Urdu/Hindi Questions at the Syntax-Pragmatics-Prosody Interface

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Context

- Part of a Research Unit (FOR 2111) *Questions at the Interfaces* at Konstanz
    - Looking at non-canonical uses of questions across languages
    - We are Project P4, working on Urdu/Hindi
    - Biezma is Project P2, looking at Romance
- Generally trying to understand the interplay between **prosody, morphosyntax** and **semantics/pragmatics**.
- This talk:
    - polar *kya* 'what' vs, other question types
    - focus on issues at the prosody-syntax interface

Structure of Talk

1. Some background on questions in Urdu/Hindi
2. Uses of *kya* 'what'
3. Polar *kya*: interaction between prosodic information, syntax and interpretation
4. Ambiguous Strings: Polar *kya* and wh-constituent (thematic) *kya*
5. Resolution via a new proposal for the Prosody-Syntax Interface
6. Outlook and Summary

Background: Questions in Urdu/Hindi

Urdu/Hindi has traditionally been characterized as a **wh-in-situ** language (but also see Bayer and Cheng 2015).

(1) a. sita=ne   dʰyan=se   **ram=ko**   dekʰ-a   tʰ-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   dʰyan=se   **kɪs=ko**   dekʰ-a   tʰ-a?
         Sita.F=Erg carefully   who.Obl=Acc see-Perf.M.Sg be.Past-M.Sg
         'Who had Sita looked at carefully?'

The default word order in Urdu/Hindi is **SOV**.

Background: Questions in Urdu/Hindi

- The **default** position for wh-words is actually not the in-situ position.
- It is the immediately **preverbal** position.
- This is the default focus position
  (Gambhir 1981, Butt and King 1996, 1997, Kidwai 2000).

  (2) a. **sita=ne**   ram=ko   dekʰ-a   tʰ-a
           Sita.F=Erg Ram.M=Acc see-Perf.M.Sg be.Past-M.Sg
           'Sita had seen Ram.'

       b. ram=ko   **kıs=ne**   dekʰ-a   tʰ-a?
           Ram.M=Acc who.Obl=Erg see-Perf.M.Sg be.Past-M.Sg
           'Who saw Ram?'

Default Position for Focus

- Féry et al. (2016) conducted a comparative study of Hindi and Indian English.
- They asked questions like:
    - *In front of the well, who is pushing the car?* (Questioning the Subject)
    - *In front of the well, what is the man pushing?* (Questioning the Object)
- They found the following word orders in the responses.

	SOV	OSV
Subject Questioned (n=28)	6	22
Object Questioned (n=26)	26	–

$\implies$ Default information focus position is immediately preverbal.

Wh-Questions in Bollywood Scripts

- We extracted wh-words (kwords) from 12 Bollywood Scripts.
- The table shows the word order distribution of a subset of wh-words
- Again, the default position is the immediately preverbal position.

Distribution	Core Arguments (without *kya*)	Adjuncts ('where', 'when')	Total
Single Word	28	14	42
Initial	9	10	19
Medial	2	12	14
Preverbal	**118**	**209**	**327**
In Verbal Complex	0	5	5
Postverbal/Final	6	7	13
Embedded	12	17	29
No Verb	14	5	19
Total	189	279	468

Scrambling of Wh-Constituents

- Besides the default position, wh-words can appear anywhere in the clause:
    1. They have exactly the same kind of scrambling possibilities as normal NPs (Manetta 2012).
    2. **But:** there is a difference in interpretation which has to do with information structure.
- More research needs to be done on this (e.g., see Butt et al. 2016).
- Focus of this talk:
    - the multifunctional uses of *kya* 'what'
        - wh-constituent questions
        - polar questions
        - (alternative questions)
    - and disambiguation possibilities via the prosody-syntax interface.

Uses of *kya* 'what'

Thematic wh-word 'what'

1 As a wh-constituent

(3) sita=ne **kya** dekʰ-a tʰ-a
Sita.F=Erg what see-Perf.M.Sg be.Past-M.Sg
'What had Sita seen?'

2 Within an NP

(4) 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?'

Uses of *kya* 'what'

- Wh-counterpart of the scope marking construction (Dayal 1996, 2000)
- Licenses matrix scope of wh-in-situ

  (5) a. sita   **ye**   soc-ti   hai   [ki ram
          Sita.F.Nom this think-Impf.F.Sg be.Pres.3.Sg that Ram
          ja-ye-ga]
          go-3.Sg-Fut-M.Sg
          'Sita thinks that Ram will go.'
          (lit.: Sita thinks this, that Ram will go.)
       b. sita   **kya** soc-ti   hai   [ki kon
          Sita.F.Nom what think-Impf.F.Sg be.Pres.3.Sg that who
          ja-ye-ga?]
          go-3.Sg-Fut-M.Sg
          'Who does Sita think will go?'
          (lit.: What does Sita think, that who will go?)

Uses of *kya* 'what'

The *kya* 'what' is also found with in alternative questions
(Han and Romero 2004, Bhatt and Dayal 2014).

(6)   (kya) candra=ne kofi p-i ya cai?
       what Chandra.F=Erg coffee.F.Nom drink-Perf.F.Sg or tea.F.Nom
       'Did Chandra drink tea or coffee?'

Much more to be said about these.

- complex patterns that need to be explained
- not focus of this talk

kya and Alternative Questions

- **Interesting Puzzle:** Bhatt and Dayal (2014) show that when *kya* is initial, one can get two readings with sentences containing 'or'.

    (7) **kya** candra=ne kofi ya cai p-i?
         what Chandra.F=Erg coffee.F.Nom or tea.F.Nom drink-Perf.F.Sg
         'Did Chandra drink tea or coffee?'
         Alternative Question Reading: Did Chandra drink tea or did she drink coffee?
         Polar Question Reading: Is it the case that Chandra drank either tea or coffee?'

- But when the *kya* is final, the alternative question reading is out.

    (8) candra=ne kofi ya cai p-i **kya**?
         Chandra.F=Erg coffee.F.Nom or tea.F.Nom drink-Perf.F.Sg what
         'Did Chandra drink tea or coffee?'
         *Alternative Question Reading: Did Chandra drink tea or did she drink coffee?
         Polar Question Reading: Is it the case that Chandra drank either tea or coffee?'

Polar Questions

- Urdu/Hindi has basic SOV word order.
- Question vs. declarative status is signaled via intonation (with some variation).

Declarative: Intonational phrase boundary is L-L%

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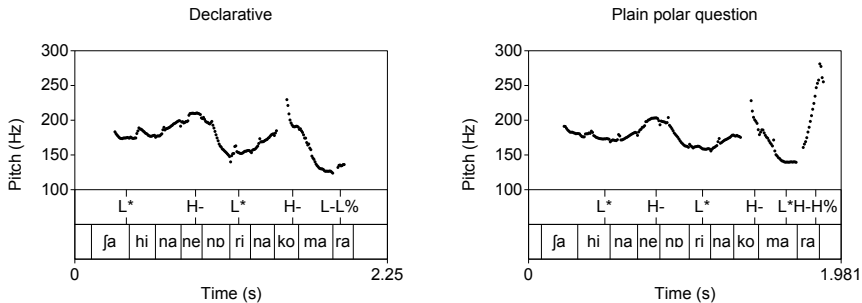   'Shahina hit Norina.'   (Declarative)

Polar Question: Intonational phrase boundary is L/H-H%

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

Polar Questions

Figure: F$_0$ contour of a string identical declarative and polar question.

Polar *kya* 'what'   ✿

- Polar questions can optionally be expressed with *kya* 'what'.

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

- Grammars and previous literature report polar *kya* as appearing only clause initially in Urdu/Hindi.

Polar *kya* 'what'

- In contrast, Bhatt and Dayal (2014) point out that it can appear anywhere in the clause.

  (12) (kya) ɑnu=ne   (kya) uma=ko (kya) kɪtab   (%kya) d-i   (kya)?
        what A.F=Erg what U.F=Dat what book.F.Sg.Nom what   give-Perf.F.Sg what

  'Did Anu give a/the book to Uma?

- However, it is strongly **dispreferred** in immediately preverbal position.
- Hypothesis: this is because the immediately preverbal position is the default position for:
  - focus
  - and therefore **wh-constituent questions**.

Polar *kya* 'what'

- Bhatt&Dayal establish that polar *kya* is NOT a question marker.
    - It is optional in matrix clauses.
    - Generally disallowed in embedded clauses (complements of "rogative" predicates like 'wonder' and 'ask' are an exception).

- **Current State of Our Art** (Biezma et al. 2018)
    - Polar *kya* is a focus sensitive item which serves to constrain the set of possible answers viable in the context of an utterance.
    - It imposes restrictions on what the question is about.
    - Polar *kya* questions convey some assumptions regarding the possible answers that plain information-seeking questions do not convey.

Proposal So Far (Biezma et al. 2018)

- We build on Biezma and Rawlins (2012), which bridges (Hamblin) semantics and discourse using the Q(uestion)U(under)D(iscussion) discourse model.
- According to Biezma and Rawlins (2012), polar questions
    a. state that the content proposition is a possible answer
    b. inquire whether the content proposition holds (its semantics is merely the singleton set)
    c. require that other alternatives are available in discourse.
- Polar *kya* further conventionally imposes that the possible answers be a subset of the focus alternatives of the utterance.

Our Current Proposal (Biezma et al. 2018)

Polar questions denote singleton sets (based on Biezma and Rawlins 2012),
see also (Roberts 1996, Farkas and Bruce 2010, a.o.)

(13) $[\![_{[\mathbf{Q}]} \; \alpha \;]\!]^c = [\![\alpha]\!]^c$
         defined only if

     a. $[\![\alpha]\!]^c \subseteq \mathsf{QUD}(\mathsf{M}_{?\alpha})$
     b. $|\; [\![\alpha]\!]^c \cup \mathsf{QUD}(\mathsf{M}_{?\alpha}) \;| > 1$

Polar *kya*-questions

(14) $[\![_{[\mathbf{Q}]} [\_\_ \, \boldsymbol{kya} \; m_{\mathbf{F}} \; \_\_]]\!]^c = [\![[\_\_ m \; \_\_]]\!]^c$
         defined only if

     a. $[\![[\_\_ m \; \_\_]]\!]^c \subseteq \mathsf{QUD}(\mathsf{M}_{kya})$
     b. $|\; [\![[\_\_ m \; \_\_]]\!]^c \cup \mathsf{QUD}(\mathsf{M}_{kya}) \;| > 1$
     c. $\mathsf{QUD}(\mathsf{M}_{kya}) \subseteq [\![[\_\_ m_{\mathbf{F}} \; \_\_]]\!]^f$

An Example:

- Polar-*kya* is a focus sensitive question operator.
- It constrains the alternatives that the speaker is entertaining.

(15)   Ravi gave *kya* [a toy]$_F$ to Amra?
       $\llbracket$**Ravi gave** *kya* **[a toy]$_F$ to Amra?**$\rrbracket^c =$
       $$\llbracket \textbf{Ravi gave a toy to Amra} \rrbracket^c =$$
       $$\{\text{Ravi gave a toy to Amra}\}$$

   defined only if

   a. $\{\text{Ravi gave a toy to Amra}\} \subseteq \text{QUD}(M_{kya})$
   b. $|\{\text{Ravi gave a toy to Amra}\} \cup \text{QUD}(M_{kya})| > 1$
   c.
       $$\text{QUD}(M_{kya}) \subseteq \left\{ \begin{array}{l} \text{Ravi gave a toy to Amra;} \\ \text{Ravi gave a book to Amra;} \\ \text{Ravi gave a game to Amra;} \\ \qquad \qquad \cdots \end{array} \right\}$$

       $\simeq$ What did Ravi give to Amra?

Further Predictions — The Answer "Nothing"

- The 'topic'/QUD has to be regarding what Ravi gave to Amra in (16).

  (16) ravi=ne   amra=ko   **kya   kʰilona**   di-ya?
        Ravi=Erg Amra=Dat what toy.M.Sg.Nom give-Perf.M.Sg
        'Did Ravi give a toy to Amra?'

- The QUD conventionally enforced with a polar *kya*-question entails that Ravi gave something to Amra in (16).

Given the constraints (conventionally) imposed by polar *kya*-questions on the QUD, we rule out the possibility of having 'Ravi didn't give anything to Amra' as an answer to (16).

Non-serious Invitations

A doesn't feel like offering coffee to their visitor and wishes the offer to be declined. If the speaker is not afraid of this coming across, s/he wouldn't utter the *kya*-question:

(17) (kya) ap   (kya) coffee   l-ẽ-g-e?
      what you.Hon   what coffee.F.Sg take-2.Pl-Fut-M.Pl
      'Will you have coffee?'

The polar *kya*-question excludes *nothing*.

Surprise, incredulity...

- A corpus study (Bollywood movies) has yielded the observation that polar *kya* questions tend to be used in situations when an extra pragmatic import is to be conveyed (e.g., rhetoricity, sarcasm, surprise, ...).

- We see these as derivative, following from the analysis of polar *kya* as a focus sensitive operator.

(18)   **kya**   ye   sɑc   hai?
       what   this   true   be.Pres.3Sg
       'Could this be true?'   Script, *Socha Na Tha*

(19)   kya   mɛ̃   tʊm=se   pyar   kɑr-ta   hũ?
       what   I   you=Inst   love   do-Impf.M.Sg   be.Pres.1Sg
       'Is it possible I am in love with you?'   Script of *Socha Na Tha*
       Context: guy has been chasing woman X the whole movie and has now just figured out
       that he is actually in love, with woman Y, his best friend.

kya can associate with the entire proposition.

Alternative Analyses

- Bhatt and Dayal (2014) invoke given vs. new in their analysis. and see the polar *kya* as a question operator that interacts with topicalization.
- (Newer work by Bhatt and Dayal sees the distinction as being between at-issue and non-at-issue information.)
- Syed and Dash (2017) compare polar 'what' across Hindi, Bangla and Oṛiya and also see polar 'what' as a focus sensitive operator.

Taking Stock

- Both approches treat polar 'what' on a par with plain polar questions — not aware of the extra pragmatic nuances.
- Neither proposal seriously factors in the **prosodic dimension**.
- However, this dimension is crucial for the **disambiguation** between various uses of *kya* 'what'.

Polar kya vs. Constituent Questions

Some utterances are ambiguous between polar *kya* and wh-constituent questions.

(20) mɛ̃   **kya** bol-ũ?
      I.Nom what speak-1.Sg
      Constituent Question: 'What should I say?'
      Polar Question: 'Should I say (something)?'   Script, *Ankhon Dekhi*

(21) **kya** tɑklif   ho rɑh-i   hai   [. . .]?
      what bother.Nom be Prog-F.Sg be.Pres.3.Sg
      Constituent Question: 'What's bothering (you)?'
      Polar Question: 'Is something bothering (you)?'   Script, *Ankhon Dekhi*

(22) shahina=ne naz=ko **kya** tofa   di-ya
      Shahina=Erg Naz=Acc what present.M.Sg give-Perf.M.Sg
      Constituent Question: 'What gift did Shahina give to Naz?'
      Polar Question: 'Did Shahina (actually) give a gift to Naz?'

Ambiguity in Syntax

- There are two possible syntactic (and thus semantic) analyses:
  - as a constituent question
  - as a polar question
- For our syntactic analysis, we use Lexical-Functional Grammar
 (LFG; see the brandnew introduction by Börjars, Nordlinger, and Sadler)

Syntactic Analysis - the LFG Architecture

- There are two syntactic representations in LFG.
    - c(onstituent)-structure: represents linear order, hierarchical relationships and constituency
    - f(unctional)-structure: represents basic predicate-argument relations and functional information
- Below is a simplified analysis (Butt and King 2015).

(1) a. Yassin will watch the movie.
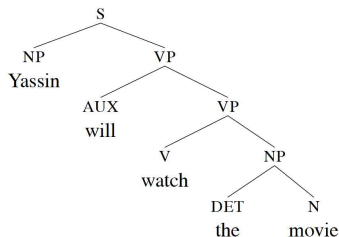
b. **c-structure** c. **f-structure**

LFG Architecture

- LFG has a *projection architecture*.
- The different levels of representation are related to each other via mathematically defined projections.
- c-structure and f-structure are related to one another by the ϕ-projection, realized below via f-structural annotations on c-structure.
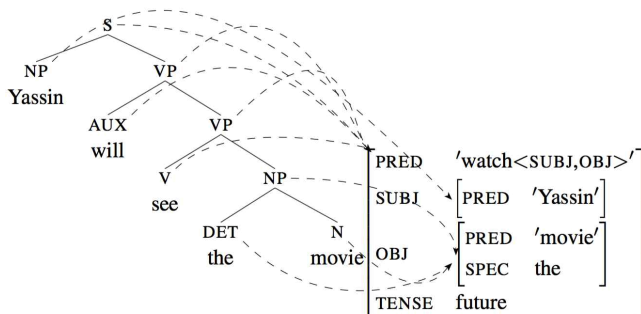
a.   S $\longrightarrow$ NP   VP
                        ($\uparrow$SUBJ)=$\downarrow$ $\uparrow$=$\downarrow$

b.   VP $\longrightarrow$ AUX   VP
                        ($\uparrow$TENSE) = $\downarrow$ $\uparrow$=$\downarrow$

c.   VP $\longrightarrow$ V   NP
                        $\uparrow$=$\downarrow$ ($\uparrow$OBJ)=$\downarrow$

Projection

- Each piece of the c-structure thus contributes information to the f-structure.

(2) Yassin will watch the movie.

- The f-structure provides the main basis for further semantic analysis.

LFG's Projections

Over the years, more projections than the original core c-structure, f-structure and s(emantic)-structure have been argued for:

- a(rgument)-structure: place for thematic roles and information about predicate composition (complex predicates)
- i(nformation)-structure: place for information structural components (inspired mainly by Vallduvi (1992)).
- p(rosodic)-structure: place for intonational and prosodic information (Butt and King (1998), Mycock (2006), Bögel (2015))

The architecture of LFG allows for complex interactions across projections.

Syntactic analysis of Urdu *kya*

- We follow the general syntactic analyses as established as part of the Urdu grammar (Butt and King, 2007).
- Following Slade (2011), we analyze the *kya* as a Q.
- We assume one underspecified *kya* for the polar and the *wh*-readings.
- The underspecification is realized as a disjunction in the lexical entry below.
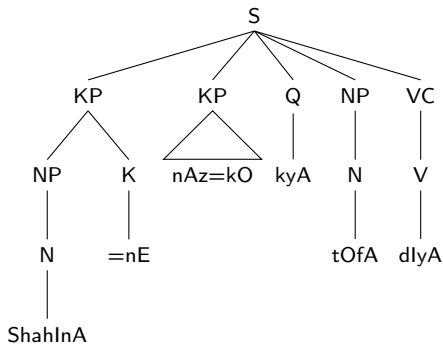
kyA	Q	{ (↑ QUESTION-TYPE)	= polar
		| (↑ QUESTION-TYPE)	= const}
		...	

One String — Two Possible Analyses

Wh-Question
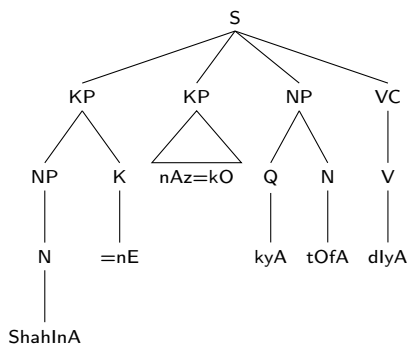
Polar kya

$\rightarrow$ Spelling: Tansliteration from Arabic-based Urdu script (Malik et al. 2010).

Syntactic ambiguities - resolved by prosody

Ambiguous interpretation cannot be resolved by means of syntax alone!

(23)   shahina=ne naz=ko **kya** tofa   di-ya
       Shahina=Erg Naz=Acc what present.M.Sg give-Perf.M.Sg
       a) Polar Question: 'Did Shahina (actually) give a gift to Naz?'
       b) Constituent Question: 'What gift did Shahina give to Naz?'

           a) `Play Sound`   b) `Play Sound`

$\rightarrow$ Conclusion: prosodic information crucial for the overall analysis!

- The thematic wh-word *kya* has a high tone: H* (LH*?)
- The polar *kya* is always flat or falling

Question:

How should the prosodic information be integrated into the analysis (architecture wise) so it enables a disambiguation of the syntactic analyses?

$\Rightarrow$ We analyze *kya* at the prosody–syntax interface following the proposal made by Bögel (2015).
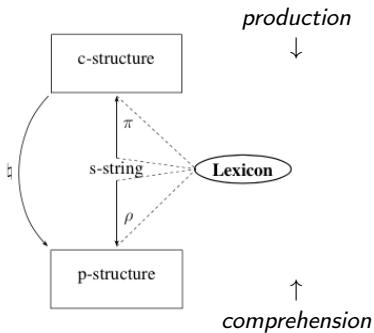
The Prosody-Syntax interface - the theory

Two perspectives:

(Roughly following models as proposed by, a.o., Levelt (1999) and Jackendoff (2002)

- *Production*: from meaning to form (syntax $\rightarrow$ prosody)
- *Comprehension*: from form to meaning (prosody $\rightarrow$ syntax)

production
↓

comprehension
↑

♮: The *Transfer of structure* $\rightarrow$ Information on (larger) syntactic and prosodic phrasing, and on intonation is exchanged

ρ: The *Transfer of vocabulary* $\rightarrow$ Associates morphosyntactic and phonological information on lexical elements and projects them to their respective structures

P-structure – the p-diagram (during comprehension!)

Input to the p-diagram comes from the speech signal

- $\rightarrow$ linear representation
- $\rightarrow$ structured syllablewise
- $\Rightarrow$ Each syllable is part of a vector associating the syllable with relevant values:
  - $\rightarrow$ F_0, *duration, intensity, ...*

PHRASING	σ	σ	σ	...	
...	...	...	...	...	
DURATION	0.25	0.17	0.18	...	
F_0 (mean)	193	200	222	...	
VALUE	[sha]	[hi]	[na]	...	
V. INDEX	S_1	S_2	S_3	...	

P-structure – from signal to interpretation

- **Input:** The 'raw' speech signal information:

DUR.	0.25	0.17	0.18	0.14	0.31	0.13	0.24	0.15	0.19	0.14	0.16	SIGNAL
F_{0_mean}	193	200	222	241	198	231	248	224	193	174	205	↓
VALUE	[sha]	[hi]	[na]	[ne]	[naz]	[ko]	[kja]	[toh]	[fa]	[di]	[ja]	
INDEX	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	...

$\rightarrow$ Pauses, patterns in F_0 and other acoustic indicators can be further interpreted

- **Interpretation:** Categorical interpretation on the basis of 'raw' information:

PHRAS.	$(_\iota\ (_\varphi$	...	...	...	...	...	...	...	...	...	$)_\varphi)_\iota$	INTERPRETATION
TOBI	...	...	...	...	...	...	H*	...	...	...	...	↓
DUR.	0.25	0.17	0.18	0.14	0.31	0.13	0.24	0.15	0.19	0.14	0.16	SIGNAL
F_{0_mean}	193	200	222	241	198	231	248	224	193	174	205	↓
VALUE	[sha]	[hi]	[na]	[ne]	[naz]	[ko]	[kja]	[toh]	[fa]	[di]	[ja]	
INDEX	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	...

$\rightarrow$ Includes language-specific prosodic/phonological readjustments

At the interface

The information stored in p-structure is communicated to syntax via two transfer levels:

- The Transfer of Structure (suprasegmental information)
- The Transfer of Vocabulary (segmental/lexical information)

During the Transfer of Vocabulary, p-structure is matched against the **multidimensional lexicon** of LFG

The Transfer of Vocabulary

- Associates morphosyntactic and phonological information on lexical elements
- $\rightarrow$ via the multidimensional lexicon ...

s(yntactic)-form				p(honological)-form	
tOfA	N	($\uparrow$ PRED)	= 'tOfA'	P-FORM	[tofa]
		($\uparrow$ NUM)	= sg	SEGMENTS	/t o f a/
		($\uparrow$ GEND)	= masc	METR. FRAME	$('\sigma\sigma)_\omega$
kyA	Q	{ ($\uparrow$ QUESTION-TYPE)	= polar	P-FORM	[kja]
		| ($\uparrow$ QUESTION-TYPE)	= const}	SEGMENTS	/k j a/
		...		METR. FRAME	σ

- Each lexical dimension can only be accessed by the related module
- $\rightarrow$ Modular: strict separation of module-related information
- $\rightarrow$ Translation function: Once a dimension (here: p-form) is triggered, the related dimensions can be accessed as well.
- $\Rightarrow$ Associated **s-form is selected and made available to c-structure**.

The Transfer of Vocabulary II

c-structure

$\uparrow$

Lexicon:

s(yntactic)-form	
$(\uparrow \text{PRED})$	= 'ShahInA'
$(\uparrow \text{NUM})$	= sg
$(\uparrow \text{GEND})$	= fem
p(honological)-form	
P-FORM	[shahina]
SEGMENTS	/s h a h i n a/
METR. FRAME	$(\sigma'\sigma\sigma)_\omega$

$\uparrow$

P-structure:

DURATION	0.25	0.17	0.18	...
F_0 (mean)	193	200	222	...
VALUE	[sha]	[hi]	[na]	...
V. INDEX	S_1	S_2	S_3	...

The Transfer of Structure (during comprehension)

For <u>constituent</u> *kya*:

C-structure:

$$Q$$
$$(\natural(T(*))\ S\ \text{ToBI}) =_c (L)H^*$$

P-structure:

ToBI	...	H*	...	...
...	...	...	...	...
VALUES	[...]	[...]	[...]	[...]
V.INDEX	S_3	S_4	S_5	S_6

Translate as:
for each terminal node **T** *under the current node (***=Q), for the syllable* **S** *the value for the attribute* **ToBI** *must be (=$_c$)* **H***.

$\rightarrow$ For polar *kya*: $(\natural\ (T(*))\ S\ \text{ToBI})\ \tilde{}\ = H^*$

Overall framework - during comprehension

... and production...

Overall framework - during production (quick walk ...)

Input to p-structure from:

– syntactic-to-prosodic phrasing (e.g., 'match')

– lexical p-form information

– subject to postlexical phonology and

  prosodic well-formedness constraints

$\rightarrow$ Foundation for the interface to phonetics

Taking stock II

- Urdu *kya* can be syntactically ambiguous between a constituent and a polar interpretation
- However, there is a prosodic difference:
    - constituent *kya* is indicated by an (L)H*
    - polar *kya* has a flat or falling pitch
- At the prosody-syntax interface, the syntactically ambiguous structures can thus be resolved with reference to prosody
- We can formally analyze this process in the theoretical LFG framework.
- The prosody-syntax interface proposed by Bögel (2015) is psycholinguistically well informed.

Question: Can we also implement this computationally?

Computational implementation: ParGram and XLE

- LFG was designed to be computationally tractable from its very beginnings.
- Various computational grammar development platforms.
- The PARC based XLE is an industrial-strength state of the art platform (Crouch et al. 2017).
- Computational grammars for interesting range of languages have been built over the years (Sulger et al. 2013) using the ParGram (Parallel Grammar) approach (Butt et al. 1999).
- Some of these can be accessed via the CLARIN XLE Website (http://clarino.uib.no/iness/xle-web for a range of implemented grammars)

Computational implementation: INESS
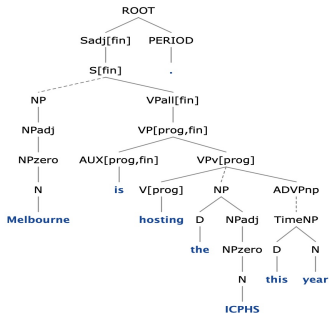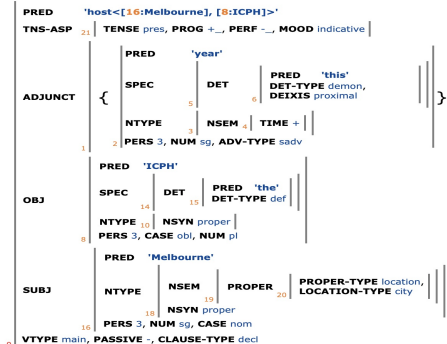
Computational implementation

- Some of the architectural extensions proposed for LFG have not been implemented.
- The connection to speech has not been attempted
    - neither text-to-speech
    - nor speech processing
- **Question:** can Bögel's proposal for the prosody-syntax interface be implemented and interfaced with existing grammars?
- In this talk: work with a 'toy' (small) grammar to establish proof of concept.

DEMO: *shahina ne naz ko kya tofa diya* → ShahInA nE NAz kO kyA tOfA dIyA

- Spelling: effect of transliteration (aim is to have a core grammar for Urdu AND Hindi)

Yes we can!

Rule-based Implementation with Perl (aided by Praat scripting and XLE)

1. Extract information from the speech signal
2. Transform 'raw' signal information into categorical units (= prosody): the p-diagram
3. Match syllables against the lexicon to acquire s-forms
4. Check whether *kya* carries H*
5. Parse the tree via XLE

1. Extract information from the speech signal

- **Input**: (smoothed) wav+TextGrid with syllables

| sha | hi | na | ne | naz | ko | kja | toh | fa | di | ja |
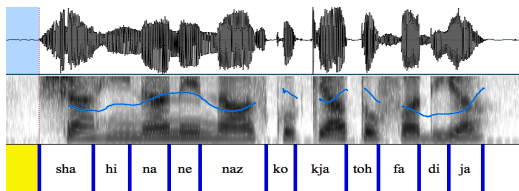
- Relevant information extracted syllablewise (via Praat):
    - syllable value
    - start/end time and duration
    - min/max/mean F_0
    - F_0 at 7 evenly distributed points across the syllable
    - (intensity)
    - ...

2. Creating the p-diagram

- Recalculate all pitch values into semitones (=normalization)
- **Remodel the pitch**: subtract each semitone from the following one

Rising		Falling	
Semitone diff	*Category*	*Semitone diff*	*Category*
0.5 > x > 0	m	-0.5 < x < 0	m
1 > x > 0.5	mH	-1 < x < -0.5	mL
1.5 > x > 1	H1	-1.5 < x < -1	L1
2 > x > 1.5	H2	-2 < x < -1.5	L2
2.5 > x > 2	H3	-2.5 < x < -2	L3
x > 2.5	H4	x < -2.5	L4

- Determine the pitch movement **within** the syllable and **across** the syllable to identify pitch accents and boundary tones (e.g., boundary tone: a strong rise followed by a 'reset' of pitch across two syllables)
- $\rightarrow$ Associate phonological phrase boundaries with the boundary tones

3. Matching against the lexicon

- Originally implemented as finite state transducers - access only the 'fully-fledged' form
- Syllables are matched against the lexicon
    - If match is found, the match is stored
    - But: search continues to ensure exhaustive parsing: (sha.hi.)na.)(ne.)
- Output is a lexicon with s-forms, p-forms, and p-form information for the parsed sentence
- → s-forms are handed over to syntax

4. Parsing with XLE

- For *kya*, the algorithm checks back to the p-diagram for the ToBI-value
- Depending on the result, the sentence with *kya* is either parsed as a constituent question or a polar question.

Further comments:

- Should be reversible as well (although not at the phonology-phonetics interface)
- Algorithm provides structures that need to be discussed 'in theory'
- Acquired information can be used for 'reannotation'

DEMO

5. Semantic/Pragmatic Interpretation

For semantic/pragmatic analysis, the following information becomes available via the syntax-prosody interface:

1 The fact that it is a polar question
   `QUESTION-TYPE polar`

2 The fact that there was a *kya*
   `INT-FORM kya`

3 What material the polar *kya* can be associated with:

- Material to its right, in particular the constituent on its immediate right (via f-precedence and right sister).
- Material that is prosodically stressed (via a Metarulemacro that checks for each constituent whether it was stressed via the prosody-syntax interface).
- Preferences for association (via integration of OT-style constraints).

This information can be passed on to the semantic/pragmatic component and used to construct an analysis at this level (Bobrow et al. 2007).

Architectural Observation — Polar Questions

- Prosody directly indicates meaning: no overt syntactic element implicated (cf. Steedman 2014).
- A general type of solution to this irrelevance of syntax has been to postulate some kind of null element or operator in the syntax.
- For example, Bhatt and Dayal (2014) for Urdu/Hindi polar *kya*, following Han and Romero (2004).

$$[_{CP} \text{ Null-Yes/No-Operator} [\text{ IP }]]$$

- We do not need to postulate a null question operator in the syntax.
- Rather than "reconstructing" the effect of prosody in the syntax via empty elements so that semantic interpretation can proceed correctly, we integrate the relevant prosodic information directly.

Possible future directions

- A computational model of production
- Integration of the calculation of the semantic representation (end-to-end model)
- Implementation for a prosodically well-studied language
- Implementation of 'non-local' phenomena (several indicators)
- Modeling of interaction between prosody and meaning without syntactic clues/ambiguities

Thank You!

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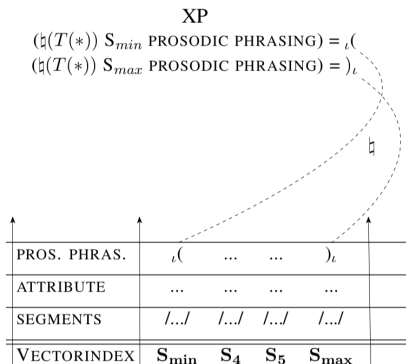
Bollywood Scripts

We have machine readable data (and the movies) for the following scripts:

1 Ankhon Dekhi (2014)
2 Dedh Ishqiya (2014)
3 Dum Laga Ke Haisha (2015)
4 Jab We Met (2007)
5 Lootera (2013)
6 Masaan (2015)
7 NH10 (2015)
8 Queen (2014)
9 Socha Na Tha (2005)
10 Talvar (2015)
11 Titli (2014)
12 Udaan (2010)

The Transfer of Structure ... from syntax to prosody

$$XP$$
$$(\natural(T(*)) \; S_{min} \; \text{PROSODIC PHRASING}) = {}_{\iota}($$
$$(\natural(T(*)) \; S_{max} \; \text{PROSODIC PHRASING}) = {)}_{\iota}$$

PROS. PHRAS.	${}_{\iota}($	...	...	${)}_{\iota}$	
ATTRIBUTE	...	...	...	...	
SEGMENTS	/.../	/.../	/.../	/.../	
VECTORINDEX	S_{min}	S_4	S_5	S_{max}	

- where S_{min} refers to the *first* syllable within the scope of a node
- where S_{max} refers to the *last* syllable within the scope of a node,
  for example: $(\natural(T(*))S_{max} \text{ Phrasing}) = {)}_{\iota}$
$\rightarrow$ In the case of constituent *kya*, Q would be annotated with:
  $(\natural(T(*))S \text{ ToBI}) = $ H*