THE UNIVERSITY of York

UNIVERSITY OF CAMBRIDGE

Centre for Music & Science

Temporal co-ordination in conversation

Richard Ogden, University of York
Sarah Hawkins, University of Cambridge

Research context

- What are the commonalities and differences in the cognitive processes underpinning alignment in different modalities? How does speech relate to other physical (and visible) behaviours?
- How is social alignment achieved in conversation and music-making?
- We talk in time, and we talk in interaction.

This sub-project:

- How is rhythmic organisation used to handle speaker-to-speaker transitions?
- Focus: Question + Answer, a common adjacency pair, where speaker transition is strongly projected by the Q
- What is the temporal relation between Q and A?

Displaying alignment in answers to questions

A: are you enjoying your place now
B: yeah I am, it's great

L: where is that
R: it's near Girton

R: was that here as well
L: I walked in and saw the cameras

demographic questions; initial consent

Minutes

≥ 5	conversation	• How did you get here? • What do you think of the room?
10	non-musical play	• card houses • tallest tower: blocks • market stall: playdough *at least 2*
10	musical play	• xylophone, kalimba • drums, claves ***no shakers!***
10	conversation	• 9/11; Princess Diana's death… • important event you shared

detailed musical questions; final consent; £8

Who?

"Pilot":

5 dyads,

- 3 musician pairs
- 2 non-musician
- various tasks

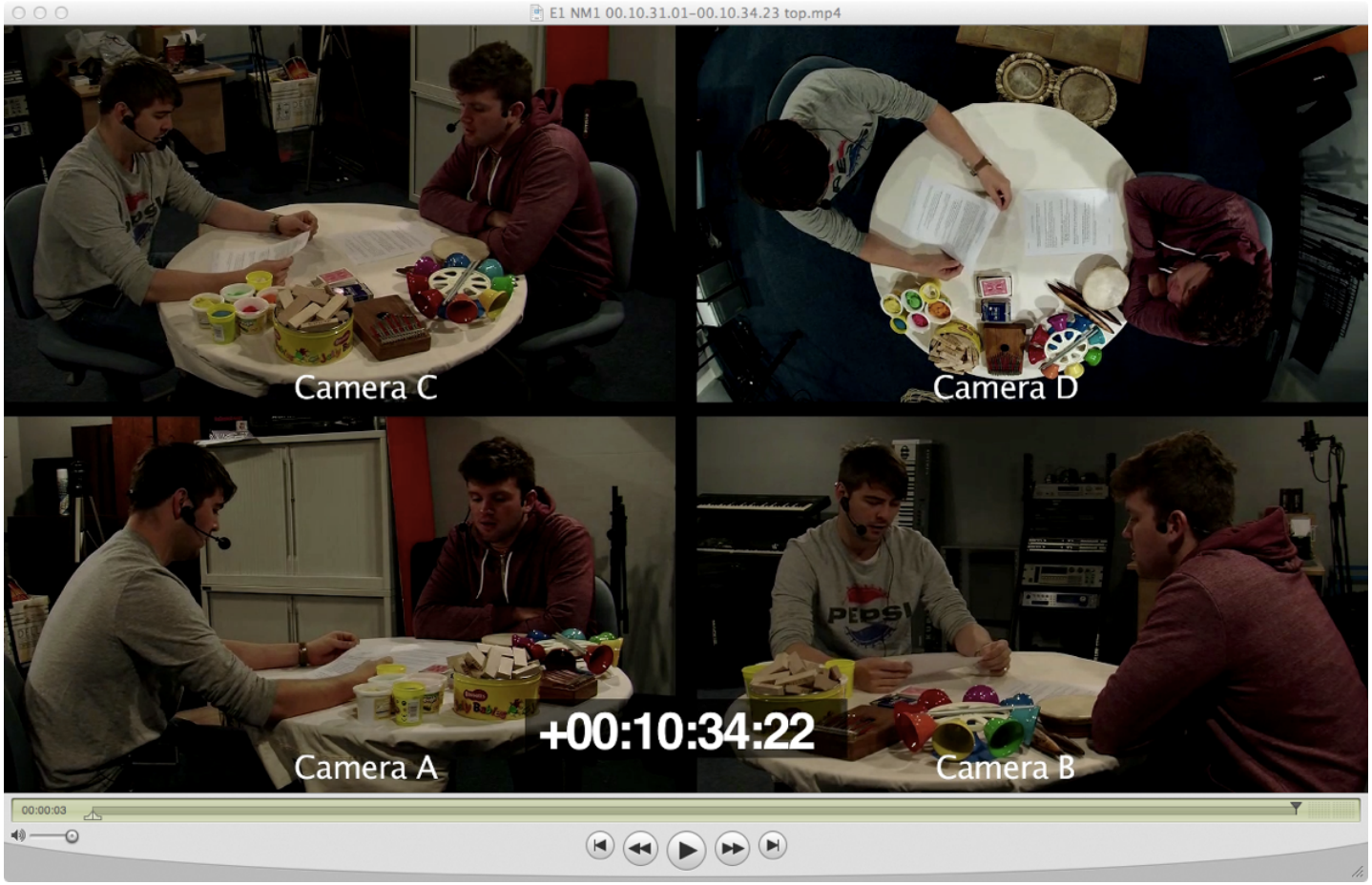
"Experiment 1"

8 dyads	M	F
musician	2	2
nonmusn	2	2

Dyads:

- friends
- same-sex
- native speakers of English
- 18-31 years
- university educated
- both musicians, or both non-musicians

Recording



- 4 video cameras
- overhead omni mike
- stereo pair (music)
- 2 close-talking mikes

Labelling

- A single framework for labelling events, currently with:
  - 22 tiers for speech and movement
  - + 4 for music
- Gesture labelled without audio in Elan;
  speech labelled without video in Praat.
- Tracking beats in speech and music:
  pikes (Loehr 2007): f0 max/min + gesture peak
  currently, largely by hand; automatic (Cummins) tried but rejected—needs more exploration

Pikes: Loehr (2007) Gesture 7(2) 179–214
Cummins beats: http://cspeech.ucd.ie/~fred/beatExtraction.php

‘Pike’

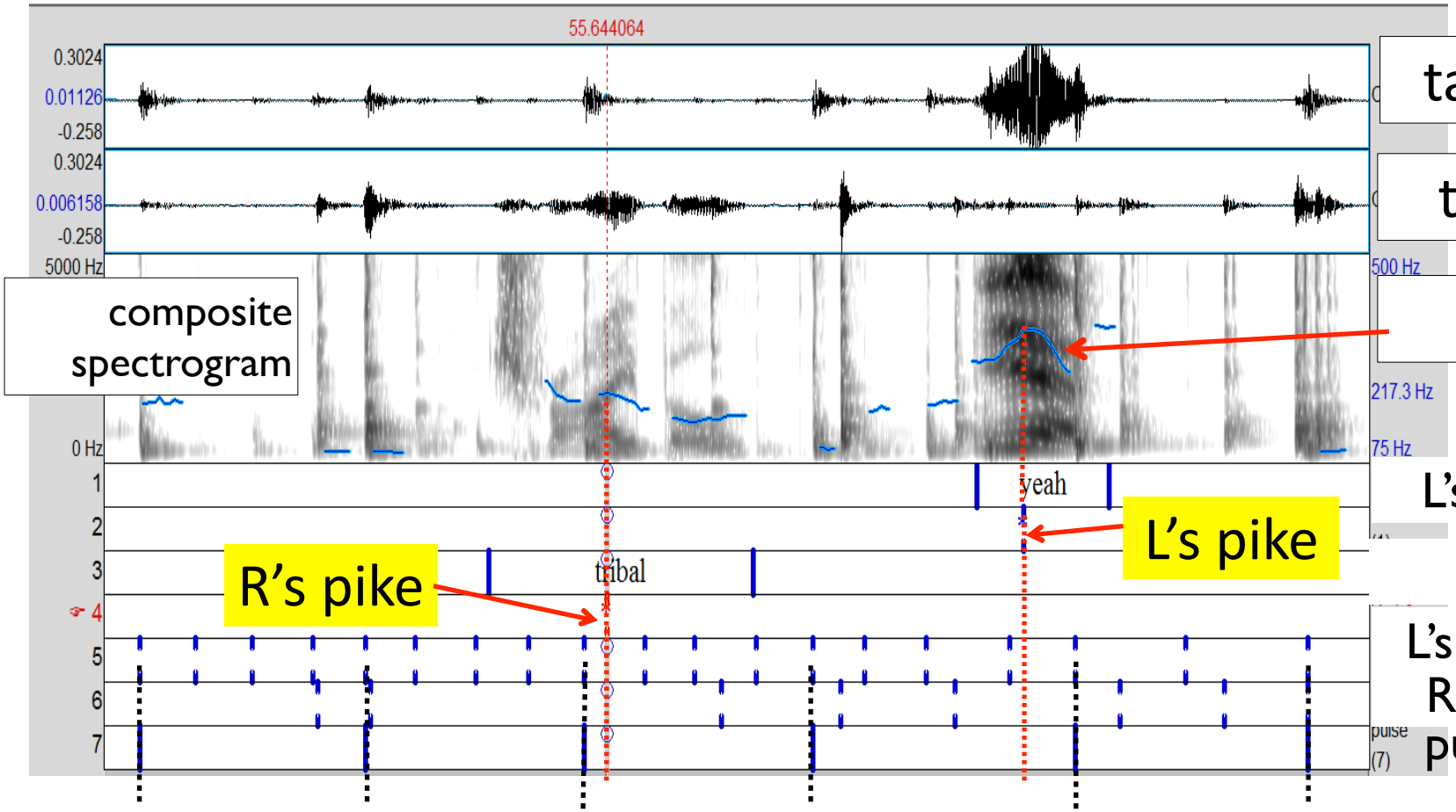
(Loehr 2007, 2012)

- Peaks of physical activity tend to be temporally co-ordinated:
  - F0 prominence
  - blink
  - peak of gesture
- Loehr looks at individuals’ behaviour, not at the use of pikes to co-ordinate behaviour between individuals: can pikes be used as a method to co-ordinate interaction?

Hawkins, Cross & Ogden (2013)

- Looked at transitions between speech and music in musicians and non-musicians
- Showed that both groups use rhythmical pulses in speech and in music to co-ordinate interaction: successful interactions in both modalities show a tighter relation of pulses to pikes, and participants show stronger rhythmic entrainment.

Labelling



talker-player L

talker-player R

composite spectrogram

f0 contour

L's words

L's pike

R's pike

R's words

L's notes

R's notes

pulse (tactus)

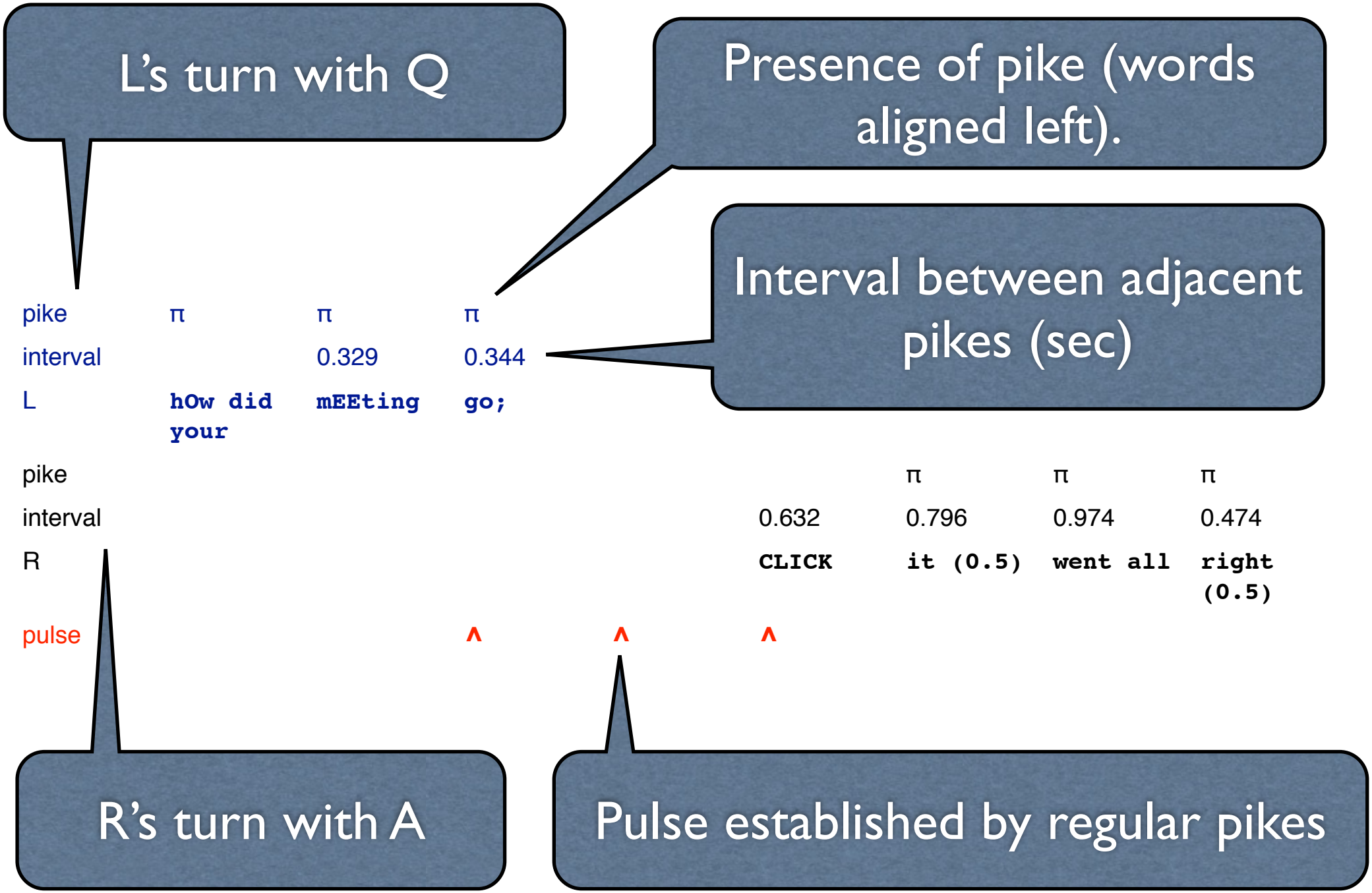
Data analysed here

- A collection of 56 Question + Answer pairs
- Labelled using terms from Stivers et al. (PNAS, 2009), which draws on Raymond (ASR, 2003):
  - Q type: WHQ, YNQ
  - A follows Q?
  - visible component?
  - response preferred/dispreferred

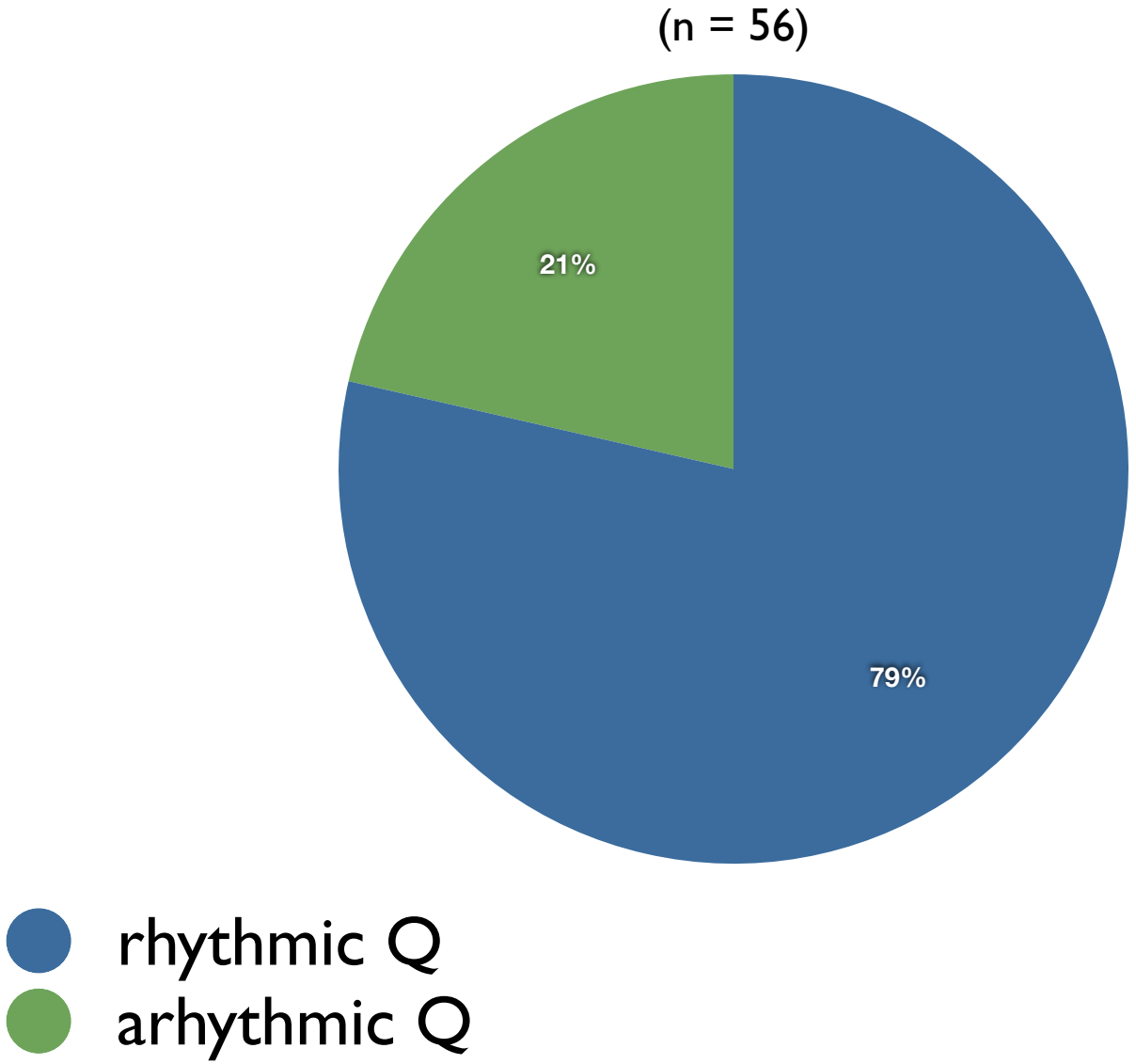
Inter-turn temporal organisation

Couper-Kuhlen, *English Speech Rhythm*, 1993

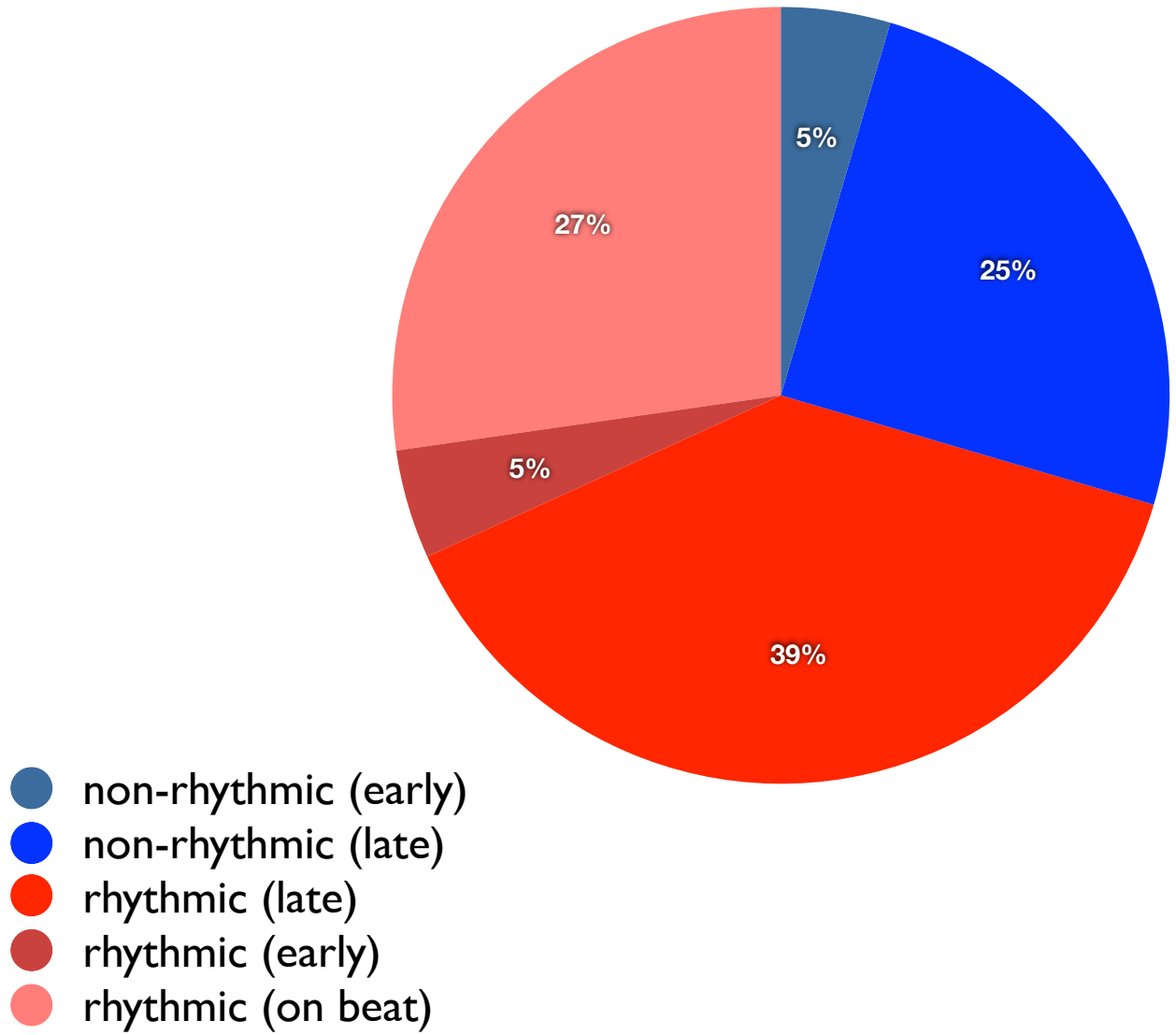
- Presupposes rhythmicity in the Q: 1/5 Qs are arhythmic
- Rhythmic: first pike of A comes in on a beat established in the Q
- Non-rhythmic: first pike of A does not come in on a beat established in the Q
- Timing: early, on-beat, late


L's turn with Q
Presence of pike (words aligned left).
Interval between adjacent pikes (sec)
pike π π π
interval 0.329 0.344
L hOw did mEEting go; your
pike π π π
interval 0.632 0.796 0.974 0.474
R CLICK it (0.5) went all right (0.5)
pulse ^ ^ ^
R's turn with A
Pulse established by regular pikes

Rhythmic vs. Arhythmic Questions



Rhythmic vs. non-rhythmic entry into the turn space (n = 44)



Arhythmic Qs

- Q too short to establish a pulse (minimum of two stressed syllables needed):
  `d'they `rEcognise you. ; <<all> what> `BY you?`
- Q produced too quiet or breathy to measure anything
- Expansion by same speaker in same Turn Constructional Unit, no A
- Perturbations in production of Q (e.g. self-repairs)
- … or just not rhythmic!

Rhythmic, on-beat entry into the turn-space

pike

interval

L

pike

interval

R

pulse

did

L starts an interrogatively formatted Q.
R can already prepare for a yes/no formatted answer.

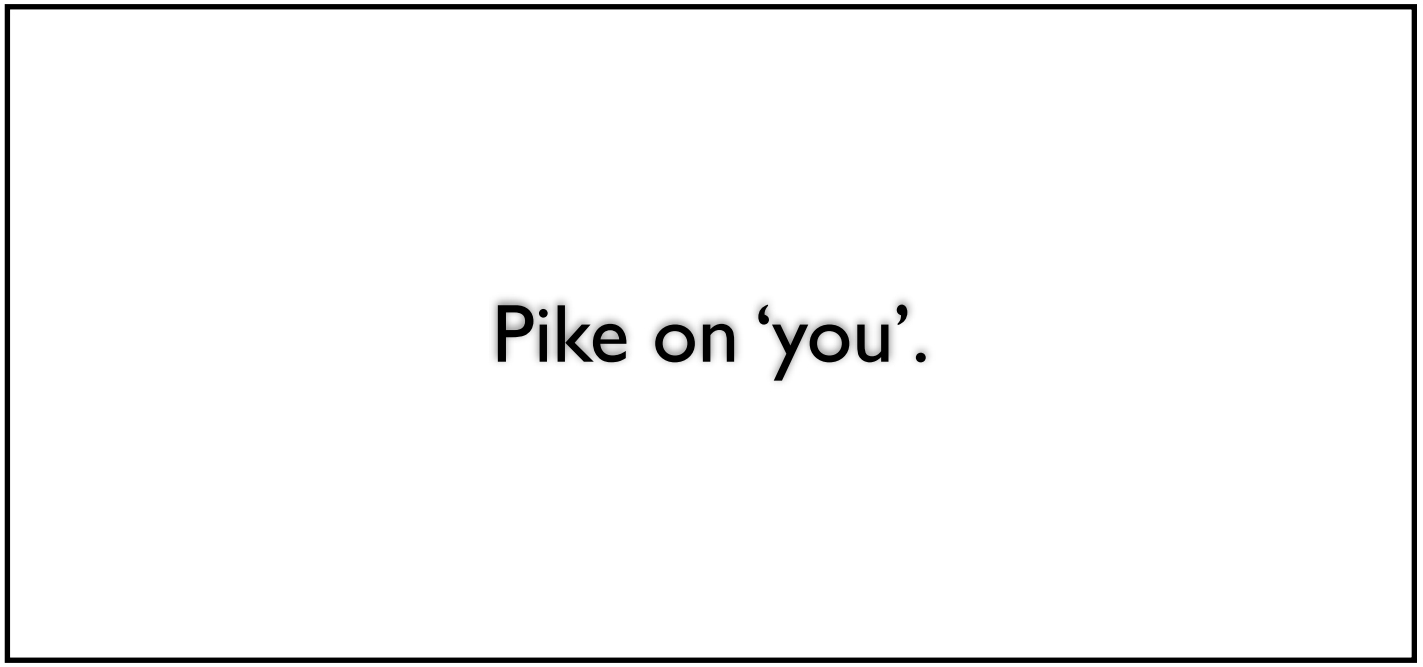
Rhythmic, on-beat entry into the turn-space

pike
interval
L
pike
interval
R

pulse

π

did yOU



Rhythmic, on-beat entry into the turn-space

pike	π	π
interval		0.29
L	**did yOU still**	**gO to**
pike		
interval		
R		
pulse		

Next pike on ‘go’.
Interval of 290ms.

Rhythmic, on-beat entry into the turn-space

pike	π	π	π
interval		0.29	0.36
L	**did yOU still**	**gO to**	**schO**
pike			
interval			
R			
pulse			^

Next pike on ‘school’.
Interval of 360ms.
(Weak) pulse established.
R now knows what a fitted answer would be and has a time slot.

Rhythmic, on-beat entry into the turn-space

pike	π	π	π	
interval		0.29	0.36	
L	**did yOU still**	**gO to**	**schOOl?**	
pike				π
interval				0.36
R				**yEAh?**
pulse			^	^

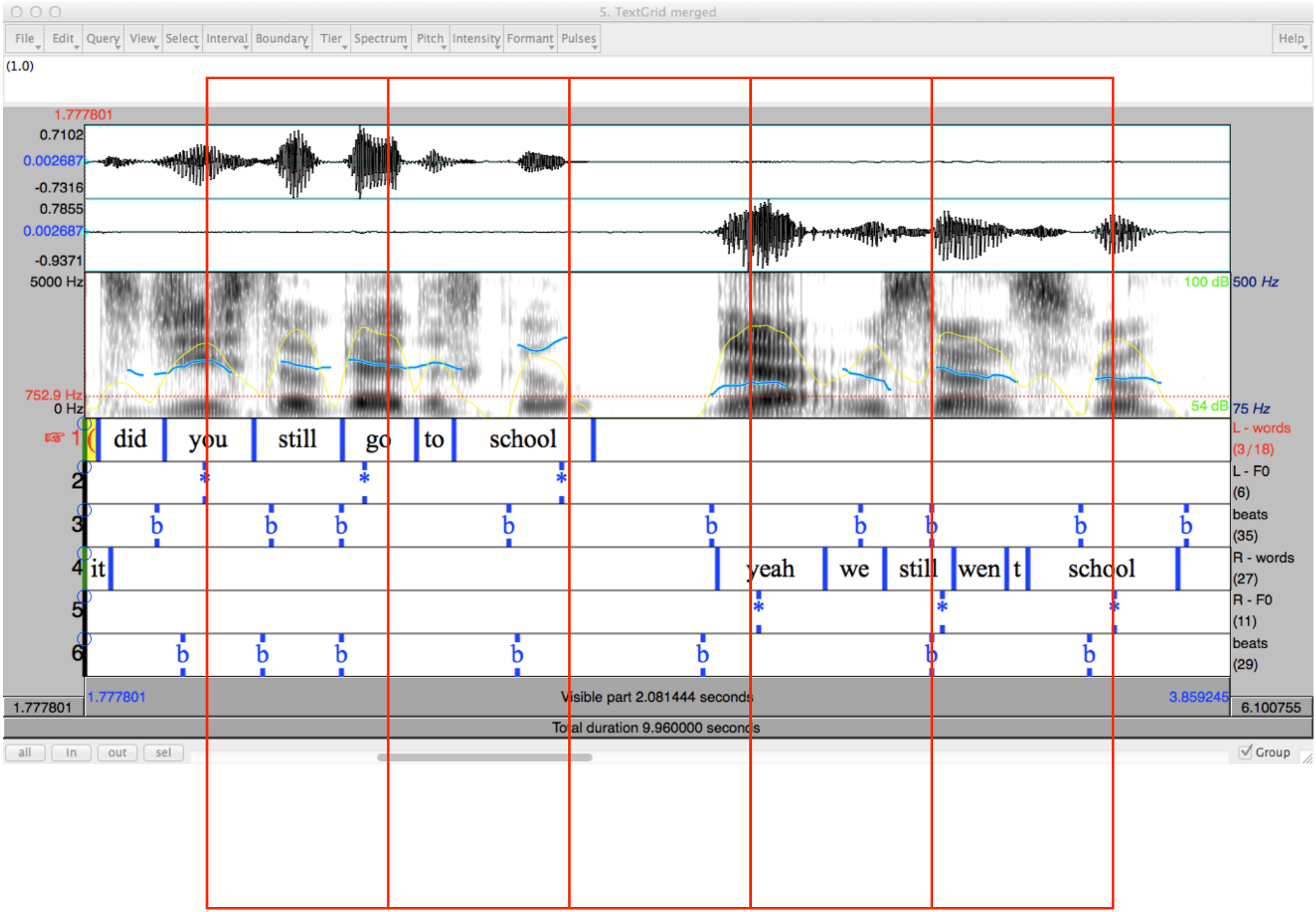
R produces a fitted response-token on beat with pulse in Q.

Rhythmic, on-beat entry into the turn-space

pike	π	π	π			
interval		0.29	0.36			
L	**did yOU still**	**gO to**	**schOOl?**			
pike				π	π	π
interval				0.36	0.33	0.31
R				**yEAh?. we**	**stIll went to**	**-schOOl-**
pulse			^	^	^	^

Even though the pulse in L's turn is not precise,
R orients to it and uses it to time his A, which is syntactically and pragmatically fitted to the Q.

Temporal organisation is a shared resource
(cf. Pickering & Garrod).


5. TextGrid merged
File Edit Query View Select Interval Boundary Tier Spectrum Pitch Intensity Formant Pulses Help
(1.0)
1.777801
0.7102
0.002687
-0.7316
0.7855
0.002687
-0.9371
5000 Hz
100 dB
500 Hz
752.9 Hz
0 Hz
54 dB
75 Hz
1 did you still go to school
L - words
(3 / 18)
2
L - F0
(6)
3
beats
(35)
4 it yeah we still wen t school
R - words
(27)
5
R - F0
(11)
6
beats
(29)
1.777801
1.777801
Visible part 2.081444 seconds
3.859245
6.100755
Total duration 9.960000 seconds
all in out sel
Group

Rhythmic, on-beat entry into the turn-space

pike	π	π			
interval		0.38			
L	**sAme**	**pEople?**			
pike			π	π	π
interval			~0.38	~0.38	~0.38
R					**yeah**
			NOD	**NOD**	**NOD**
pulse			^	^	^

Answers with rhythmic, on-beat entry

- Usually fitted to Q, e.g. 'yes'/'no' to polar Q; fitted response to WH-word
- ... or an account for why no proper A ('I can't remember', 'I don't know')
- A aligns with the Q : it recognises that a Q has been asked, and a fitted A is provided in the appropriate temporal and sequential slot

Rhythmic, early entry into the turn-space

Pulse maintained to 3rd position

pike

interval

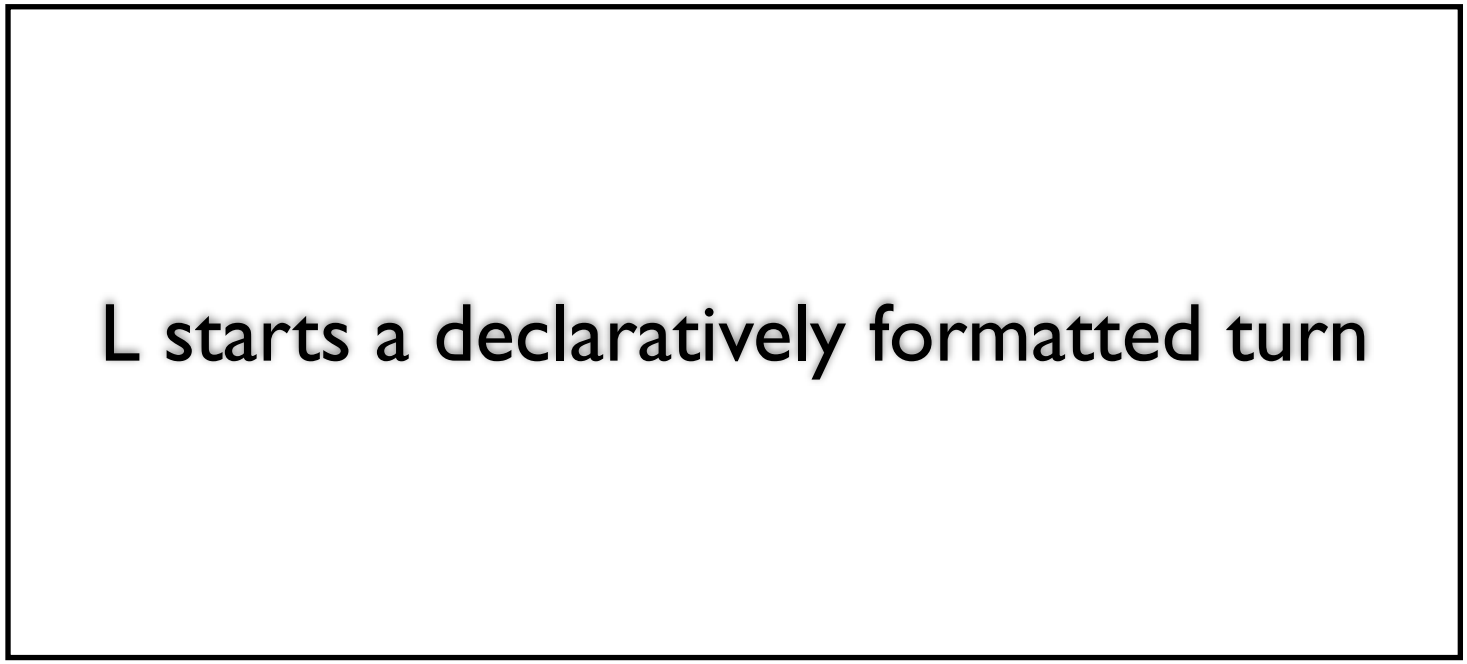
L **it was a**

pike

interval

R

pulse



Rhythmic, early entry into the turn-space

Pulse maintained to 3rd position

pike	π	π
interval		0.37
L	**it was a SUnday**	**wAsn't**
pike		
interval		
R		
pulse		

... with a tag which makes relevant a response from R (with preference for confirmation).

Rhythmic, early entry into the turn-space

Pulse maintained to 3rd position

pike	π	π	π
interval		0.37	0.321
L	**it was a SUnday**	**wasn't**	**it**
pike			π
interval			0.301
R			**yEAh**
pulse			**^**

R's response comes immediately the Q is recognisable but a bit before it is due

Rhythmic, early entry into the turn-space

Pulse maintained to 3rd position

pike	π	π	π	
interval		0.37	0.321	
L	**it was a SUnday**	**wAsn't**	**it**	
pike			π	π
interval			0.301	0.377
R			**yEAh it**	**wAs**
pulse			**^**	**^**

A in two parts: response token + S

Rhythmic, early entry into the turn-space

Pulse maintained to 3rd position

pike	π	π	π		π
interval		0.37	0.321		0.734/0.376
L	**it was a SUnday**	**wAsn't**	**it**		**yEAh**
pike			π	π	π
interval			0.301	0.377	0.381
R			**yEAh it**	**wAs**	**yEAh**
pulse			^	^	^

Overlapping, simultaneous pikes in third position;
mutual orientation to pulse in the Q+A pair.
L and R display a shared understanding.

Rhythmic, late entry into the turn-space

pike	π	π
interval		0.33
R	**[hOw was your**	**mEEting.**
pike		
interval		
L	**[good**	
pulse		

Rhythmic, late entry into the turn-space

pike	π	π
interval		0.33
R	**[hOw was your**	**mEEting.**
pike		
interval		
L	**[good**	
pulse		^

Rhythmic, late entry into the turn-space

pike	π	π
interval		0.33
R	**[hOw was your**	**mEEting.**
pike		
interval		
L	**[good**	**it was**
pulse	**^**	**^**

Rhythmic, late entry into the turn-space

pike	π	π			
interval		0.33			
R	**[hOw was your**	**mEEting.**			
pike					π
interval					0.99
L	**[good**			**it was gOOd; it was very**	
pulse			**^**	**^**	**^**

Two beats of silence + pike of ‘good’ on third beat.

Rhythmic, late entry into the turn-space

pike	π	π					
interval		0.33					
R	**[hOw was your**	**mEEting.**					
pike					π	π	
interval					0.99	0.33	
L	**[good**			**it was**	**gOOd; it was very**	**lO:ng; it**	
pulse			**^**	**^**	**^**	**^**	

Rhythmic, late entry into the turn-space

pike	π	π					
interval		0.33					
R	**[hOw was your**	**`mEEting.**					
pike				π	π	π	π
interval				0.99	0.33	0.48	0.43
L	**[good**		**it was**	**gOOd; it was very**	**lO:ng; it**	**stARted at e-**	**lEven**
pulse		^	^	^	^		

Pulse not maintained; complex answer.

Answers with rhythmic, late entry

- Usually fitted to Q (e.g. 'yes', 'no' to polar Q; fitted response to WH-word)
- but often presents a complication in the A, e.g. displaying some kind of effort (remembering a name or date)
- A aligns with the Q

Non-rhythmic, late entry into the turn-space

pike			π		π	
interval			0.361			
R		don't/ yOU play	hOckey			
	di(d)n't					
pike					π	π
interval				0.725	0.908	0.449
L				I	dO again	nOW
pulse		^		^		

But: onset of A on second pulse after Q. No 'yes'.

First pike of A 2.5 pulses after Q
Resolves ambiguity in Q

Non-rhythmic, late entry into the turn-space

pike	π	π	π			
interval		0.268	0.298			
R	**what d'you**	**thInk of the**	**rOOm**			
pike					π	π
interval				0.626	0.817	0.346
L				**it's**	**quIte a nice**	**rOOm**
pulse			^	^	^	

But: onset of A on second pulse after Q

First pike of A 2.74 pulses after Q

Answers with non-rhythmic entry

Auer, Couper-Kuhlen & Müller 1999; Couper-Kuhlen 1993

- These answers tend to be more complex, e.g. correcting a presupposition of the Q
- Although the first pike of the answer is not rhythmically aligned, in answers that align with the Q, the production of speech often starts on beat
- A more marked format

Pulses and the pre-turn space

- Sometimes the A is prefaced with on-beat pre-turn material: in-breaths, clicks, *uhm*, etc. These are signs of 'gearing up to speak', so they project incipient speakership without yet taking a turn.
  (Cf. Ogden, *JIPA* 2013: clicks as metronomes)
- Such on-beat in-comings display an orientation to the relevance of an on-beat A, even if the first pike of the turn is not on beat.

Rhythmic, on-beat pre-turn material

pike		π	π	π				
interval			0.528	0.523				
R	**has hE got to do a**		**nIGHt shift to-**	**nIGHt or**				
pike						π	π	π
interval					0.551	1.033/0.482	0.271	0.582
L					**CLICK no**	**hE's on**	**nIghts from to-**	**mOrrow**
pulse				^	^	^		

Aligned but dispreferred response ('no')
Click provides a rhythmic and on-beat entry into the turn space

Rhythmic, on-beat pre-turn material

pike		π	π	π			
interval			0.646	0.779			
L	**is it just the**	**cOllege meet the**	**rOwing (..) in the**	**mORning**			
pike					π	π	π
interval					0.855	0.859	0.495
R					**UH (0.3) well**	**yEAh it's like**	**All the colleges**
pulse			^	^	^	^	

Complex response projected ('well')
'Uh' on beat; orients to relevance of a well-timed response

Rhythmic, on-beat pre-turn material

pike	π	π	π				
interval		0.329	0.344				
L	**hOw did your**	**mEEting**	**go;**				
pike					π	π	π
interval				0.632	0.796	0.974	0.474
R				**CLICK**	**It' (0.5)**	**wEnt all**	**rIGHt (0.5)**
pulse		^	^	^			

Dispreferred response (gap; non-rhythmic entry)
CLICK on beat;
orients to relevance of a well-timed response

Non-rhythmic, late entry into the turn-space

- Pike of A is often not on beat with the pulse of the Q; but often, the onset of talk (rather than the pike) occurs on beat with the pulse.
- Suggests two sub-types of rhythmical alignment: pike-to-pike, pike-to-onset.
- Suggests measures need to include non-verbal (but vocal) material.

Further questions

- Best way to model pikes and rhythms?
- Most effective number of pikes to give a pulse?
- Can turns be designed so as to be long enough to produce a pulse?
- How are disfluencies and perturbations in the progressivity of social actions handled?
- Do we find cases where rhythm is repaired? (Would demonstrate orientation to wrong/right versions.)

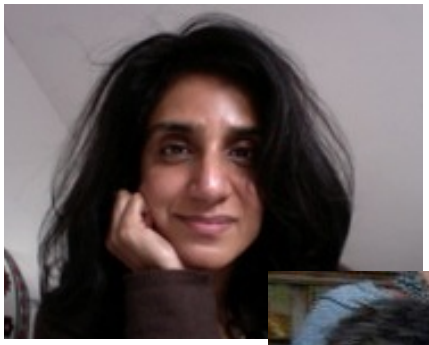
Conclusions

- Alignment in interaction is handled through lexical and syntactic design (and parallelism); but also phonetic design
- Rhythmicity is a locally available resource and handles contingencies of interacting in time: it helps to reinforce intersubjectivity: participants' displayed understandings of one another
- Our study contrasts with many studies of rhythm and timing in speech: it does not lead us to assume global properties language by language

Thanks to!

Ian Cross

Satinder Gill



David Greatrex

Hannah Leach

Daniel Halford

Rein Ove Sikveland

Newton Trust, U. Cambridge; BA/Leverhulme Foundation Small Grant