perf.M.Sg
 ‘Did Shahina give a gift to Naz?’
- b. jahina=ne naz=ko [kya tohfa] di-ya?
 Shahina.F=Erg Naz.F=Dat what present.M.Sg.Nom give-Perf.M.Sg
 ‘What gift did Shahina give to Naz?’

Our investigations show that the *wh*-constituent *kya* is prosodically characterized by a rising contour while polar *kya* is accentless. Furthermore, the nouns following *wh*-constituent *kya* are shorter in duration as compared with the nouns following polar *kya*. Our experiments also show that speakers of Urdu/Hindi are perceptually sensitive to the prosodic properties of *wh*-constituent vs. polar *kya*. We model this effect within Bögel’s (2015) prosody-syntax architecture and show how the prosodic information guides syntactic disambiguation, which in turn results in the activation of the appropriate semantic information for polar vs. *wh*-constituent readings of *kya*.

The paper is structured as follows. Section 2 provides information on Urdu/Hindi intonation. Section 3 discusses the intonation as well as the functions of polar *kya*. Section 4 presents the syntactic and prosodic properties of *wh*-constituent questions that are relevant for the purposes of this paper. Section 5 discusses the ambiguity that arises due to the distributional properties of polar and *wh*-constituent *kya* in more detail. We here present a production and a perception experiment focusing on ambiguities at the preverbal position and establish that the prosodic realization of *kya* is crucial for disambiguation. This information is then used in Sect. 6 to show how examples as in (4) can be disambiguated via the prosody-syntax architecture developed by Bögel (2015). The analysis is complex in the sense that information coming from the various modules of grammar, namely prosody and syntax, must be integrated. However, the analysis is also simple in that the architecture allows a seamless integration of the information, lay-

³ See Butt et al. (2016, 2017) for details on this.

ing the foundation for work on more complex aspects of question formation in Urdu/Hindi. Section 7 concludes the paper.

2 Basic Intonational Characteristics of Urdu/Hindi

In order to understand how prosody can disambiguate between polar and wh-constituent *kyā*, some more general information about the prosody of Urdu/Hindi is in order. In the following sections, we discuss what is known about the basic intonational contour of sentences and the prosodic realization of focus.

2.1 Basic Intonational Patterns

As established early on by Harnsberger (1994), the basic prosodic structure of an Urdu/Hindi clause is a series of LH contours. The precise nature and distribution of these LH contours remains to be established. For example, Harnsberger sees LH contours being associated with content words, but this does not quite hold up as wh-words also receive an LH contour.

Harnsberger (1994, 42) leaves the precise analysis of the LH open. He lists three possibilities: 1) a bitonal pitch accent; 2) an L* pitch accent followed by an H boundary tone; 3) an LH accentual phrase. Our current approach is to follow the analyses in Hayes & Lahiri (1991) and Féry (2010), who work with p(rosodic)-phrases and i(ntonational)-phrases as per the Prosodic Hierarchy (Nespor & Vogel 1986; Selkirk 1995). Féry surveys two Indo-Aryan (Hindi and Bangla) and two Dravidian languages (Tamil and Malayalam) and proposes a new class in the typological space of intonational systems, namely “phrase languages”. Phrase languages are characterized by a phrasal accent which determines the prosodic phrasing (rather than pitch accents). In South Asian languages, this phrasal accent is LH, whereby the association of the L and the H with syllables may vary. Hayes & Lahiri (1991) associate an L* with a stressed syllable in Bengali, but this generalization does not quite seem to work for Urdu/Hindi (e.g., Féry 2010 and confirmed by our own work) and remains the subject of further investigation. Similarly, the H is not necessarily associated with the right edge of the p-phrase, but can vary. One factor we have identified as a source of variation is the use of contrastive focus (Jabeen & Braun 2018), whereby the H tends to align with the last syllable of the noun rather than the case marker in case marked NPs that are focused contrastively.

The clause final intonation is determined by the intonational phrase boundary. In declaratives and *wh*-constituent questions this is generally an L% and in polar questions this is an H%, though we have found some variability in our data (cf. also Moore 1965; Harnsberger 1994; Sect. 3).

An interesting characteristic of Urdu/Hindi declarative intonation is that while sentences show a regular LH f_0 contour on all p-phrases, this does not apply to whatever constituent appears clause-finally (Harnsberger 1994), cf. also Keane (2014) for a similar pattern in Tamil. The clause-final constituent always has a falling intonation. An explanation for this pattern remains to be found.

2.2 Prosody of focus

In terms of prosodic marking of focus, the literature to date has identified differing factors. These include an increased pitch span of the basic LH contour, greater intensity, longer syllable duration within the focused element, and pitch compression after the focused element (Moore 1965; Harnsberger 1994; Dyrud 2001; Patil et al. 2008; Genzel & Kügler 2010; Jabeen et al. 2016; Butt et al. 2016; Jabeen & Braun 2018).

3 Polar Questions

Polar questions in Urdu/Hindi are string identical to the corresponding declarative, as shown in (5) and (6). The difference between question vs. declarative status is signaled via intonation. Declaratives generally have an L% boundary,⁴ while a polar question is signaled by an H% boundary (Fig. 1).

- (5) (jahina=ne norina=ko mara)_{L%}
 Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
 'Shahina hit Norina.' (Declarative)

⁴ Urdu/Hindi also has declaratives with a rising final boundary H% (Patil et al. 2008; Puri 2013). This high boundary tone in declaratives is scaled lower than the high boundary tone in polar questions. Patil et al. report that this final rise in declaratives is not necessarily interpreted as a list intonation by Hindi speakers. More work remains to be done on charting this variation and potential associated differences in interpretation in Urdu/Hindi.

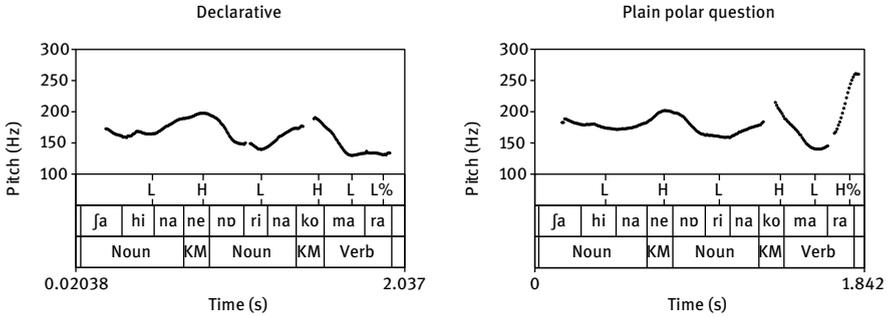


Fig. 1: F₀ contour of a string identical declarative and polar question.

- (6) (jahina=ne norina=ko mara)_{H%}
 Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
 ‘Did Shahina hit Norina?’ (Polar Question)

Examples (7) and (8) show the prosodic analysis we assume for a typical transitive declarative and its polar question variant.

- (7) L H L H L L%
 ((jahina=ne)_p (norina=ko)_p (mara)_p)_I
 Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
 ‘Shahina hit Norina.’ (Declarative)

- (8) L H L H L H%
 ((jahina=ne)_p (norina=ko)_p (mara)_p)_I
 Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
 ‘Did Shahina hit Norina?’ (Polar Question)

3.1 Polar *kya* – Distribution and prosody

Polar questions can optionally use *kya* ‘what’ as shown in (9). This use of *kya* has been dubbed “polar *kya*” by Bhatt & Dayal (2020).

- (9) *kya* jahina=ne norina=ko mar-a?
 what Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
 ‘Did Shahina hit Norina?’

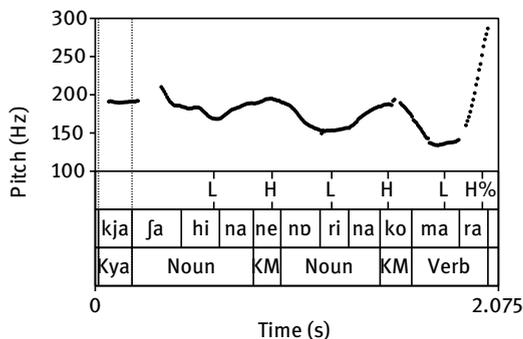


Fig. 2: A polar question with sentence initial *kya*.

Figure 2 shows that, like plain polar questions, a polar question with *kya* ends with a high boundary tone (Harnsberger 1994). Figure 2 also shows that polar *kya* at the sentence initial position is accentless. Harnsberger (1994) has only one example of polar *kya* and he assigns it an LH contour. He reports that polar *kya*, unlike wh-constituent *kya*, is not marked by high F0 register (pitch range). We did not find any instances of polar *kya* with an LH contour in our data but do observe accentless or falling patterns.

The previous, mainly descriptive, literature reports polar *kya* as appearing only clause initially in Urdu/Hindi (Glassman 1977; Platts 1884; Masica 1991; Montaut 2004). However, Bhatt & Dayal (2020) show that polar *kya* can be scrambled among the major constituents of a clause, as illustrated in (10). The prosody of polar *kya* is always flat or falling in any of the possible positions.

- (10) (kya) anu=ne (kya) uma=ko (kya) kitab (%kya)
 what Anu.F=Erg what Uma.F=Dat what book.F.Sg.Nom what
 d-i (kya)?
 give-Perf.F.Sg what
 ‘Did Anu give a/the book to Uma?’

There is one constraint on polar *kya*: it is dispreferred in the immediately preverbal position. We assume that this dispreference is directly related to the fact that the default position for wh-constituent questions is this immediately preverbal position (see Sect. 4).

3.2 Polar *kya* – Function

Masica (1991) shows that polar ‘what’ elements or question particles are pervasive in Indo-Aryan and identifies a typological variation by which they either appear clause initially as in Urdu/Hindi or clause finally as in Bangla or Sinhala (for the latter, see Slade 2011). Despite their optionality in Urdu/Hindi, these question particles were generally taken to have a clause typing function (Montaut 2004; Masica 1991; Cheng 1997).

Bhatt & Dayal (2020) adduce several arguments against this analysis. One argument is that it is optional in matrix clauses, a feature not associated with clause typing question markers in general. Another is that it does not fulfill a clause-typing function exactly where it would have been most useful, namely in embedded clauses. Polar *kya* is generally disallowed in embedded interrogative clauses (11a), which is exactly where one would need a question marker as the interrogative status of the embedded clause cannot be signaled via intonation. On the other hand, polar *kya* is allowed in complements of rogative predicates (Lahiri 2002) such as ‘wonder’ and ‘ask’ (11b).

- (11) a. *anu jan-ti hai [ki kya tum cai
 Anu know-Impf.F.Sg be.Pres.3.Sg that what you tea
 pi-yo-ge?]
 drink-2.Pl-Fut.M.Pl
 Intended: ‘Anu knows whether you will drink tea.’ (Non-rogative)
- b. anu jan-na cah-ti hai [ki kya tum cai
 Anu know-Inf.M.Sg want-Impf.F.Sg be.Pres.3.Sg that what you tea
 pi-yo-ge?]
 drink-2.Pl-Fut.M.Pl
 ‘Anu wants to know whether you will drink tea?’ (Rogative)

In previous versions, Bhatt & Dayal (2020) analyzed the word order variation found with *kya* in terms of given vs. new information, whereby all the information to the left of polar *kya* was considered as given and the material to the right as open to question. Their current analysis sees the difference as being between at-issue (to the right) vs. not (to the left). This analysis is illustrated by data as in (12), which shows that it is infelicitous to question/correct material to the left of polar *kya* (not-at-issue) but it is good to question/correct material to the right of polar *kya* (at-issue).

- (12) A: *anu=ne kya uma=ko tohfa di-ya?*
 Anu.F=Erg what Uma.F=Dat present.M.Sg.Nom give-Perf.M.Sg
 'Did Anu give a/the present to Uma?'
- B: *#nahĩ, asim=ne di-ya*
 no Asim.M=Erg give-Perf.M.Sg
 'No, Asim did.'
- C: *nahĩ, asim=ko di-ya*
 no Asim.M=Dat give-Perf.M.Sg
 'No, to Asim.'

Our own investigation of the prosody of polar *kya* confirms data as in (12) only with respect to a default prosodic structure of a polar question where the entire proposition is in question and the verb is prosodically prominent. However, if another part of the sentence is instead made prominent, that part is available for questioning.

- (13) A. ***anu=ne***_{Prominent} *kya uma=ko tohfa di-ya?*
 Anu.F=Erg what Uma.F=Dat present.M.Sg.Nom give-Perf.M.Sg
 'Did ANU give a/the present to Uma?'
- B. *nahĩ, **asim=ne** di-ya*
 no Asim.M=Erg give-Perf.M.Sg
 'No, Asim did.'

Reacting to our observation, Bhatt & Dayal (2020) present data as in (14) and posit that prosodic prominence may not license just any element in the clause, but is very likely restricted to the adjacent element to the left of polar *kya*. This issue remains to be investigated at greater depth.

- (14) **#*ram=ne***_{Prominent} *sita=ko kya kal kitab*
 Ram.M=Erg Sita.F=Dat what yesterday book.F.Sg.Nom
d-i t^h-i ya mina=ne?
 give-Perf.F.Sg be-Past.F.Sg or Mina.F=Erg
 'Had Ram given a/the book to Sita yesterday or had Mina?'

Our current analysis of polar *kya* follows that of Biezma et al. (2018), who propose that polar *kya* is a focus sensitive operator that associates with the focused mate-

rial. It will either associate with a (left-adjacent) prosodically prominent item in the clause or, by default, with the item to its right. Importantly, when it associates with a prosodically prominent item, it is the item itself that bears the prosodic marking of prominence while polar *kya* remains accentless. As a focus sensitive operator, polar *kya* constrains the set of possible answers viable in the context of an utterance. Assuming that polar questions denote singleton sets as proposed in Biezma & Rawlins (2012) (see also Roberts 1996; Farkas & Bruce 2010) so that a polar question asks about the proffered alternative and conveys that there are other alternatives in the context of utterance, then polar *kya* questions can be understood as further constraining the alternatives to be entertained. Under the Question-Under-Discussion (QUD) approach (Roberts 1996), the polar *kya* is seen as constraining the shape of the QUD. It imposes restrictions on what the question is about and conveys assumptions as to the possible answers to the question. Overall, polar *kya* adds a pragmatic import to polar questions that differentiates these questions from plain information-seeking polar questions.

This analysis is broadly consonant with Syed & Dash (2017), who also see polar question particles in Hindi, Bangla, and Odia as focus sensitive operators, though their analysis relies heavily on syntactic mechanisms, with no recourse to formal pragmatic theories and no integration of prosodic factors. Our analysis is also broadly consonant with the proposal for polar *kya* in Bhatt & Dayal (2020), who see polar *kya* as dividing a clause into information that is at-issue vs. not and locate polar *kya* in a ForceP projection.

We do not pursue the analysis of the syntax-pragmatic interface in this paper, but instead concentrate on the prosody-syntax interface by looking more closely at polar *kya* vs. the wh-constituent version of *kya*.

4 Wh-constituent questions

As already illustrated in (4), the use of *kya* can lead to ambiguity between polar and wh-constituent readings. In this section, we briefly present the centrally relevant prosodic and syntactic properties of wh-questions in Urdu/Hindi.

4.1 Syntax

Urdu/Hindi is traditionally characterized as a wh-in-situ language (Bayer & Cheng 2015). Example (15) shows the wh-phrase *kis=ko* placed in-situ (corresponding constituents shown in italics).

- (15) a. *sita=ne d^hyan=se ram=ko dek^h-a t^h-a*
 Sita.F=Erg carefully Ram.M=Acc see-Perf.M.Sg be.Past-M.Sg
 'Sita had looked at Ram carefully'
- b. *sita=ne d^hyan=se kis=ko dek^h-a t^h-a?*
 Sita.F=Erg carefully who.Obl=Acc see-Perf.M.Sg be.Past-M.Sg
 'Who had Sita looked at carefully?'

However, a closer investigation reveals that the default/preferred position for *wh*-words is in fact the immediately preverbal position (Féry 2010; Dayal 2017; Butt 2018), as illustrated in (16). This position has also been shown to be the default focus position (Gambhir 1981; Butt & King 1996, 1997; Kidwai 2000). As *wh*-words are considered to be semantically focused, it stands to reason that their preferred position is immediately preverbal.

- (16) a. *sita=ne ram=ko dek^h-a t^h-a*
 Sita.F=Erg Ram.M=Acc see-Perf.M.Sg be.Past-M.Sg
 'Sita had seen Ram.'
- b. *ram=ko kis=ne dek^h-a t^h-a?*
 Ram.M=Acc who.Obl=Erg see-Perf.M.Sg be.Past-M.Sg
 'Who saw Ram?'

Nevertheless, the immediately preverbal position is only the preferred position for *wh*-words in constituent questions. Manetta (2012) demonstrates that *wh*-phrases have the same kind of scrambling possibilities as normal NPs do. Consequently, *wh*-words can in principle appear anywhere in the clause, as shown in (17).

- (17) a. *anu=ne uma=ko kya di-ya?*
 Anu.F=Erg Uma.F=Dat what give-Perf.M.Sg
 'What did Anu give to Uma?'
- b. *%kya anu=ne uma=ko di-ya?*
- c. *anu=ne kya uma=ko di-ya?*
- d. *anu=ne uma=ko di-ya kya?*

As with the distributional possibilities of polar *kya*, there is one position that is dispreferred. In this case it is the clause initial position, which had earlier been identified as the canonical position for polar *kya* (Masica 1991; Montaut 2004).

Overall, the different word orders appear to go hand in hand with differences in interpretation. For example, Butt et al. (2016) investigate constructions as in

(18) where the *wh*-word appears immediately postverbally within the verbal complex (Bhatt & Dayal 2007; Manetta 2012). They adduce evidence to show that this immediately postverbal position within the verbal complex is a secondary focus position that occurs when the primary focus of the question is placed on the verb.

- (18) *sita=ne d^hyan=se [dek^h-a kɪs=ko t^h-a]?*
 Sita.F=Erg carefully see-Perf.M.Sg who.Obl=Acc be.Past-M.Sg
 ‘Who had Sita looked at carefully?’

The pragmatic effect of the other word orders remains to be fully investigated.

4.2 Prosody

Figure 3 shows the most typical f_0 contour of a *wh*-question. The highest f_0 peak in the sentence aligns with the question word *kya* ‘what’. F_0 drops on the following noun and the verb to reach a low final boundary tone.

Harnsberger (1994) shows that the prosodic realization of *wh*-words is similar to that of focus. He reports that the f_0 on the *wh*-word is upstepped, leading to a raise in register, and that the f_0 on the subsequent phrases is compressed. Butt et al. (2016) corroborate the findings of Harnsberger and show that the preverbal *wh*-phrases have the highest f_0 maxima in a clause. The boundary tone in *wh*-questions is typically low (Moore 1965; Harnsberger 1994); however, we have found some variation with respect to this in our data, with high boundary tones also occurring (also see Sengar & Mannell (2012), who exclusively report a high

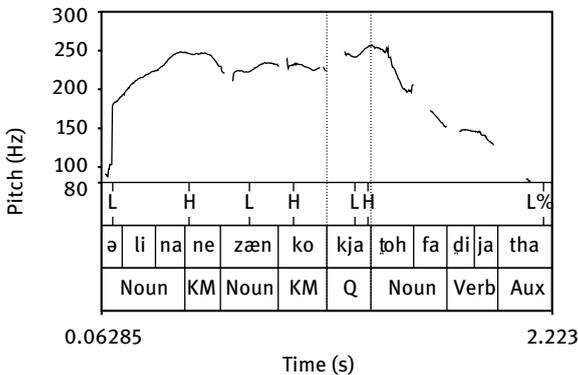


Fig. 3: A *wh*-question with the *wh*-word at the preverbal position.

boundary tone for *wh*-questions). The nature and scope of this variation remain to be thoroughly investigated.

5 Ambiguity resolution via prosodic information

The polyfunctionality of *kya* leads to ambiguous strings, particularly in examples as in (19), repeated here from (4). In these cases *kya* can either be seen as part of a polar question (19a), or it can be interpreted as a *wh*-word that is part of a nominal phrase (19b).

- (19) a. jahina=ne naz=ko kya [tohfa] di-ya?
 S.F=Erg N.F=Dat what present.M.Sg.Nom give-Perf.M.Sg
 ‘Did Shahina give a gift to Naz?’
- b. jahina=ne naz=ko [kya tohfa] di-ya?
 S.F=Erg N.F=Dat what present.M.Sg.Nom give-Perf.M.Sg
 ‘What gift did Shahina give to Naz?’

We maintain that prosodic cues are instrumental for the disambiguation of the examples in (19) and that these cues are centered primarily on the differences in prosody associated with polar *kya* (flat or falling) vs. the constituent *kya*, that bears the basic LH contour. In this section, we demonstrate that the prosodic difference between polar and *wh*-constituent *kya* is indeed robust by adducing evidence from a production and a perception experiment.

5.1 Production experiment

5.1.1 Materials

We constructed five sets of sentences with *kya* followed by a noun at the preverbal position. Three of the nouns following *kya* were monosyllabic whereas two were bisyllabic. All the target sentences were ditransitive. Each sentence had a *wh*-constituent as well as a polar reading. Each target sentence was presented in both polar and *wh*-constituent question contexts. In order to avoid the influence of word order on the production of sentences, the contexts were given in English while the target sentences were presented in the Urdu script. An example sentence with both polar and *wh*-constituent question contexts is given in (20):

Context for wh-constituent reading:

You want to know what gift was given.

Context for polar reading:

You want to know if Shahina gave Naz a gift.

- (20) jahina=ne naz=ko kya tohfa di-ya?
 Shahina.F=Erg Naz.F=Dat what present.M.Sg.Nom give-Perf.M.Sg
 ‘What gift did Shahina give to Naz?’
 ‘Did Shahina give a gift to Naz?’

5.1.2 Participants

Three speakers of Urdu (2 females) were recorded for this experiment. They were all Pakistanis living in Germany. They were multilingual who spoke Urdu as well as English and at least one other regional language from Pakistan.⁵

5.1.3 Data collection

The data was recorded in the phonetics lab in University of Konstanz with a head mounted Shure microphone at the sampling frequency of 44.1KHz. Every target sentence was followed by two declarative sentences functioning as fillers. The target sentences were presented in a slide presentation and the participants controlled the pace of the experiment. The participants were asked to read the context silently and pronounce the target sentence keeping in mind the given context. They were asked to repeat the sentence in case of coughing, laughing, or stuttering. They were all paid a small remuneration for participating in the experiment.

5.1.4 Data analysis

The sentences were analyzed using PRAAT (Boersma & Weenink, 2013, v. 6.0.28). The target sentences were labelled manually to measure the duration of *kya* and the following nouns. The f_0 contour of the question word and the following noun as well as the boundary tone were also labelled. The f_0 values at the local minima and maxima were obtained for the analysis of *kya* and the noun. As the data set is

⁵ We are aware that their language background influences their language production but Urdu is a lingua franca and it is difficult to find monolingual literate speakers of Urdu even in Pakistan.

small, no regression analysis was conducted. In the following section, we report the results in terms of descriptive statistics.

5.1.5 Results

5.1.5.1 Duration

Our analysis shows that the wh-constituent *kya* has a longer duration than polar *kya*. Additionally, the nouns are longer after polar *kya* than after wh-constituent *kya*. Table 1 shows the average duration of syllables in the target words. This difference in duration is probably correlated with the fact that the noun following the polar *kya* is emphasized (see Sect. 5.1.6).

Tab. 1: Average duration (ms) of polar and wh-constituent *kya* and the following monosyllabic and disyllabic nouns.

	<i>kya</i>	Monosyllabic N	Disyllabic N		
			Total	Syllable 1	Syllable 2
polar <i>kya</i>	204	330	408	165	243
wh-constituent <i>kya</i>	232	271	370	153	217

5.1.5.2 F_0 contour

Wh-constituent *kya* is produced with an LH contour whereas polar *kya* is always accentless and there is no intonational contour associated with it. However, the results of the analysis of the f_0 contour of nouns following *kya* are less clear cut. The noun after polar *kya* is often, but not always, produced with the LH contour (77%). The f_0 on the noun after the wh-constituent *kya* is mostly compressed (77%). These results indicate a tendency rather than provide an absolute distinction in the f_0 contour of nouns following preverbal polar and wh-constituent *kya*. The general difference between the f_0 contour of the constituent question and polar *kya* is illustrated by Fig. 4, which shows the f_0 contour of the potentially ambiguous examples in (21).

- (21) *alina=ne zain=ko kya tohfa di-ya t^h-a?*
 Alina=Erg Zain=Dat what present.M.Sg give-Perf.M.Sg be.Past-M.Sg
 Constituent Question: 'What gift did Alina give to Zain?'
 Polar Question: 'Did Alina (actually) give a gift to Zain?'

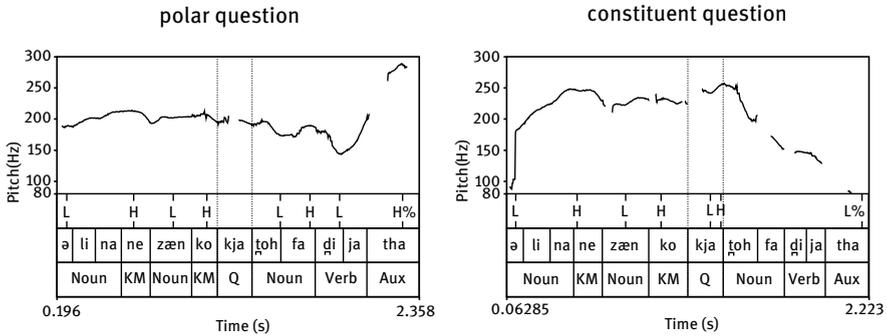


Fig. 4: Polar and wh-constituent readings of *kya*

As noted earlier, there is variability in the realization of the boundary tones so that a proportion of wh-questions were also produced with a high boundary tone, though the pitch excursion does not match the steep rise found in polar questions.

5.1.6 Discussion

The production data reported here shows that there are prosodic differences between wh-constituent and polar *kya*. The wh-constituent *kya* is produced with longer duration and an LH contour while f_0 is compressed on the following noun. This is in line with the findings of Harnsberger (1994) and Butt et al. (2016). Polar *kya*, on the other hand, is produced with shorter duration, is accentless, and the LH contour aligns with the noun following it. Moreover, the nouns following polar *kya* have a longer duration as compared with the nouns after the wh-constituent *kya*. We interpret this difference in their prosody in terms of focus marking. Wh-constituent *kya* is focused as indicated by its longer duration and the LH contour in comparison to its polar variant. Polar *kya* is accentless and it is the following noun that is focused, as shown by its LH contour and longer duration as compared to the noun following wh-constituent *kya*.⁷

5.2 Perception experiment

The production data presented above shows that there are prosodic differences in the production of polar vs. wh-constituent *kya* as well as the following noun. We investigated whether speakers of Urdu are perceptually sensitive to these prosodic

differences and whether they have preferences regarding the association of a particular prosodic pattern with *kya* as either a polar or a wh-constituent question.

5.2.1 Materials

In this experiment, we used the same dataset of sentences as the one used in the production experiment. One set of recordings from the production experiment, produced by a female speaker, was used as a stimulus for the perception experiment. This ensured that the participants in the perception experiment were presented with the same prosodic structures as found in the production experiment. As there is variation in the use of boundary tones in polar and wh-questions, we kept the boundary tones consistent across all our target sentences in both the contexts. The contexts were shown in the Urdu script. Each participant was presented with all the target sentences in matching (recorded and presented in the same context) and mismatching (recorded in one and presented in the other) contexts. The prosodic structure of the target sentences was not manipulated. The only manipulated variable was the context.

5.2.2 Procedure

The experiment was carried out via a web-based interface designed specifically for this experiment using Xojo Dev Center (<http://www.xojo.com/>). The participants were asked to read the context carefully, listen to the target sentence, and rate the naturalness of the sentence in the given context. The rating was based on a five-point Likert scale from 1 (most unnatural) to 5 (most natural) (Likert 1932). The participants controlled the pace of the experiment. They had to play the sentence at least once before rating but could play the target sentence no more than three times. The average time spent on each item was 13 seconds.

5.2.3 Participants

Twenty-seven respondents (4 females) aged between 21 and 30 participated in the experiment. They were all Pakistanis living in Germany. All participants were multilingual and spoke Urdu frequently in their daily life along with English, German, and at least one regional language from Pakistan. They were paid a small remuneration for participating in the experiment.

5.2.4 Data analysis

We used participants' ratings of target sentences in matching and mismatching contexts. For the statistical analysis, we fitted a series of LMER models with ratings as dependent variable and the presented and recorded contexts (polar/wh-question) and their interaction as fixed factors and items and participants as crossed random factors (Baayen et al. 2008).

5.2.5 Results

We found significant interaction between the ratings for recorded and presented contexts (β : 0.84, SE = 0.23, t = 3.6, p < 0.001). The results of participants' ratings are shown in Fig. 5. It shows that *kya* as a wh-constituent question received significantly better ratings than its polar variant (β : 0.62, SE = 0.2, t = 2.1, p = 0.03).

Moreover, the sentences recorded in the wh-constituent context and presented in the polar context were rated as less natural (β : 0.53, SE = 0.1, t = 3.4, p < 0.001) than their counterparts in the matching contexts. Similarly the sentences recorded as polar questions but presented in the wh-constituent context were rated as less natural but the difference between matching and mismatching ratings in the context of polar questions failed to reach significance (β : -0.31, SE = 0.1, t = -1.8, p = 0.06).

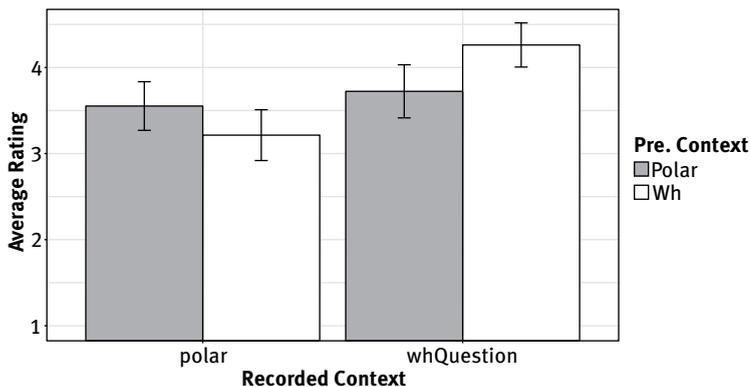


Fig. 5: Mean ratings for preverbal polar and wh- *kya*. The whiskers indicate 95% confidence interval.

5.2.6 Discussion

As the immediately preverbal position is preferred for constituent questions (Gambhir 1981; Butt & King 1997; Kidwai 2000), it stands to reason that *kya* as a constituent question receives better ratings at this position than its polar variant. This is indeed what is found and our results thus further support the existing claims about the distributional preference for polar and wh-constituent *kya* as discussed above (Bhatt & Dayal 2020).

5.3 Interim summary

The findings of our production and perception experiments show that prosodic information can be used to disambiguate between questions with pre-verbal wh-constituent and polar *kya*. We have shown that *kya* as a constituent question has the prosodic structure associated with focus and is followed by f_0 compression, a typical feature of post-focal constituents. On the other hand, polar *kya* is accentless and is followed by a noun with an LH contour. In the following section, we show how this prosodic information can be combined with syntactic structure to disambiguate between wh-constituent and polar *kya* using the framework of Lexical Functional Grammar (Bresnan & Kaplan 1982; Dalrymple 2001).

6 The syntax–prosody interface

Initial LFG proposals for the p(rosodic)-structure were “syntactocentric” (cf. Jackendoff (2002), see Butt & King (1998)), but newer proposals have moved towards seeing prosody as an independent level of representation (Mycock 2013; Dalrymple & Mycock 2011; Dalrymple & Nikolaeva 2011; Bögel 2015), where prosody is taken to interact with morphosyntax, but is not derived from it.

For the analysis of *kya*, we follow the version of the syntax-prosody interface proposed by Bögel (2015). Based on the assumption that *listening* and *speaking* are inherently different processes at the interface between prosody and syntax (and grammar in general), the proposal makes a crucial distinction between *production* and *comprehension*. *Production* refers to the construction of an utterance from MEANING to FORM and *comprehension* refers to the process of understanding an utterance, i.e., from FORM to MEANING. With respect to the interface between syntax and prosody, the former is concerned with the syntax-to-prosody interface, while the latter is concerned with the prosody-to-syntax interface.

- *Production/generation/speaking*:
from MEANING to FORM (syntax → prosody)
- *Comprehension/perception/listening*:
from FORM to MEANING (prosody → syntax)

In terms of syntactic analysis, we base ourselves on the approach to Urdu syntax established as part of the Urdu ParGram grammar (Butt & King 2007). The Urdu ParGram grammar uses a flat structure in which all major constituents are allowed to scramble. One of these major constituents is the verbal complex, labeled VC in the c-structure analyses.⁶

In what follows, we focus on the prosody → syntax interface, i.e., we model a process of *comprehension* and show how the respective prosodic information associated with polar and wh-constituent *kya* (as established in the previous sections) can guide syntactic disambiguation, thus supporting the correct semantic interpretation of *kya*. The syntactically ambiguous example in (22) serves as an illustration.

- (22) *alina=ne zain=ko kya tohfa di-ya t^h-a?*
 Alina=Erg Zain=Dat what present.M.Sg give-Perf.M.Sg be.Past-M.Sg
 Constituent Question: ‘What gift did Alina give to Zain?’
 Polar Question: ‘Did Alina (actually) give a gift to Zain?’

Example (22) allows for two possible interpretations: a) as a constituent question, where *kya* is grouped together with *tohfa* ‘gift’, and b) as a polar question, where *kya* stands on its own. Following Slade (2011), we analyze *kya* as a Q node within the c-structure and we furthermore assume only one underspecified *kya* ‘what’ for the polar and the wh-readings.⁷ Figure 6 shows the c-structures for both interpretations of *kya*: While *kya* forms an NP together with the associated N in the wh-reading, it remains an independent daughter of S in the polar *kya* interpretation.

⁶ LFG assumes two syntax-related structures: 1) c(onstituent)-structure, which represents the linear order and hierarchical structure of the constituents (i.e., the syntactic ‘tree’), 2) f(unctional)-structure, which encodes predicate-argument relations and functional information.

⁷ We could assume two separate lexical and syntactic entities and treat polar and constituent question *kya* as an accidental homophony. However, cross-linguistic evidence shows that there is a general trend for ‘what’ to be used for other question types and we believe that this is not an accident. We are working on a unified semantic approach to polar and constituent question *what* and we here anticipate that approach by positing just one underlying and underspecified entry for *kya*.

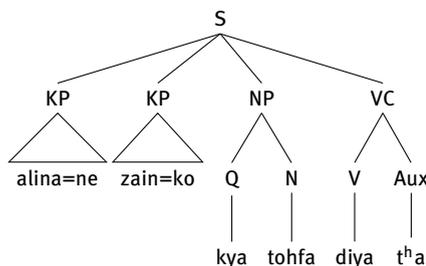
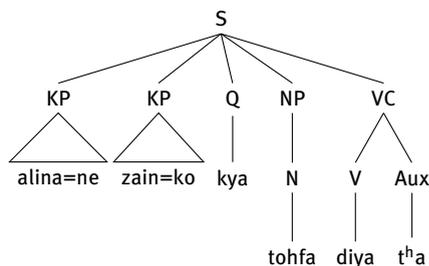
Wh-Question:**Polar *kya*:**

Fig. 6: C-structures for the *wh*-constituent and for *polar kya* questions.

As demonstrated in the previous sections, syntactic ambiguities that arise from the use of *kya* can be resolved via prosodic disambiguation. In the following, we adopt the formal approach to the prosody-syntax interface proposed in Bögel (2015).

6.1 The prosody–syntax interface

Two information transfer processes are assumed at the interface between prosody (p-structure)⁸ and syntax (c-structure): The *Transfer of Structure* (η) relates syntactic and prosodic constituency above the word level and exchanges information on intonational cues. The *Transfer of Vocabulary* (ρ/π), on the other hand, operates on the word level and below by associating the morphosyntactic and phonological form of each item (word) within the lexicon before projecting these onto the respective structures: lexical phonological information is associated with p-structure and lexical morphosyntactic information is associated with c-structure. Figure 7 shows how these transfer processes are integrated into the LFG architecture.⁹

We illustrate how the system works with a concrete example involving the *comprehension* of the utterance shown earlier in (22). In a very first step the acoustic signal corresponding to (22) is received and processed by a hearer. This ‘raw’

⁸ In fact, p-structure represents phonetic, postlexical phonological, and prosodic information. See below for a short explanation and Bögel (2015) for details.

⁹ The string represents the linear order of the single lexical items as they are parsed by syntax. Generally, the (syntactic) string is parallel to the linear order of the actual pronunciation; however, there are instances where postlexical phonology/prosody can change the linear order on the basis of phonological constraints, for example *prosodic inversion* (Halpern 1995).

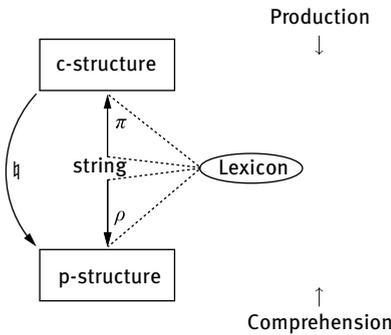


Fig. 7: The transfer processes at the syntax–prosody interface

acoustic information is stored in the *p-diagram*, a syllable-based linear and compact representation of information related to p-structure.

DUR.	0,08	0,16	0,14	0,17	0,28	0,23	0,21	0,20	0,16	0,13	0,11	0,22	SIGNAL
F ₀	164	211	239	243	228	229	247	229	162	147	136	(83)	↓
VALUE	[ə]	[li]	[na]	[ne]	[zæn]	[ko]	[kja]	[tʰoh]	[fa]	[dʲi]	[ja]	[tʰa]	
INDEX	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈	S ₉	S ₁₀	S ₁₁	S ₁₂	...

Fig. 8: Representation of ‘raw’ acoustic signal information in the p-diagram

In the p-diagram, each syllable receives a vector containing the values for the attributes relevant for the interpretation. For example, the vector for the third syllable (S₃) contains the syllable’s duration [DUR = 0,14 s] and its (mean) fundamental frequency [F₀ = 239]. Further possible attributes could be INTENSITY or PAUSE DURATION, for example.

As the speech signal is processed, the phonetic information is identified and used to analyze the speech signal in terms of phonological categories (Fig. 9). For example, f₀ can be interpreted in terms of pitch accents and boundary tones such as H* or L-L%.¹⁰ (PROSODIC) PHRAS(ING), on the other hand, indicates larger prosodic domains on the basis of f₀ or DURATION. Both of these attributes can serve as a reference to the *transfer of structure* as demonstrated below. Since we are mainly concerned with the identification of polar vs. wh-constituent *kyā*, the figure only presents the relevant information for the present research question and leaves aside the insertion of further pitch accents, boundary tones, and lower

¹⁰ In Fig. 9, “ToBI” refers to the system of “Tones and Break Indices” originally devised for English (Silverman et al. 1992).

PHRAS.	(_i) _i	INTERPRETATION
TOBI LH	↓
DUR.	0,08 0,16 0,14 0,17 0,28 0,23 0,21 0,20 0,16 0,13 0,11 0,22	SIGNAL
F ₀	164 211 239 243 228 229 247 229 162 147 136 (83)	↓
VALUE	[ə] [li] [na] [ne] [zæn] [ko] [kja] [təh] [fa] [di] [ja] [tʰa]	
INDEX	S ₁ S ₂ S ₃ S ₄ S ₅ S ₆ S ₇ S ₈ S ₉ S ₁₀ S ₁₁ S ₁₂	...

Fig. 9: Categorical interpretation on the basis of ‘raw’ information

prosodic domains (e.g., phonological phrase boundaries). Note, however, that all of these could in principle be calculated on the basis of the information encoded under duration, and the difference in *f*₀ between adjacent syllables.

During the *Transfer of Vocabulary*, (segmental) information coming from the speech signal is matched against the p(honological)-form of a multidimensional lexicon. LFG is committed to the strong lexicalist hypothesis (Lapointe 1980, 8). As a consequence, only fully formed words can enter the syntactic tree (Bresnan & Mchombo 1995; Asudeh et al. 2013) and the lexical ‘surface’ form contains complete words (albeit these surface forms are assumed to be generated dynamically, following e.g., Kiparsky (1982) and Meinzer et al. (2009)). The lexicon includes several ‘dimensions’ each associated with a particular module of grammar. The *s(yntactic)-form* encodes morphosyntactic and functional information (on e.g., word category, number, person) and is associated with syntactic structure. The *p(honological)-form*, on the other hand, provides segmental information and metrical structure (e.g., the number of syllables). A third dimension (*concept*) is concerned with meaning, but this is not detailed any further in this paper. Sample lexical entries for the noun *tohfa* ‘gift’ and the question word *kya* ‘what’ are provided in Table 2.

When a p-form is identified in the multidimensional lexicon, the associated s-form information also becomes available and can be used as input to c-structure terminal nodes via the π -projection (Kaplan 1987; Asudeh & Toivonen 2009). In a

Tab. 2: Lexical entries for *kya* and *tohfa*

concept	s-form	p-form
‘GIFT’	N (↑ PRED) = ‘tohfa’ (↑ NUM) = sg (↑ GEND) = masc	SEGMENTS /t o h f a/ METRICAL STRUCTURE σσ
‘WHAT’	Q (↑ INT-FORM) = <i>kya</i>	SEGMENTS /k j a/ METRICAL STRUCTURE σ

the indicated Syllable (S). For the attribute ToBI, this syllable must have ($=_c$) the value LH.¹²

In short, this approach allows for a syntactic construction to ‘check’ whether a particular value is present in p-structure. Note that the constraining equation $=_c$ is a so-called ‘hard constraint’. If the desired value (LH) is not present, this particular syntactic structure will not be parsed.

6.2 Analysis

With the prosody-syntax interface in place, we are now in a position to show how the utterance in (24) (repeated from (22)) can be disambiguated.

- (24) *alina=ne zain=ko kya tohfa di-ya t^h-a?*
 Alina=Erg Zain=Dat what present.M.Sg give-Perf.M.Sg be.Past-M.Sg
 Constituent Question: ‘What gift did Alina give to Zain?’
 Polar Question: ‘Did Alina (actually) give a gift to Zain?’

6.2.1 Constituent question *kya*

We begin with the wh-constituent reading of *kya*. As shown in Sect. 5, *kya* carries an LH f_0 contour. This information is available through p-structure and can be accessed by the *transfer of structure* as in (25).

- (25) *kya*: ($\uparrow(T^*)$) ToBI) $=_c$ LH

The c-structure analysis and the lexicon are repeated in Fig. 11, as is the relevant part of the speech signal represented in the p-diagram. The speech signal contains an LH on vector S7, which represents the segmental string [kja]. The related p-form / k j a / is accessed in the lexicon via the *transfer of vocabulary*. The lexicon then relates the p-form / k j a / to its associated s-form *kya*, which specifies that it is a Q at c-structure. The lexicon otherwise has nothing to say about *kya*. It is completely underspecified as to whether this *kya* signals a wh-constituent or a polar question.

The rules of our grammar allow for two c-structure analyses of the utterance in (23) as shown in Figs. 11 and 12. However, the c-structure in Fig. 11 is only li-

¹² $T^*(*)$ S is in a sense redundant here, because Q is a terminal node and there is only one syllable related with it (*kya*). However, references to prosodic constituency (Bögel, this volume) or to more complex pitch contours often require reference to several terminal nodes/syllables.

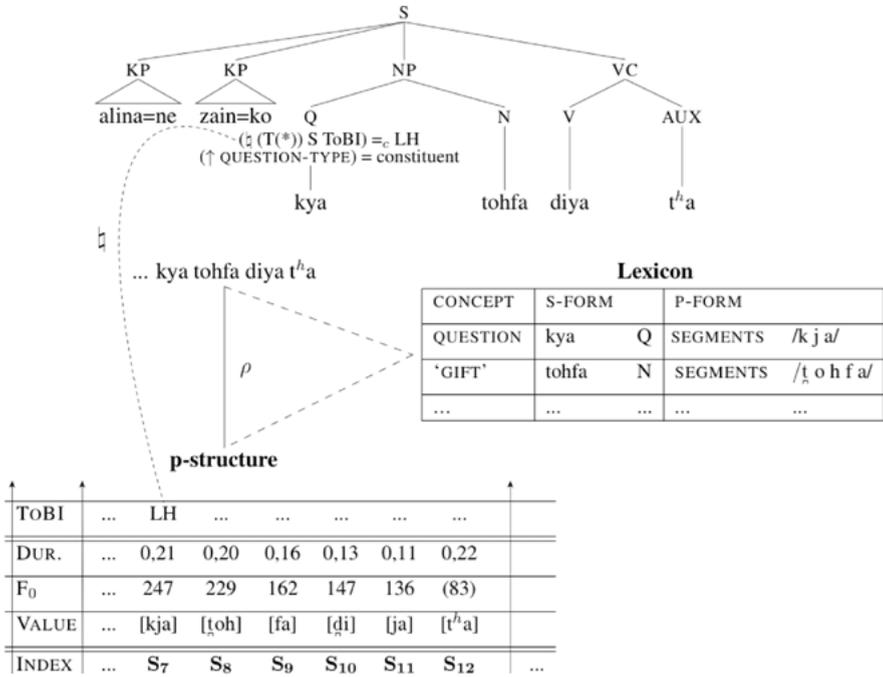


Fig. 11: *kya* as a constituent question

censed if *kya* can be interpreted as a constituent question. In order to be interpreted this way, it needs to be associated with an LH. This is part of the grammatical knowledge of the language and is encoded in our analysis as part of the c-structure annotation on *kya* in Fig. 11, as shown in (26).

$$\begin{aligned}
 (26) \quad NP &\rightarrow Q && N \\
 & && (\ddagger(T^*)) S \text{ ToBI} =_c \text{ LH} \\
 & && (\uparrow \text{QUESTION-TYPE}) = \text{constituent}
 \end{aligned}$$

The c-structure annotation on Q in the constituent question interpretation features a constraining equation which ensures that *kya* can only be parsed as a terminal Q node if there is an LH on the corresponding p-form. This is ensured via the *Transfer of Structure*, which relates c-structural and p-structural information via the ‡ projection.

If *kya* is indeed associated with an LH in the speech signal, it can be identified as a constituent question. This information is passed along to the f-structure via the second annotation under Q in (26): an equation assigning the value “constituent” to the feature QUESTION-TYPE.

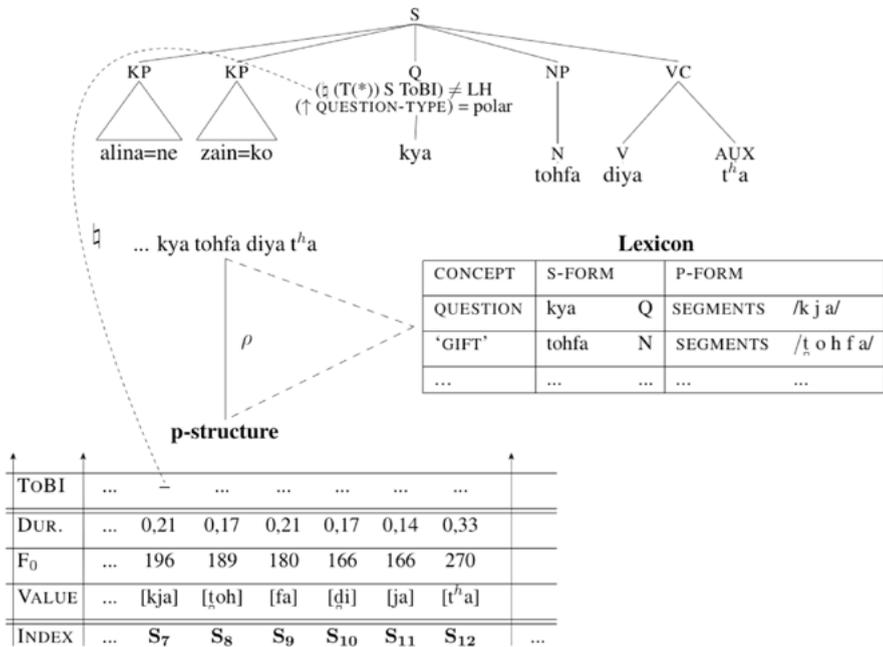


Fig. 12: *kya* as a polar question

Q in (29) is satisfied or not is again determined via the *Transfer of Structure*, which relates prosodic information with syntactic information via the \natural projection.

Beside the distinct LH contour on *kya*, the production experiment in Sect. 5.1 also showed that the f_0 and the duration of the noun following *kya* change on the basis of its interpretation as a polar or wh-constituent question. In principle, this information could be included at the prosody-syntax interface as well. For example, the longer duration and the typical LH pattern of the noun following polar *kya* indicate a phonological phrase, while the shorter duration and the f_0 compression on the noun following constituent *kya* point towards the noun being phrased with another element. These phrasing patterns can be used to inform syntactic phrasing via the *transfer of structure*;¹³ however, the importance of the cues related to the noun from the perspective of perception needs to be left for further research. Furthermore, as polar *kya*, being a focus sensitive operator, takes scope over either the item to its right or a prominent item to its left, an analysis based on the prosody of *kya* itself and not the associated noun is more elegant and effective to help disambiguate between polar and wh-constituent readings.

¹³ For a concrete example in German, see Bögel, this volume.

Finally, a note on the generalizability of the rules in (26) and (29). The rules are generally applicable, as shown with (27). The wh-constituent rule in (26) is, however, only one possible expansion of the NP. Other expansions allow for the possibility of NPs containing determiners, adjectives, numerals, etc. In the computational Urdu grammar (Butt & King 2007) the NP is quite complex, carefully juggling dependencies and ordering constraints within the NP. The rule in (26) is a subrule within the larger expansion possibilities for an NP.

6.3 Preferences in distribution

In this final analysis section, we address the issue of preferences found with regard to the distribution of polar vs. wh-constituent *kya*. Recall that polar *kya* and wh-constituent *kya* in principle have the distribution of other major constituents in the clause. However, polar *kya* is dispreferred in the immediately preverbal position. We propose that polar *kya* is dispreferred in this position because this is the default position for focus, hence the most natural position for wh-constituent *kya* and hence also an unnatural position for polar *kya* as a focus sensitive operator. Conversely, the reason for the dispreference for the clause initial position by wh-constituent *kya* must be seen as following from distributional preferences for polar *kya*, where the clause initial position has been reported as the default.

These positional (dis)preferences can be modeled very elegantly via the OT-style constraints implemented as part of the XLE grammar development platform for LFG grammars (Frank et al. 1998; Crouch et al. 2017). The OT component implemented within XLE can serve to formulate constraints which disprefer an analysis in which wh-constituent *kya* is placed clause initially and polar *kya* is placed in the immediately preverbal position. The OT-style constraints implemented within XLE can be used in both directions: parsing and generation. Given that Bögel’s prosody-syntax architecture takes the needs of comprehension vs. production very seriously, these OT-style constraints are exactly right for our analysis.

7 Conclusion

In this paper, we have presented a prosodic analysis of *kya* ‘what’ in Urdu. We have shown that ambiguities arise because of the polyfunctionality of *kya* and because of the distributional possibilities of polar and wh-constituent *kya* in the clause. We demonstrate that while *kya* is string identical in polar and wh-constituent questions, the prosodic cues differ quite starkly. With the help of a production experi-

ment, we showed that *wh*-constituent *kya* has the prosodic realization associated with focus whereas polar *kya* is accentless. Our perception experiment showed that speakers of Urdu are sensitive to the prosodic differences between polar *kya* and *wh*-constituent *kya* clauses. We posit that prosodic information is crucial for the resolution of syntactic ambiguity and use this information to disambiguate between the two syntactic possibilities. We demonstrate concretely how the relevant prosodic information can be accessed via syntax within the prosody-syntax architecture proposed by Bögel (2015). Bögel's analysis is couched within LFG, which formulates a modular and constraint-based view of syntax. Modules of grammar interact with one another via a complex yet mathematically well defined projection architecture. The modules are characterized by a separate internal logic and concomitant representations, allowing for the specification of prosodic information within a prosodic component that can be accessed freely in the form of targeted requests of information by other parts of the grammar, such as the syntactic modules. Once the syntactic disambiguation has taken place on the basis of prosodic information, the appropriate semantic and pragmatic interpretation (Biezma et al. 2018) can then also be triggered on the basis of the available syntactic information.

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