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

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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 and that the correct interpretation of *kya* is dependent solely on prosodic cues. We report on a production experiment which establishes that the wh-constituent *kya* is prosodically focused while polar *kya* is accentless. We further show that speakers of Urdu/Hindi are perceptually sensitive to the distributional and prosodic properties of wh-constituent and polar *kya*. We take the information established about *kya* 'what' and show how the prosodic difference between the two realizations of *kya* guides 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 (2015) framework of the prosody-syntax interface.

1 Introduction

The study of the role of prosody in Urdu/Hindi[1] questions and how it interacts with the syntax and semantics of questions is in its infancy. Our contribution in

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[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).

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 section 3 for details).

(1) ɑnu=ne uma=ko kɪtab 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 a polar question, as shown in (2). The literature reports that the default placement for this polar *kya* is in the clause initial position (Masica, 1991; Montaut, 2004), but Bhatt & Dayal (2015) show that it can in fact scramble among all the major constituents of a clause (see section 3 for details).

(2) (**kya**) ɑnu=ne uma=ko kɪtab 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 section 4) leads to ambiguities with respect to the constituent question use of *kya*, which is illustrated in (3).[2]

(3) ɑnu=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)

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 (4-a) or as a wh-constituent question (4-b) where *kya* 'what' is part of an NP.

(4) a. ʃahina=ne naz=ko **kya** [tofa] 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. ʃahina=ne naz=ko [**kya** tofa] 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 results indicate that the wh-constituent *kya* is prosodically focused while

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

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

polar *kya* is accentless. Our experiments also show that speakers of Urdu/Hindi are perceptually sensitive to the distributional and 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 some background on the intonation of Urdu/Hindi. Section 3 discusses the intonation as well as the function 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 disambigution. This information is then used in section 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, laying the foundation for work on more complex aspects of question formation in Urdu/Hindi. Section 7 concludes the paper.

2 Some Prosodic Background

In order to understand how prosody is functioning to disambiguate between polar and wh-constituent *kya*, some general background 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 A basic LH contour

The intonational pattern of Urdu/Hindi declaratives is characterized by an LH f_0 contour on individual parts of a sentence, except for the clause-final verbal complex, which varies according to sentence type (Moore, 1965; Harnsberger, 1994). The precise domain of the LH contour remains to be determined. Harnsberger (1994) speaks of content words, yet his data contains LH contours on non-content words as well. From the data we have seen, it seems likely that the prosodic word is the relevant domain for the LH contour. The L tone seems to always align with the stressed syllable within this domain and the H appears as a boundary tone on its right edge. For example, Butt & King (2004) show that most of the case markers in Urdu/Hindi are clitics, placing them within the same prosodic word as the noun they attach to. Data from Urdu/Hindi consistently shows the H being able to be realized on the case marker of a given noun, rather than being confined to the noun (content word) itself. Examples are provided in Figure 1.

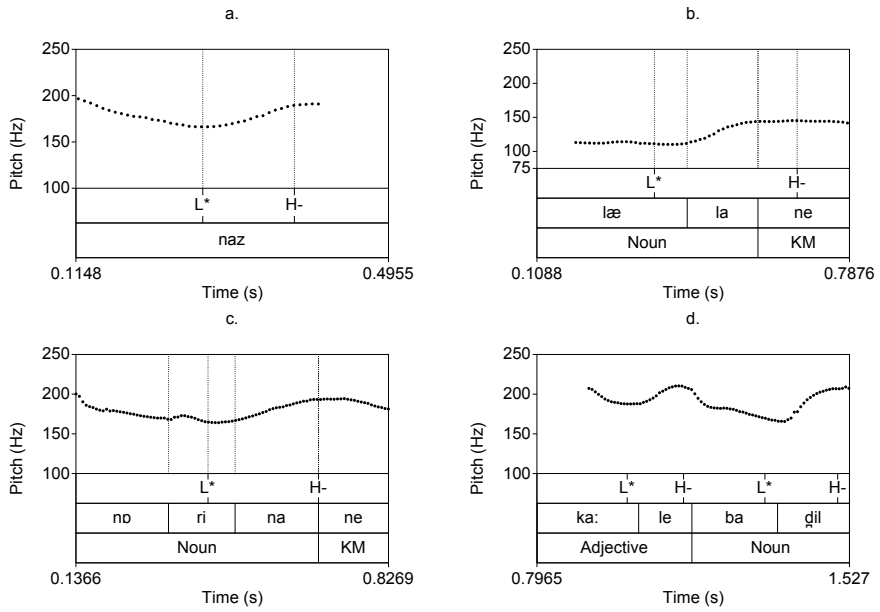

Figure 1: F_0 contour of a monosyllabic noun (a) without case marker, a disyllabic (b), and a trisyllabic noun (c) followed by a case marker (KM) and the contour of a noun phrase with a modifying adjective (d). All of them were produced in out of the blue utterances.

Harnsberger (1994) cites data from Mohanan (1994) with respect to noun-noun compounds which shows that each part of the compound receives its own LH contour. Furthermore, Figure 1d above shows that the LH contour is realized separately on the noun and its preceding adjective. This again points towards the prosodic word being the relevant domain of the LH contour.

Harnsberger (1994) also poses questions about the precise interpretation of the low tone as L* and the H tone as either the trailing end of a bitonal unit or a phonological/accentual phrase boundary. He himself does not reach a definitive conclusion and sets out three possible ways of interpreting the LH contour: LH accentual phrase, L+H pitch accent, and L*+H/L+H*. If the first label is adopted for Urdu/Hindi, it means that this language has lexically specified pitch accents like Japanese. Whereas adopting any of the other three labels means that Urdu/Hindi is an intonation language like English and German and the LH contour is assigned post-lexically. Adopting the latter approach, we investigated whether the LH contour is a bitonal unit or an L* followed by H- phonological phrase boundary tone.

In order to shed light on this issue, we manipulated the number of syllables in subject nouns. We placed monosyllabic nouns without a case marker as well as disyllabic and trisyllabic nouns followed by the ergative case marker *ne* at the sentence initial position. If the H tone were part of a bitonal unit, it would be expected to occur at a fixed interval from L*. We found that the LH contour was

clearly realized in monosyllabic nouns. Moreover, regardless of the number of syllables, the L tone always aligned with the stressed syllable in bisyllabic and trisyllabic nouns and the H tone aligned with either the end of the noun or the case marker (Figure 1). This leads us to claim that the H tone in the LH tonal sequence in Urdu/Hindi is in fact a phrase boundary tone and not part of a bitonal unit. The variable alignment of the H tone with the end of noun or the case marker has also been discussed by Moore. He observed that the late (on the case marker or the first consonant of the following word) and early (end of noun) alignment of H tone has a free distribution. Jabeen & Braun (2018), however, found that the late alignment of the f_0 peak correlates with narrowly focused nouns whereas the early alignment is associated with correctively focused nouns.

Finally, it must be noted that this general pattern of association is violable. Depending on speech tempo, these patterns may vary. For example, the LH pattern can spread beyond a prosodic word in fast speech.

2.2 Prosody of focus

The LH contour discussed above is found on the focused constituents as well, albeit the f_0 range is wider and the syllable duration is longer. Hence Moore (1965) claims that focus (he uses the term interchangeably with emphasis) inserts a phonological phrase boundary to the right edge of the focused constituent in Urdu/Hindi. These findings are corroborated by Harnsberger (1994) who also finds post focal compression in his data. This compression is different from post focal deaccentuation as the default LH contour is still realised although the f_0 span between Ls and Hs is narrower.

Post focal compression (deaccentuation in other languages) is one of the important cues of focus marking cross linguistically. Patil et al. (2008), however, claim that post focal compression is the single most significant and reliable cue to mark narrow focus in Urdu/Hindi. They claim that Urdu/Hindi does not use f_0 raising to mark focused constituents and report that focus does not increase the duration of the focused constituent either. But a closer look at their results, reported in the appendix of their paper, shows that focus does indeed raise the f_0 maximum and increase the duration of the focused constituent at both sentence initial and preverbal positions. Thus the overall emerging picture is that narrow focus in Urdu/Hindi has the same LH contour as the one seen in broad focus but narrow focus increases the duration, raises the f_0 maximum, thereby increasing the f_0 range of the focused constituent, and is followed by post focal compression.

2.3 Intonation

As in other languages, different clause types correlate with different intonational patterns. In Urdu/Hindi, these are expressed at the right edge, with declaratives generally being signalled via L% and polar interrogatives with a final H%. Further

discussion of the realization of the LH contour and the boundary tones in declaratives, polar, and wh-questions is part of the following sections.

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 signalled via intonation. Declaratives generally have an L-L% boundary,[4] while a polar question is signalled by an L/H-H% boundary (Figure 2).

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

(6) (ʃahina=ne norina=ko mara)$_{\text{L/H-H\%}}$
Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
'Did Shahina hit Norina?' (Polar Question)

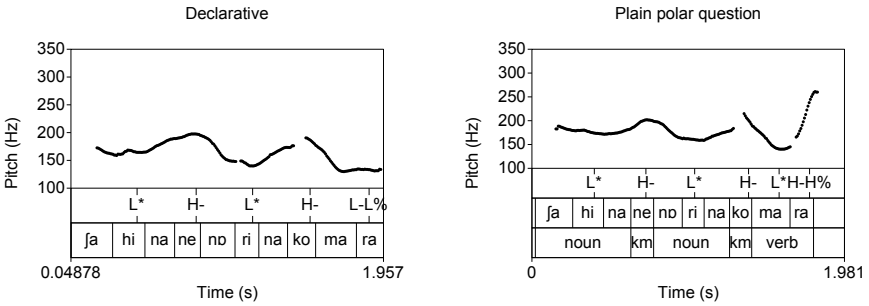

Figure 2: F_0 contour of a string identical declarative and polar question.

3.1 Polar *kya* — Distribution and Prosody

Polar questions can optionally use *kya* 'what' as shown in (7). This use of *kya* has been dubbed "polar *kya*" by Bhatt & Dayal (2015).

(7) **kya** ʃahina=ne norina=ko mar-a?
what Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
'Did Shahina hit Norina?'

[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 continuation rise by Hindi speakers. More work remains to be done on charting the possible variation of intonational contours in Urdu/Hindi.

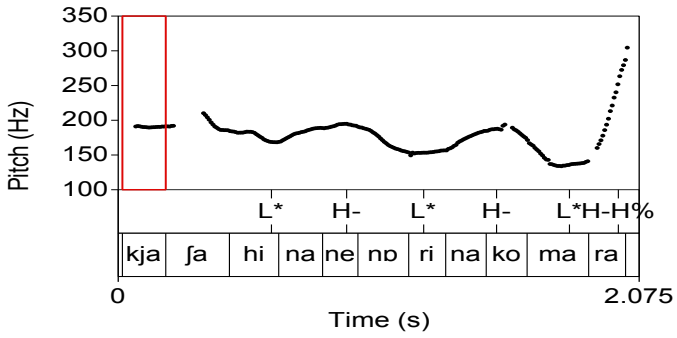

Figure 3: A polar question with sentence initial *kya*.

Figure 3 shows that, like plain polar questions, a polar question with *kya* ends with a high boundary tone. This lack of difference in the final boundary tone of polar questions with and without *kya* is borne out by previous literature (Harnsberger, 1994). Figure 3 also shows that polar *kya* at the sentence initial position is accentless.[5]

As mentioned earlier in the introduction, grammar books and previous literature report polar *kya* as appearing only clause initially in Urdu/Hindi (Glassman, 1977; Platts, 1884; Masica, 1991; Montaut, 2004). However, Bhatt & Dayal (2015) observed that polar *kya* can be scrambled among the main constituents in a clause, as shown in (8). The position of polar *kya* does not affect its prosodic realization, which is always accentless.

(8) (kya) ɑnu=ne (kya) uma=ko (kya) kɪtab (%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?

3.2 Polar *kya* — Function

Bhatt & Dayal (2015) adduce several arguments against the traditional analysis of polar *kya* as a question marker (Masica, 1991). One argument is that it is generally optional in matrix clauses, a feature not associated with question markers in general. Moreover, polar *kya* is generally disallowed in embedded interrogative clauses (9-a), which is exactly where one would need a question marker as the interrogative status of the embedded clause cannot be signaled via intonation. On

[5]Harnsberger (1994) has one example of polar *kya* and assigns an LH contour to polar *kya*, but does say that it is not marked by a unique register (pitch range). We did not find any instances of polar *kya* with an LH contour in our data.

the other hand, polar *kya* is allowed in complements of rogative predicates such as 'wonder' and 'ask' (9-b).

(9) a. *ɑnu 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. ɑnu 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)

Concluding from this discussion that polar *kya* is not a question marker, its function needs to be explained. Bhatt & Dayal (2015) claim that *kya* is used to partition a sentence into given vs. new. They explain that the constituents to the left of *kya* are given whereas the material to its right is new and open to question. Thus the subject in (10) cannot be questioned whereas *kya* takes scope over the direct and indirect objects as well as the verb to its right and makes them available for questioning.

(10) A. **ɑnu=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. #nɑhĩ, **asɪm=ne** di-ya
no Asim.M=Erg give-Perf.M.Sg
'No, Asim did.'

Our own investigation of the prosody of polar *kya* confirms Bhatt & Dayal (2015)'s claims 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.

(11) A. **ɑnu=ne**$_{Prominent}$ **kya** uma=ko tohfa
Anu.F=Erg what Uma.F=Dat present.M.Sg.Nom
di-ya?
give-Perf.M.Sg
'Did ANU give a/the present to Uma?'

B. nɑhĩ, **asɪm=ne** di-ya
no Asim.M=Erg give-Perf.M.Sg
'No, Asim did.'

Given this and other data , Biezma et al. (2017) instead propose that polar *kya* is a focus sensitive operator that associates with focused material. It will either associate with a 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. 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 questions.

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 thus 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 (12) shows the wh-phrase *kis=ko* placed in-situ.

(12) a. sita=ne d^{h}yan=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^{h}yan=se **kɪs=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 (13). This position has also been shown to be the 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.

(13) 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 **kɪs=ne** dek^{h}-a t^{h}-a?
Ram.M=Acc who.Obl=Erg see-Perf.M.Sg be.Past-M.Sg
'Who saw Ram?'

However, 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 (14).

(14) a. ɑnu=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** ɑnu=ne uma=ko di-ya?
c. ɑnu=ne **kya** uma=ko di-ya?
d. ɑnu=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 intial position, which has been identified as the default 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 (15) 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.

(15) 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 4 shows the f_0 contour of the sentence in (16). The highest f_0 peak in the sentence aligns with the question word *kis=ko* 'whom'. The H tone on the question word is maintained on the following case clitic. F_0 drops on the verb to reach a low tone but rises at the end of the sentence to achieve a high final boundary tone.

(16) ʃahina=ne kis=ko mara?
Shahina.F=Erg whom=Acc hit-Perf.M.Sg
'Whom did Shahina hit?'

Harnsberger (1994) claimed that the prosodic realization of wh-words is similar to that of focused constituents, i.e. longer duration and wider f_0 span followed by post focal compression. He reports that the f_0 on the wh-word is upstepped, leading to a raise in register, and 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 sentence followed by compression on the subsequent verb and the auxiliary. They explain this in terms of phonological phrasing and claim that the preverbal wh-words in Urdu/Hindi are prosodically focused and have a phonological phrase boundary on their right edge.

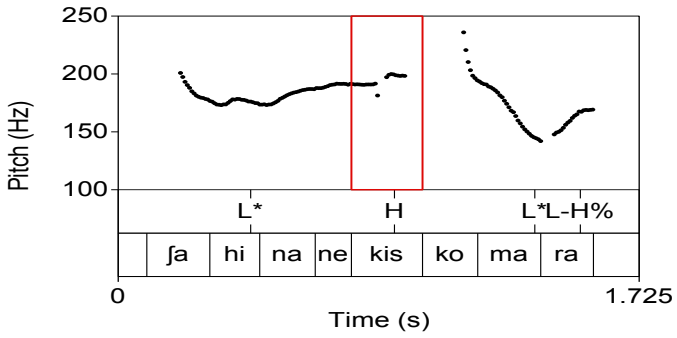

Figure 4: A wh-question with the wh-word at the preverbal position.

5 Ambiguity Resolution via Prosodic Information

The polyfunctionality of *kya* leads to ambiguous strings, particularly in examples as in (17), repeated here from (4). In these cases *kya* can either be seen as part of a polar question (17-a), or it can be interpreted as a wh-word that is part of a nominal phrase.

(17) a. ʃahina=ne naz=ko **kya** [tofa] 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. ʃahina=ne naz=ko [**kya** tofa] 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 the examples in (17) can only be disambiguated via prosodic cues and that these cues are centered primarily on the differences in prosody associated with polar *kya* (accentless) vs. the constituent *kya*, that bears an H tone. 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. Each sentence had a wh-constituent as well as a polar reading. All the target sentences were presented in 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 Urdu script. An example sentence with the con-

texts is given below:

Context for wh- reading:
You want to know what gift was given.
Context for polar reading:
You want to know if Shahina gave Naz a gift.

(18) ʃahina=ne naz=ko kya tofa 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?'

The words following *kya* were nouns (3 monosyllabic and 2 bisyllabic). All the sentences were ditransitive.

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.[6]

5.1.3 Data collection

The data was recorded in the phonetics lab in University of Konstanz with a head mounted Schure microphone at the sampling frequency of 44100. Every target sentence was followed by two declarative sentences functioning as fillers. The target sentences were presented via Ms PowerPoint 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 analysed using PRAAT (Boersma & Weenink (2013), (v. 6.0.28). The target sentences were labelled manually to measure the duration of *kya*. The f_0 contour of the question word and the following noun 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 small, no statistical analysis was conducted. In the following section, we report results averaged across speakers.

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

5.1.5 Results

5.1.5.1 Duration

Our analysis shows that wh-constituent *kya* has a longer duration (232 ms) than the polar *kya* (204 ms). Interestingly, the nouns are longer after polar *kya* than after wh-constituent *kya*. We claim that this difference in duration is indicative of focus marking. We elaborate on this further in section 5.1.6.

5.1.5.2 F_0 contour

The results of the analysis of the f_0 contour are less clear cut. Wh-constituent *kya* is produced with an LH contour (72%) whereas polar *kya* is always accentless and there is no intonational contour associated with it. The noun after polar *kya* is often, but not always, produced with the LH contour (77%). On the other hand, the f_0 on the noun after wh-constituent *kya* is mostly compressed (77%). These results indicate a tendency rather than provide a clear cut distinction in the f_0 contour of preverbal polar and wh-constituent *kya*. The difference between the f_0 contour of the constituent question and polar *kya* is further illustrated in Figure 5 which shows the f_0 contour of the ambiguous examples in (17-a) and (17-b).

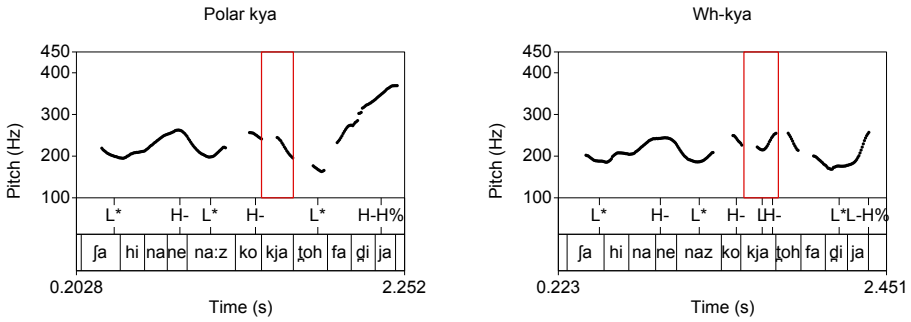

Figure 5: Polar and wh-constituent readings of *kya*

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. 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. Whereas polar *kya* is accentless and it is the following noun that is focused as shown by its LH contour in comparison with the noun after wh-constituent *kya*.

5.2 Perception experiment

The production data presented above shows that there are clear prosodic differences in the production of polar vs. wh-constituent *kya* as well as in the production of the following noun. We further investigated whether speakers of Urdu are perceptually sensitive to these prosodic differences and if they have preferences regarding the association of a particular prosodic pattern with *kya* as either a polar or a wh-word.

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, were used as stimulus for the perception experiment. This ensured that the participants in the perception experiment were presented with exactly the same prosodic structures as found in the production experiment. The contexts were presented in 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. This means that the participants could have used the prosodic cues on *kya* as well as the following noun to disambiguate between polar and wh-constituent *kya*. But this experiment aimed to investigate whether Urdu speakers are sensitive to the the prosodic difference between polar and wh-constituent realizations of *kya* and not the weighing of those cues individually. Hence 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.

5.2.4 Data analysis

We used participants' ratings of target sentences in matching and mismatching contexts. For statistical analysis, we fitted a series of LMER models with ratings as dependent variable and and the presented and recorded contexts (polar/wh-question) and their interaction as fixed factors and items and participants as random factors. We found significant interaction between the ratings for recorded and presented contexts ($p < 0.001$).

5.2.5 Results

The results of participants' ratings are shown in Figure 6. The figure shows that *kya* as a constituent question received significantly better ratings than its polar variant (β: 0.62, p = 0.03). This confirms that Urdu speakers are sensitive to the preference for wh-constituent *kya* at the preverbal position. Moreover, the sentences recorded in the wh-constituent context and presented in the polar context were rated as less natural (β: 0.53, $p < 0.001$) 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 is not significant (β: -0.31, p = 0.06).

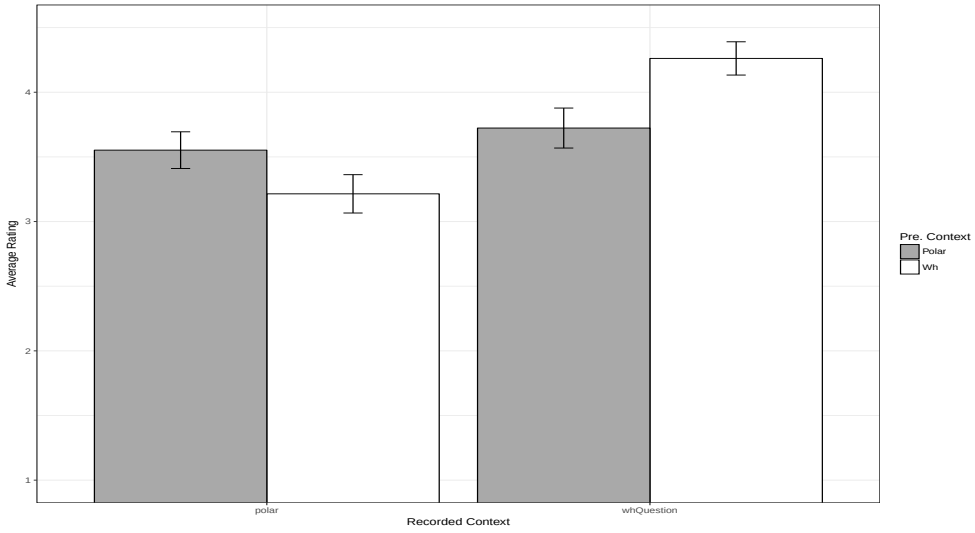

Figure 6: Mean ratings for polar and wh- *kya*. The whiskers indicate 95% CI.

5.2.6 Discussion

The results of the perception experiment provide interesting points for 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, 2015).

5.3 Interim Summary

The findings of our production and perception experiments show that prosodic information can be used to disambiguate between wh-constituent and polar *kya* at the preverbal position. We have shown that *kya* as a constituent question has the prosodic structure associated with focus and is followed by the f_0 compression typical of focused constituents. On the other hand, polar *kya* is accentless. Moreover, Urdu/Hindi speakers are sensitive to the positional distribution and the prosodic marking of wh-constituent and polar *kya*. 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 a more independent level of representation (Mycock, 2013; Dalrymple & Mycock, 2011; Dalrymple & Nikolaeva, 2011; Bögel, 2015). 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* and the grammar-internal position of the single modules (here: prosody and syntax) between the two terminal points of MEANING and FORM:

- *Production/generation/speaking*:
  from MEANING to FORM (syntax $\rightarrow$ prosody)
- *Comprehension/perception/listening*:
  from FORM to MEANING (prosody $\rightarrow$ 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.

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* can guide syntactic disambiguation, thus supporting the correct semantic interpretation of *kya*. The syntactically ambiguous example in (19) serves as an illustration.

(19) alina=ne zain=ko **kya** tofa 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 (19) allows for two possible intepretations: a) as a constituent question, where *kya* is grouped together with *tofa* '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[7] and we furthermore assume only one underspecified *kya* 'what' for the polar and the wh-readings.[8] Figure 7 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.

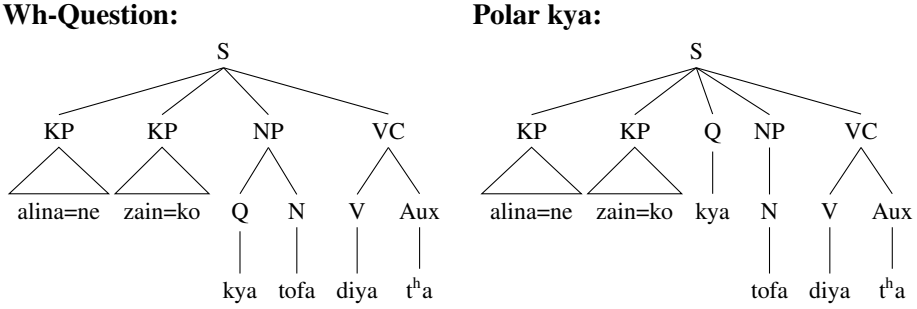

Figure 7: C-structures for the *wh*-reading and for *polar kya*.

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).

[7] 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.

[8] We could assume two separate lexical and syntactic entities and treat polar and constituent question *kya* as an accidental homophony. However, crosslinguistic 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*.

6.1 The Prosody-Syntax Interface

Two information transfer processes are assumed at the interface between prosody (p-structure)[9] and c-structure: The *Transfer of Structure* (♮) relates syntactic and prosodic constituency and exchanges information on intonational cues. It is thus concerned with the information exchange above the word level. The *Transfer of Vocabulary* (ρ/π), on the other hand, operates on the lexical level 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. The figure below shows how these transfer processes are integrated into the LFG architecture.[10]

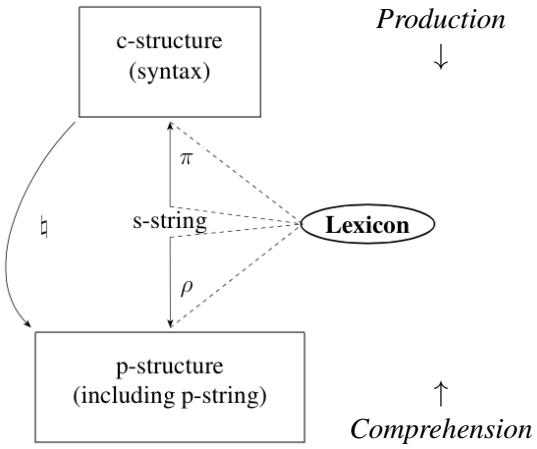

Figure 8: The transfer processes at the syntax–prosody interface

We illustrate how the system works with a concrete example involving the *comprehension* of the utterance shown earlier in (19). In a very first step the acoustic signal corresponding to (19) is received and processed by a hearer. This 'raw' acoustic information is stored in the *p-diagram*, a syllable-based linear representation of p-related information. Within the p-diagram, each syllable receives a vector containing the values for a particular attribute. For example, the duration of the third syllable S_3 is [DUR = 0,16S], the (mean) fundamental frequency for S_8 is [f_0 = 188]. Further possible attributes could be INTENSITY or PAUSE DURATION.

As the speech signal is processed, the phonetic information is identified and used to analyze the speech signal in terms of phonological categories (Figure 10).

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

[10] The s-(yntactic) string represents the linear order of the single lexical items as they are parsed by syntax. While this is generally parallel to the p-string, i.e., to what is actually pronounced, there are instances where the postlexical phonology/prosody replaces the order on the basis of phonological constraint. One example would be prosodically conditioned second position clitics placed by *prosodic inversion* (Halpern, 1995).

DUR.	0,07	0,17	0,16	0,15	0,28	0,13	0,25	0,23	0,13	0,13	0,11	0,14	SIGNAL
F_0	177	183	204	216	181	177	205	188	166	164	140	136	↓
VALUE	[ə]	[li]	[na]	[ne]	[zæn]	[ko]	[kja]	[t̪o]	[fa]	[d̪i]	[ja]	[t^ha]	
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}	...

Figure 9: Representation of 'raw' acoustic information in the p-diagram as perceived in the speech signal

For example, f_0 can be interpreted in terms of pitch accents and boundary tones such as H* or L-L%.[11] (PROSODIC) PHRAS(ING), on the other hand, indicates larger prosodic domains on the basis of f_0 or DURATION. Both of these attributes can serve as a reference to the *transfer of structure* as will be demonstrated below. As we are mainly concerned with the identification of polar vs. wh-constituent *kya* in questions, the following figure only presents the relevant information for the present research question.

PHRAS.	(ι	...	...	...	...	...	...	...	...	...	...	)ι	INTERPRETATION
TOBI	...	...	...	...	...	...	LH	...	...	...	...	...	↓
DUR.	0,07	0,17	0,16	0,15	0,28	0,13	0,25	0,23	0,13	0,13	0,11	0,14	SIGNAL
F_0	177	183	204	216	181	177	205	188	166	164	140	136	↓
VALUE	[ə]	[li]	[na]	[ne]	[zæn]	[ko]	[kja]	[t̪oh]	[fa]	[d̪i]	[ja]	[t^ha]	
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}	...

Figure 10: Categorical interpretation on the basis of 'raw' information

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'. The *s(yntactic)-form* encodes morphosyntactic and functional information 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 here further. Sample lexical entries for the noun *tofa* 'gift' and the question word *kya* 'what' are provided in Table 1.

Once a p-form is identified in the multidimensional lexicon, the s-form information associated with it also becomes available and can be used as input to c-structure

[11] In Figure 10, "ToBI" refers to the system of "Tones and Break Indices" originally devised for English (Silverman et al., 1992).

concept	s-form		p-form	
'GIFT'	N	(↑ PRED) = 'tofa' (↑ NUM) = sg (↑ GEND) = masc	SEGMENTS METRICAL STRUCTURE	/t̪ o f a/ $\sigma\sigma$
'WHAT'	Q	(↑ INT-FORM) = kya	SEGMENTS METRICAL STRUCTURE	/k j a/ σ

Table 1: Lexical entries for *kya* and *tofa*.

terminal nodes via the π projection (Kaplan, 1987; Asudeh & Toivonen, 2009). In a sense, the lexicon thus has a translation function between p- and c-structure at the word level. While all of the information associated with a given lexical entry becomes available for comprehension (or production), once one of the dimensions (e.g., c-structural or p-structural information) is accessed, we maintain LFG's principles of modularity (cf. Fodor (1983); Sadock (1991)). We do this by only allowing each of the dimensions within the lexicon to be accessed by the module whose information it encodes. That is, c-structure works with the syntactic category, semantic structure with the semantic forms, and p-structure with the phonological information.

The *Transfer of Structure* is complementary to the *Transfer of Vocabulary* in that it operates above the word-level and relates c-structure to associated infomation in p-structure and vice versa. This is the crucial part of the prosody-syntax interface with respect to information that goes beyond the lexicon. The projection $\natural$ is defined as the inverse projection of π composed with ρ, as shown in (20).[12]

(20) $\natural(\equiv \rho(\pi^{-1}))$

Figure 11 shows an abstraction of a typical *transfer of structure*-annotation at the prosody-syntax interface.
Q is the terminal node in c-structure that relates to polar or wh-constituent *kya*. This syntactic node is annotated with reference to p-structure ($\natural$). The annotation can be read as follows. For all the terminal nodes (T) of the current node (*) take the indicated Syllable (S). For the attribute ToBI, this syllable must have ($=_c$) the value LH.[13]

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, the syntactic structure will not be parsed.

[12] In the LFG architecture relations between components of grammar are governed by projection functions that map between different structures. For example, the ϕ-projection relates c-structure to f-structure. These functions can be inverted so that the inverse ϕ-projection relates f-structure to c-structure. These inverse functions allow for the inclusion of information from other modules.

[13] 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 phrasing (see XXX in this volume) or to more complex pitch contours often require reference to several terminal nodes/syllables.

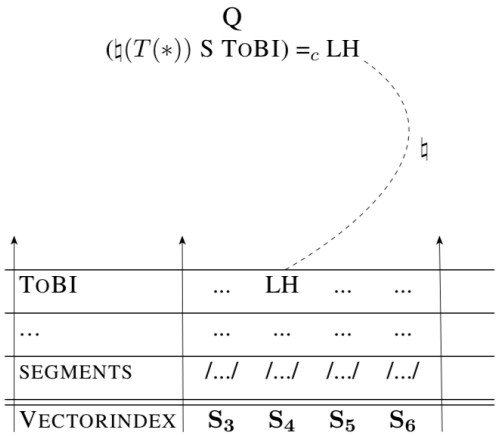

Figure 11: The *Transfer of Structure*

6.2 Analysis

With the prosody-syntax interface in place, we are now in a position to show how the utterance in (21) (repeated from (19)) can be disambiguated.

(21) alina=ne zain=ko **kya** tofa 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 constituent question reading of *kya*. As was shown in Section 5, *kya* carries an LH pitch accent. This information is available through p-structure and can be accessed by the *transfer of structure* as in (22).

(22) *kya*: (↯(T(∗))S ToBI) = LH

The c-structure analysis and the lexicon are repeated in Figure 12, as is the relevant part of the speech signal represented in the p-diagram. The speech signal contains an LH on S7, which is 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 unspecified whether this *kya* signals a constituent or a polar question.

The rules of our grammar allow for two c-structure analyses of the utterance in (23) as shown in Figures 12 and 13. However, the c-structure in Figure 12 is only licensed 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

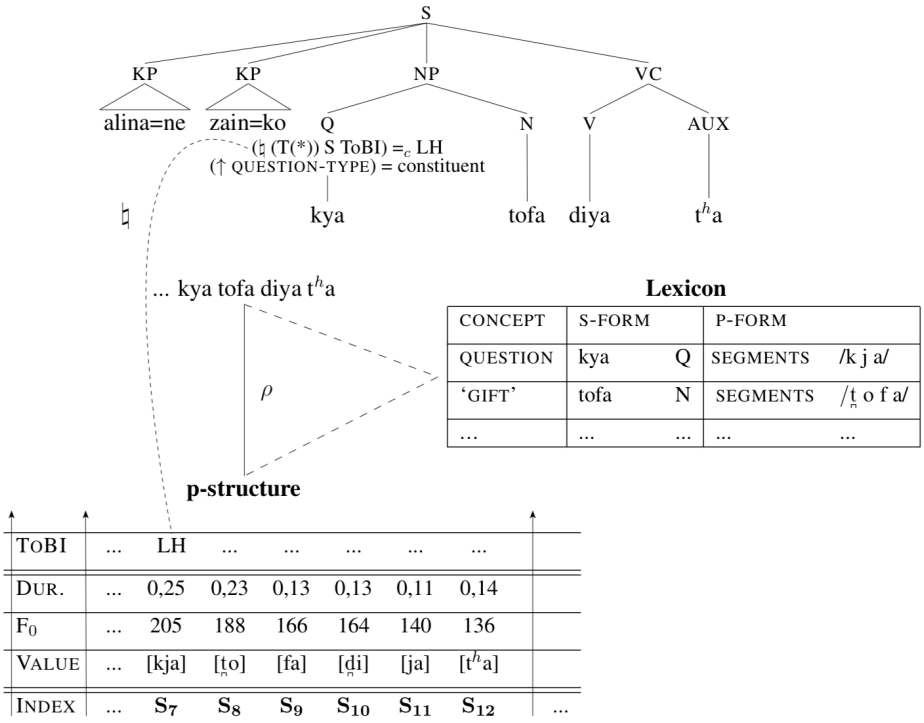

Figure 12: *kya* as a constituent question

grammatical knowledge of the language and is encoded in our analysis as part of the c-structure annotation on *kya* in Figure 12, as shown in (23).

(23) NP $\longrightarrow$ Q N
($\phi(T(*))$S ToBI) $=_c$ LH
(↑QUESTION-TYPE) = constituent

The c-structure annotation on Q features a constraining equation which ensures that *kya* can only be inserted 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 ϕ projection.

If *kya* is indeed associated with an LH in the speech signal, this can be identified as a constituent question. This information is passed along to the f-structure via the second annotation under Q in (23): an equation assigning the value "constituent" to the feature QUESTION-TYPE.

6.2.2 Polar *kya*

The analysis for polar *kya* is shown in Figure 13. Here *kya* is analyzed as an immediate daughter of S. Given that all immediate daughters of S can scramble

as part of the word order variation exhibited in Urdu/Hindi, the ability of *kya* to scramble can be dealt with via the shuffle operator on a par with the other major constituents of S.

The c-structure analysis in Figure 13 is only possible if *kya* does not carry an LH ($\neq$ LH).

(24) S $\longrightarrow$ ... Q ...
$(\natural(T(*))$ S ToBI) $\neq$ LH
(↑QUESTION-TYPE) = polar

Again, the lexical entry for *kya* has nothing in particular to say with respect to syntax other than that it is a Q. It is the same underspecified entry seen in Figure 12. The annotations on Q in (24) say two things: 1) this is a polar question; 2) but only if there is no LH on *kya*. The information as to whether the negative constraint on Q in (24) is satisfied or not is again determined via the *Transfer of Structure*, which relates prosodic with syntactic information via the $\natural$ projection.

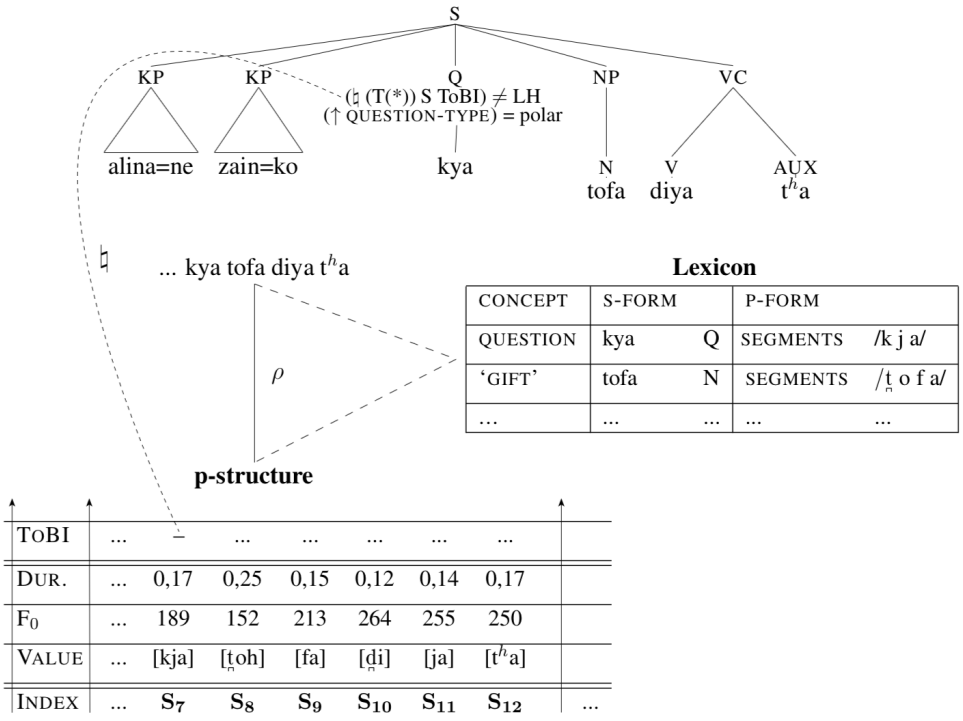

Figure 13: *kya* as a polar question

The production experiment in section 5.1 showed that the prosody of the noun following *kya* changes on the basis of its interpretation as a polar or wh-constituent question. In our analysis here, we have not included the prosodic information on the following noun. When *kya* is placed at the preverbal position, the prosody of the following noun can help disambiguate between two readings of *kya*. However,

as polar *kya*, being a focus sensitive operator, associates with the prominent item anywhere in the sentence (Biezma et al., 2017), 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.

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 the immediately preverbal 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 modelled 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 prosody associated with it differs quite starkly. With the help of a production experiment, 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 and positional difference in the production of polar and wh-constituent *kya*. 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 the 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 can then also be triggered on the basis of the available syntactic information. We do not deal with the semantics and pragmatics of *kya* in this paper, but leave that for further research (building on Biezma et al. (2017)).

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