Fundamentals of Linguistic Interaction

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Outline

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

Outline

- Main theories of first language acquisition.
  - Nativist
  - Empiricist
  - Interactive
- Interaction view. Two examples of recent work:
  - convergence in child-adult interaction
  - corrective feedback

The nativist view

Knowledge of grammar is innate, in the form of a Universal Grammar that is the initial state of the language faculty.

> "Language learning is not really something that the child does; it is something that happens to the child placed in an appropriate environment, much as the child's body grows and matures in a predetermined way when provided with appropriate nutrition and environmental stimulation"
>
> (Chomsky 1993, p. 519)

Main motivation:

- Acquisition is fast and easy,
- in spite of inadequate input (poverty of stimulus),
- and happens without direct instruction (no negative evidence).

None of these claims is well supported empirically.

The nativist view: counter evidence

- *Fast?*
  Children are exposed to language around 10 hours per day (millions of words/sentence in the first 5 years).
- *Easy?*
  Children go through learning stages and make errors over several years (meaning extension, morphological regularisation, word order).
- *Poor input?*
  Child-directed speech is simpler, clearer, and more well formed than adult-adult speech.
- *No negative evidence?*
  Typically no explicit correction, but plenty of implicit feedback (more later).

The empiricist vs. interaction views

input *vs.* interaction

sensitivity to statistical regularities in the input ignoring interaction

sensitivity to when & how the input is offered in interaction

```
Adult: Help me put your toys away, darling.
Child: I'm going to Colin's and I need some toys.
Adult: You don't need a lot of toys.
Child: Only a little bit toys.
Adult: You only need a few.
Child: Yes, a few toys.
```

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child $\rightarrow$ adult *language learning*

child $\leftarrow$ adult *child-directed speech*

The interactive view

"Relevant input" — *joint attention, engagement, topic continuity, contingent replies* . . . — has been shown to be a positive predictor of language development (Tamis-LeMonda et al. 2001; Hoff & Naigles, 2002; Rollins, 2003; Mazur et al. 2005; Hoff, 2006; a.o.)

McGillion et al. (2013): what sort of responsiveness matters?

- *semantic responsiveness*: related to the child's focus of attentions
- *temporal responsiveness*: temporally contingent with an act produced by the child.

$\rightsquigarrow$ *combined measure only significant predictor of vocabulary growth*

Longer-term: use computational modelling to investigate how these aspects relate to the learning mechanisms employed by the child – and what this can tell us about theories of dialogue.

Today: recent work on methodologies for studying *interaction* and *contingent responsiveness* in corpus data.

Two examples of concrete work

Ways of investigating how speakers pick up on each other's language (*coordinate*) at different degrees of locality.

R. Fernández & R. Grimm. Quantifying Categorical and Conceptual Convergence in Child-Adult Dialogue, *36th Annual Conference of the Cognitive Science Society*. 2014.

Empirical study on impact of one particular interactive phenomenon on learning:

S. Hiller & R. Fernández (2016) A Data-driven Investigation of Corrective Feedback on Subject Omission Errors in First Language Acquisition. In *Proceedings of CoNLL*.

Turn-based Cross-Recurrence Plots

Two-party dialogue transcript

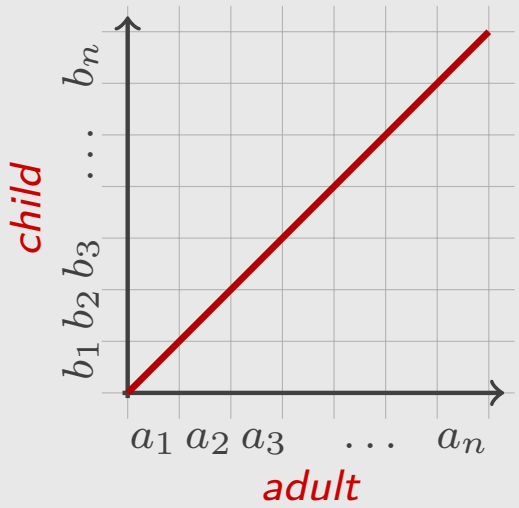
A_1: which one do you want first
B_1: that one
A_2: you like this one
B_2: yeah, give me

.
.
.

A_n: ...
B_n: ...

$\Rightarrow$

Cross-recurrence plot: each cell corresponds to a pair of turns (i, j)



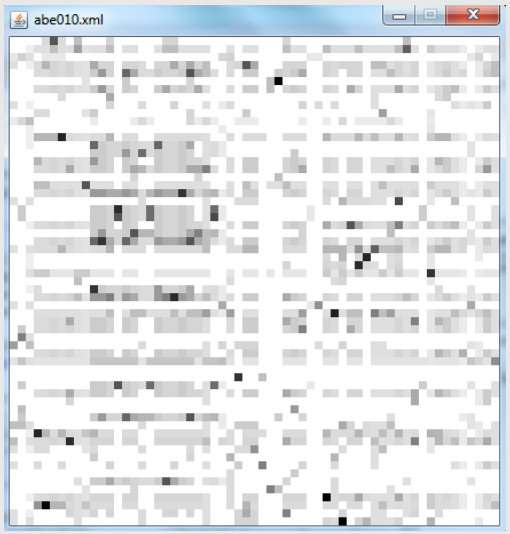
Recurrence (coordination) score for each (i, j)

- *global recurrence*: average coordination over all turn pairs
- *local recurrence*: recurrence in (semi-)adjacent turns, separated by at most distance $d < n$ (diagonal line of incidence)
- *upper recurrence*: child's turn comes after adult's *adult* $\leftarrow$ *child*
- *lower recurrence*: adult's turn comes after child's *child* $\leftarrow$ *adult*

Turn-based Cross-Recurrence Plots

CRP of a dialogue with Abe (2.5 years old):

order of turns shuffled



original dialogue

Same *global* recurrence but very different *local* recurrence

⇝ global: chance recurrence regardless of temporal development of interaction

Linguistic Measures of Recurrence

Syntactic recurrence: number of shared part-of-speech bigrams factoring out lexical identity, normalised by length of longest turn.

Lexical recurrence: shared lexeme unigrams / biagrams factoring out lexical identity, normalised by length of longest turn.

```
Adult: you are pressing a button and what happens ?
       PRO|you AUX|be PART|press DET|a N|buttton CJ|and PRO|what V|happen
Child: what happens the horse tail
       PRO|what V|happen DET|the N|horse N|tail
```

Conceptual recurrence: semantic similarity, e.g., $\langle \texttt{N|dog} \rangle \approx \langle \texttt{V|bark} \rangle$

- distributional semantic model: 2-billion-word WaCuk corpus and the DISSECT toolkit (Dinu, Pham & Baroni, 2013)
- one vector per turn by adding up the lexical vectors
- cosine of a turn pair (i, j) as the convergence score

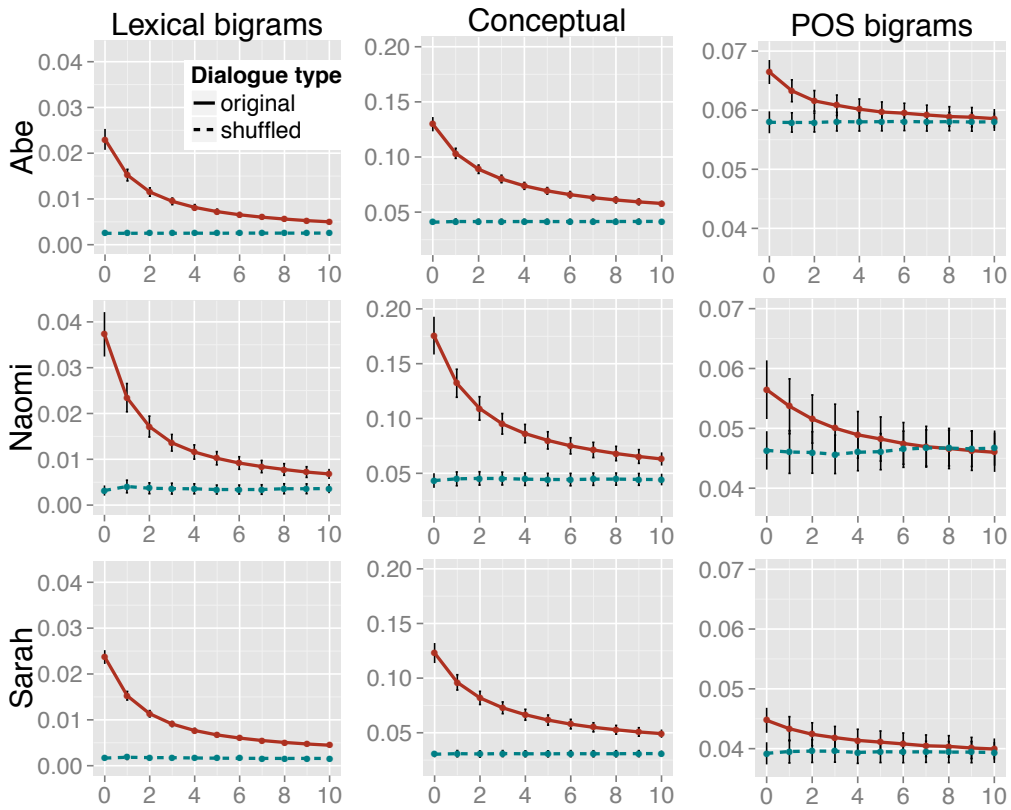
Data

379 *child-adult dialogues* from 3 children over a period of ∼3 years.

corpus	age range	# dialogues	av. # turns/dialogue
Abe	2;5 – 5;0	210	191 (sd=74)
Sarah	2;6 – 5;1	107	340 (sd=84)
Naomi	1;11 – 4;9	62	152 (sd=100)

We generate a *CRP* for each dialogue, computing convergence values for all turn pairs (i, j) for each of the linguistic convergence measures: *lexical*, *syntactic*, *conceptual*.

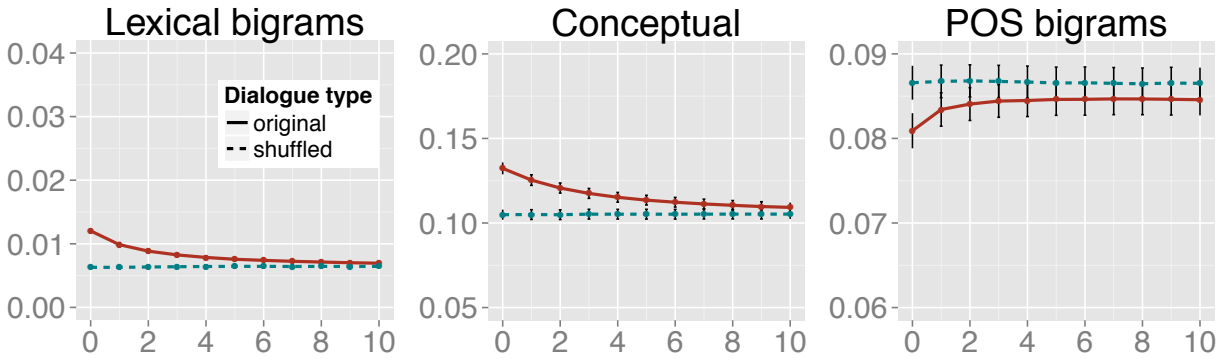
Results: child-adult dialogue



- *local vs. global*: significantly more local coordination.
- *directionality*: both coordinate more at local levels, but the adult recurs with the child significantly more.

Results: adult-adult dialogue

For comparison: ∼1000 *adult-adult dialogues* from Switchboard. We ignore backchannels (*"uh huh"*) since they are not considered proper turns (19% of all utterances).



- Semantic lexical/conceptual measures, same trend: above-chance convergence in close-by turns.
- Syntactic measure: very different coordination patterns, with adults showing syntactic *divergence* at adjacent turns:
  ⇝ less recurrence than expected by chance.

Why?

Contrast with previous evidence of syntactic alignment in adult-adult dialogue (e.g., Pickering & Ferreira 2008), but not surprising

- ⇝ advancing a conversation requires *different dialogue acts* with distinct syntactic patterns.

Why is there syntactic recurrence in child-adult dialogue?

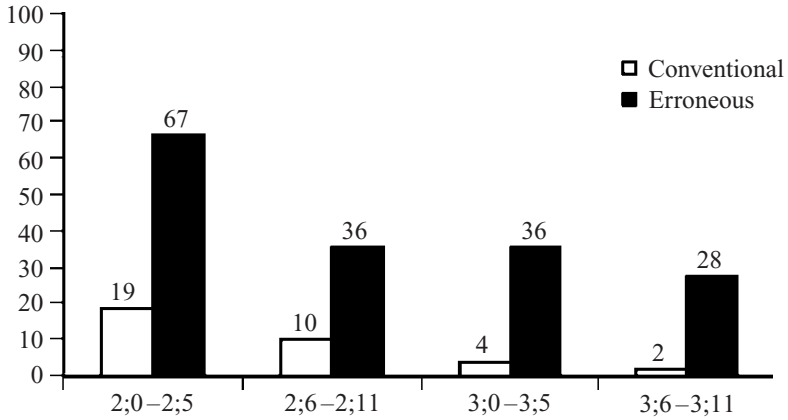
- *feedback mechanism* to ratify linguistic constructions?
- possibly related to *reformulations* / *recasts* / *corrective feedback*

```
Child:  you're good to sharing.
Mother:    I'm good at sharing?
```

Reformulations

M. Chouinard & E. Clark (2003) Adult reformulations of child errors as negative evidence, *Journal of Child Language*.

- Adults check up on the meaning intended by the child.
- 3 English and 2 French children (longitudinal data)
- Around 2/3 of erroneous utterances are reformulated by the adult.
- All types of errors (phonology, morphology, lexicon, syntax).
- Children attend to and respond to the reformulations



% of Abe's conventional utterances replayed and erroneous utterances reformulated.

Corrective feedback

S. Hiller & R. Fernández (2016) A Data-driven Investigation of Corrective Feedback on Subject Omission Errors in First Language Acquisition. In *Proceedings of CoNLL*.

An utterance by the child followed by an utterance by an adult constitutes an instance of *corrective feedback* if all the following constraints are met:

(C1) The child's utterance contains a grammatical anomaly.

(C2) There is some degree of overlap between the adult and child utterances: the adult's response is anchored to the child utterance through at least one exactly matching word.

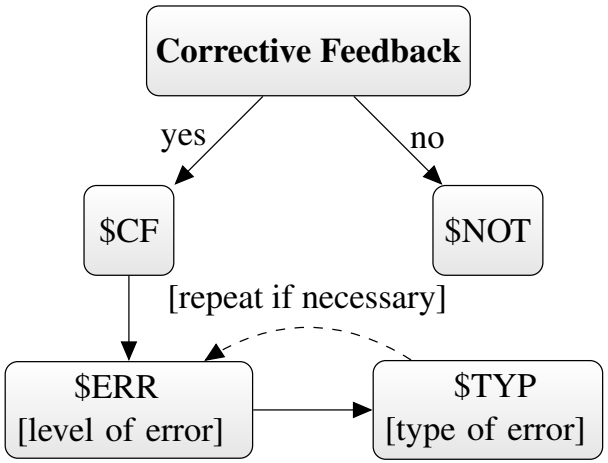
(C3) The adult utterance is not a mere repetition of the child's, i.e., there is some contrast.

(C4) This contrast offers a correct counterpart of the child's erroneous form.

Data and annotation

25 children	Total	Avg. per child
transcripts	1,683	67.32
utterances	1,598,838	63,953.52
candidate CF pairs	136,152	5,446.08

- Manual annotation: 4-6 files from four different children
- Extraction of candidate CF utterance pairs (partial repetition)



Results of corpus study

Examples:

synt: subject, omission
CHI: don't want to .
MOT: you don't want to ?

v. morph: irregular past, substitution
CHI: he falled out and bumped his head .
MOT: he fell out and bumped his head .

u. morph: auxiliary, addition
CHI: I'm read it .
DAD: you read it to mummy .

	Om	*Add*	*Sub*	**Total**
Syntax				
subject	171	–	1	172
verb	90	1	–	91
object	13	–	–	13
N morph				
poss -'s	4	1	–	5
regular pl	–	3	–	3
irregular pl	–	–	3	3
V morph				
3rd person	4	–	–	4
regular past	10	1	–	11
irregular past	1	–	4	5
Unb. morph				
det	79	–	6	85
prep	21	1	12	34
aux verb	114	5	1	120
progressive	9	0	0	9
Other	4	2	19	25
Total	520	14	46	580

- Focus on subject omission errors (SOE).
- Use of machine learning techniques to extract SEOs and CF on SOEs in the entire corpus.

Preprocessed and annotated data

CHI: I climb up daddy .

– **POS & morph**	%mor: pro.sub|I v|climb prep|up n|daddy
– **dependency**	%gra: 1|2|SUBJ 2|0|ROOT 3|2|JCT 4|3|POBJ

DAD: you did climb over daddy .

– **POS & morph**	%mor: pro|you v|do.PAST v|climb prep|over n|daddy
– **dependency**	%gra: 1|2|SUBJ 2|0|ROOT 3|2|OBJ 4|3|JCT 5|4|POBJ
– **overlap**	%adu: $EXA:climb $EXA:daddy $ADD:you did $ADD:over $DEL:i $DEL:up $REP=0.40
manual annotation	%cof: $CF $ERR=umorph:prep; $TYP=subst

Automatic detection results:

- Detection of SOE: rule-based classifier, 83% precision.
- Detection of CF on SOE: SVM, 89%.

Corrective feedback and learning

Does CF on SOE contribute to error reduction?

We compute the amount of SOEs at two different time periods, t_0 and a later time t_1. We then calculate the *relative error reduction* (`rer`) as the proportion of SOEs at t_0 that has been overcome at t_1:

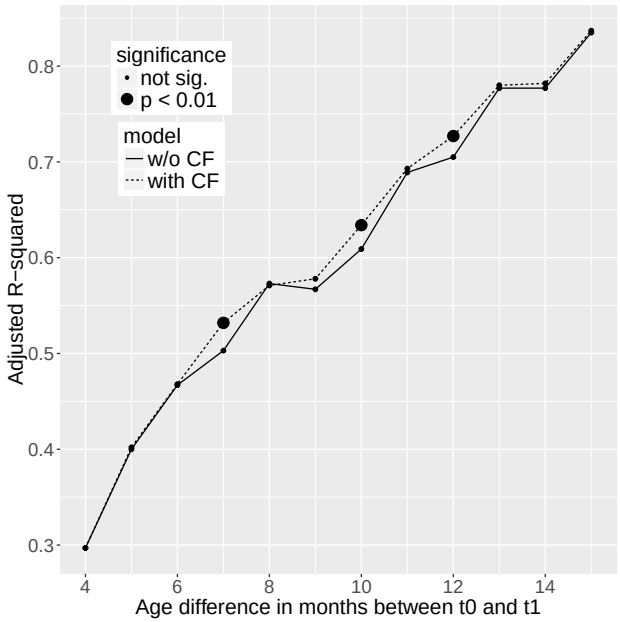
$$\texttt{rer}(t_0, t_1) = \frac{SOE_{t_0} - SOE_{t_1}}{SOE_{t_0}}$$

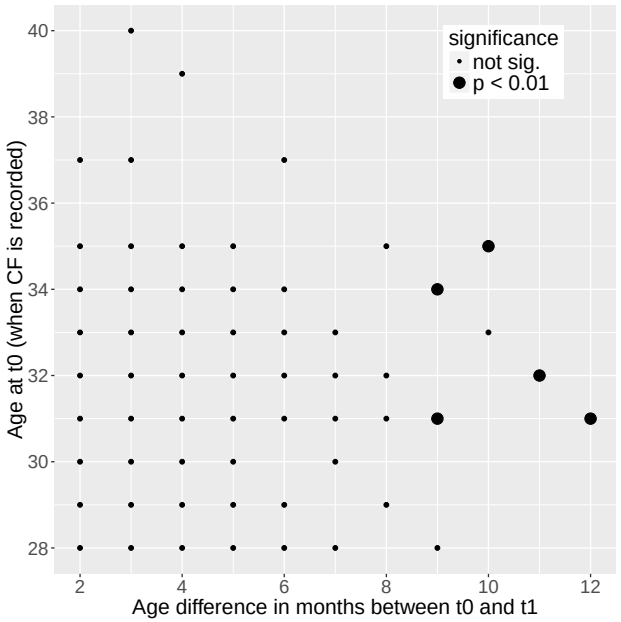
Control variables:

- child age in months (`age`);
- mean length of utterance of child speech and of child directed speech (`chi.mlu`/`cds.mlu`);
- vocabulary size of child speech and of child directed speech (`chi.vocab`/`cds.vocab`);
- proportion of child SOEs (`chi.soe`);
- proportion of child directed utterances with subject omissions (`cds.so`);
- proportion of words uttered by the child over all words uttered in the child-adult interactions (`chi.speech`).

Corrective feedback and learning

- Linear regression model with all possible pairs (t_0, t_1) for the 25 children in the corpus (N= 2613): CF explains a significant proportion of the variance in relative error reduction of SOEs independently from all other factors.
- CF has a significant effect after a time lapse of 7 to 12 months,
- for any starting age t_0 for which there is available data.





Summary and open question

- Local interaction can function as corrective feedback and contribute to language learning.
- Data-driven approach, but caution regarding errors introduced by automatic detectors.

- What does this tell us about acquisition and learning?
  - language learning in use is not totally unsupervised.
  - the learner is active in eliciting feedback

- How can we model this interactive learning process computationally?

Course outline

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- *meaning* coordination – grounding
- *style* coordination - alignment and adaptation
- language *acquisition* in interaction

thank you