

# Computational Semantics and Pragmatics

Raquel Fernández

Institute for Logic, Language & Computation  
University of Amsterdam



Autumn 2016

- **Lecturer:** Raquel Fernández ([raquel.fernandez@uva.nl](mailto:raquel.fernandez@uva.nl))  
Science Park 107, room F1.07
- **TA:** Dieuwke Hupkes ([d.hupkes@uva.nl](mailto:d.hupkes@uva.nl))
- **Website:** Slides, references, and other important information will be posted on the course's website:  
<http://www.illc.uva.nl/~raquel/teaching/cosp/cosp2016>
- **Timetable:**
  - ▶ Tuesdays & Fridays 13-15h (most of the time).  
Next lecture: Thursday at 11h in room D1.162

# Main topic in the course: Linguistic interaction



Dialogue is the primary setting for language acquisition and use:

- *spontaneous and online*: disfluent, fragmentary
- *multi-agent*: requires coordination (joint action)

# Linguistic interaction

A transcript fragment from the Switchboard corpus:

```
B.52 utt1: Yeah, /
B.52 utt2: [it's,+ it's] fun getting together with immediate family./
B.52 utt3: A lot of my cousins are real close /
B.52 utt4: {C and} we always get together during holidays and
           weddings and stuff like that, /
A.53 utt1: {F Uh, } those are the ones that are in Texas? /
B.54 utt1: # {F Uh, } no, # /
A.55 utt1: # {C Or } you # go to Indiana on that? /
B.56 utt1: the ones in Indiana, /
B.56 utt2: uh-huh. /
A.57 utt1: Uh-huh, /
A.57 utt2: where in Indiana? /
B.58 utt1: Lafayette. /
A.59 utt1: Lafayette, I don't know where, /
A.59 utt2: I used to live in Indianapolis. /
B.60 utt1: Yeah, /
B.60 utt2: it's a little north of Indianapolis, about an hour. /
```

# Overview of topics

- *timing* coordination – turn taking
- *meaning* coordination – dialogue acts and grounding
- *style* coordination - alignment and adaptation
- language *acquisition* in interaction

Of interest to linguistics, cognitive science, and artificial intelligence.

- Meaning, Reference and Modality
- Structures for Semantics
- Logic and Conversation
- Cognition and Language Development
  
- Basic Probability: Programming
- Natural Language Processing
- Information Theory

## **Relevant seminars at the ILLC:**

- Computational Linguistics Seminar (CLS)  
<http://www.illc.uva.nl/LaCo/CLS/>
- DIP (discourse processing) Colloquium

Check the ILLC Events webpage for details.

# Course evaluation

- *Coursework*: 40%
  - ▶ three graded assignments: in Python  
practical computer session next Tuesday 13 Sept to get familiar with the data
  - ▶ reading and discussion of relevant research papers ( $\approx 10\%$  at my discretion)
- *Final project (paper + presentation)*: 60%
  - ▶ individually or in groups (ideally two people)
  - ▶ on-topic philosophical/theoretical essays could be an option, but
  - ▶ ideally, your project should include an empirical/computational component, e.g. analysis of real data or some sort of implementation

# Final projects

Any topic related to the themes covered in the course. A few ideas on possible types of projects (abstracting over particular topics):

- an extension of exercises from the assignments
- a quantitative corpus study of some interesting phenomenon
- a machine learning experiment using an existing corpus
- an analysis of data collected by yourself in an experiment
- an implementation of an interesting problem
- an analysis and small extension of a paper from the literature
- an analysis of interesting connections between different approaches
- ...

Some options in this list may seem unfeasible to you, but they may be perfectly possible – don't abandon an interesting idea before discussing it with me!



# Learning outcomes

To succeed in the course, you should demonstrate an understanding of the topics covered by being able to:

- *Analyse* and critique the research questions and the methodology used to address them in existing relevant literature.
- *Formulate* your own research questions within the scope of the course.
- *Apply* appropriate (empirical/computational) techniques to address your research questions.
- *Write* about the work of others and your own work in proper scientific style.
- *Present* the work of others and your own work to an audience in a clear and engaging way.

This is a research-oriented course (slightly more appropriate for 2nd-year master's students, but 1st-year's are welcome too if committed!).

<http://www.illc.uva.nl/~raquel/teaching/cosp/cosp2016/>

# Timing coordination: turn taking

Dialogue participants do not only need to make decisions about what to say, but also about *when to say it*  $\rightsquigarrow$  *timing*

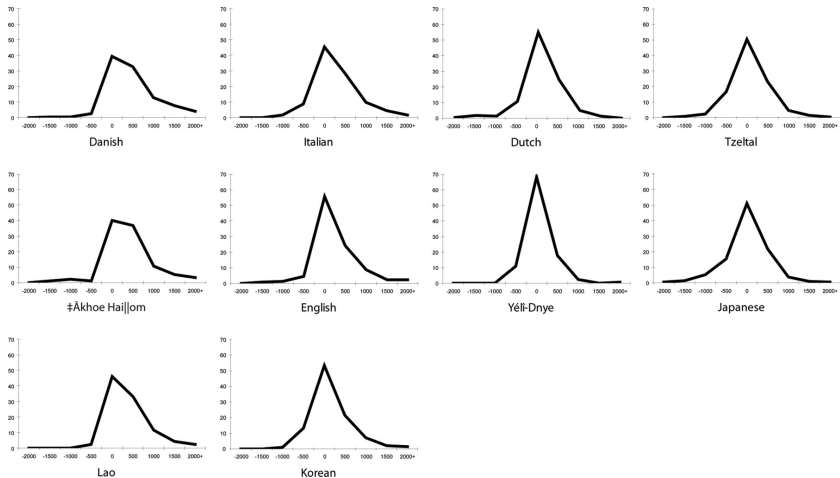
## Outline for this topic:

- Empirical observations: how turn taking works
- Models of turn taking
- Semiotics of timing
- Development and turn taking

# Turn taking: the facts

- Turn-taking is one of the fundamental organisational principles of conversation.
- Learned early: within the first 2 years of life
- There are some individual and cultural differences
- But also strong universal patterns: tendency to minimize both **overlaps** and **gaps** between turns

## Distribution of turn transition length in milliseconds in 10 languages:



Stivers et al. (2009) Universals and cultural variation in turn-taking in conversation, *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*.

# Turn taking: the facts

Turn-taking happens very smoothly:

- *Overlaps are rare*: on average, less than 5% of speech (although there can be a lot of variation).
- *Inter-turn pauses are very short*:  $\sim 200\text{ms}$  (less than 500ms.)
  - ▶ even shorter than some intra-turn pauses
  - ▶ shorter than the motor-planning needed to produce the next utterance

↪ Turn-taking can't be a reaction to silence

Sacks, Schegloff, & Jefferson, A simplest systematics for the organization of turn-taking in conversation, 1974.

Duncan, Some signals and rules for taking speaking turns in conversations. *Journal of Personality and Social Psychology*, 23(2):283–292, 1972.

Holler, Kendrick, Casillas & Levinson (editors), Turn-Taking in Human Communicative Interaction, *Frontiers in Psychology*, 2015.

# Turn taking: the facts

## Seminal work on turn taking within the framework of Conversation Analysis:

Sacks, Schegloff, & Jefferson (1974) A simplest systematics for the organization of turn-taking in conversation.

### Main empirical observations:

- (a) Overwhelmingly, one party talks at a time.
- (b) Occurrences of more than one speaker at a time are common, but brief.
- (c) Transitions (from one turn to the next) with no gap and no overlap are common. Together with transitions characterized by slight gap or slight overlap, they make up the vast majority of transitions.
- (d) Turn size is not fixed, but varies.
- (e) What parties say is not specified in advance.
- (f) Turn-allocation techniques are obviously used. A current speaker may select a next speaker (as when he addresses a question to another party); or parties may self-select in starting to talk.
- (g) Repair mechanisms exist for dealing with turn-taking errors and violations; e.g., if two parties find themselves talking at the same time, one of them will stop prematurely, thus, repairing the trouble.

# Models of turn taking

- Models based on *prediction*:  
anticipation of the end of the turn.
- Models based on *reaction*:  
response to signal indicating turn yielding.



# Turn taking models: prediction

The CA model by Sacks et al. (1974) emphasises anticipation:

- Turns consist of *turn constructional units* (TCUs) with *projectable* points that can be predicted beforehand.
- Such projectable points act as *transition relevance places* (TRPs) where turn transitions are relevant.

Three rules govern the expected behaviour at TRPs:

1. if devices to select a next speaker (e.g. questions, gaze, naming) are used, the current speaker stops and the selected speaker takes the turn;
2. else, any other speaker may take the turn (may *self-select*),
3. if no other party takes the turn, then the current speaker may continue.

# Turn taking models: reaction

Duncan and colleagues proposed a system of *turn-yielding clues*: the likelihood of a speaker change increases linearly with the number of indicators jointly displayed.

Duncan (1972). Some signals and rules for taking speaking turns in conversations. *Journal of Personality and Social Psychology*, 23(2):283–292.

- *turn yielding*: syntactic closure / pragmatic completion plus acoustic information (rising/falling intonation; faster speaking rate); . . .
- *turn-holding*: syntactic incompleteness plus prosodic patterns signal; word fragments and filled pauses.
- From the listener's side: *turn requesting* and *backchannelling* cues.

# Turn taking models: prediction vs. reaction

Recent research has aimed at making all these notions more precise: large scale studies and implementation in dialogue systems.

There is a large amount of literature . . .

Gravano and Hirshberg (2011) Turn-taking cues in task-oriented dialogue, *Computer Speech & Processing*, 5(3).

Magyari and de Ruiter (2012) Prediction of Turn-Ends Based on Anticipation of Upcoming Words, *Frontiers in Psych.*

Prediction-based models are the most common in psycholinguistics. But discussion is ongoing . . .

# Evidence for the models

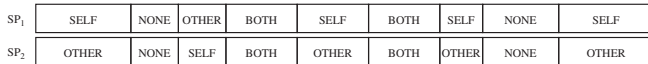
Mattias Heldner and Jens Edlund (2010), Pauses, gaps and overlaps in conversation, *Journal of Phonetics*, 38:555–568.

- Aim to challenge claims about precision timing in turn-taking
  - ▶ “no-gap / no-overlap”  $\rightsquigarrow$  turn-taking must rely solely on the ability to anticipate upcoming turn-endings

## 1. VOICE ACTIVITY DETECTION



## 2. COMMUNICATIVE STATE CLASSIFICATION



## 3. SILENCE AND OVERLAP CLASSIFICATION



# Consider these questions

Mattias Heldner and Jens Edlund (2010), Pauses, gaps and overlaps in conversation, *Journal of Phonetics*, 38:555–568.

- What is the main goal of the paper and what is the motivation behind it?
- What is the methodology adopted (data set and data processing)?
- What are the main results of the analysis?
- Can you identify some interesting speculations made in the paper?

⇒ Read the paper, take notes, and come to class on Thursday with answers to these questions.

[*We will discuss two papers (you can choose one). More at the end.*]

# Topics on timing and turn taking

- Empirical facts
- Models: prediction vs. reaction, prediction + reaction
- Semiotics of timing (e.g., rhetoric and social significance)
- Development and turn-taking

Norm: little overlap, short gap.

- Lengthy *silences* carry semiotic significance (undesired or unexpected response; rhetorical effect)
- *Overlaps* (or interruptions) may be socially loaded (sign of dominance and authority).

# Political debate in Oct 2004

## From LanguageLog ▶ The Rhetoric of Silence

**Jim Lehrer:** Do you believe you could do a better job than President Bush in preventing another 9/11-type terrorist attack on the United States?

**John Kerry:** [pause 0.278] Yes, I do. [pause 1.268] But before I answer further, let me thank you for moderating. [pause 0.588] I want to thank the University of Miami [pause 0.564] for hosting us.

▶ Audio

**Jim Lehrer:** Mr. President, you have a ninety-second rebuttal.

**George W. Bush:** [pause 0.055] uh uh I- [pause 0.165] I, too, thank the University of Miami, and [pause 0.454] and uh [pause 2.116] and say our prayers are with [speeds up] the good people of this state, who've suffered a lot.

▶ Audio



Norm: little overlap, short gap.

- Lengthy *silences* carry semiotic significance (undesired or unexpected response; rhetorical effect)
- *Overlaps* (or interruptions) may be socially loaded (sign of dominance and authority).

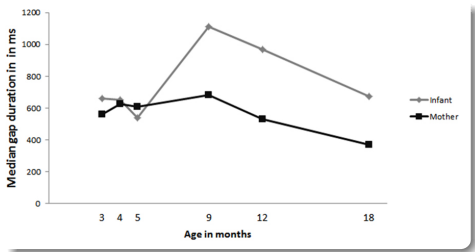
Paul Van Eecke & Raquel Fernández (2016) On the Influence of Gender on Interruptions in Multiparty Dialogue. In *Proceedings of Interspeech*.

# Turn taking: developmental evidence

Elma E. Hilbrink, Merideth Gattis and Stephen C. Levinson (2015) Early developmental changes in the timing of turn-taking: a longitudinal study of mother-infant interaction, *Frontiers in Psychology*.

Longitudinal study of 12 mother-infant dyads in free-play interactions at six ages between 3 and 18 months.

- Children develop the temporal properties of turn-taking early in infancy (vocal exchanges).
- Overlap: first more than mothers; by 18 months similar to mothers.
- Gaps: significant increase at 9 months
- Overlaps and gaps of mothers remain stable over time.



# Summary and next steps

## Turn taking: timing coordination

- Empirical facts
- Models: prediction vs. reaction, prediction + reaction
- Semiotics of timing (e.g., rhetoric and social significance)
- Development and turn-taking

*To do:* read one of these two papers (or both!), take notes and come prepared to explain and discuss.

- Helden & Edlund, Pauses, gaps and overlaps in conversations. *Journal of Phonetics*, 2010.
- Laskowski, A framework for the automatic inference of stochastic turn-taking styles, *Proc. SIGdial*, 2016.

It is OK to not understand everything in a paper.

- Consider goal, motivation, methods, results, implications, limitations
- Pay attention to style and structure.