# Is that a question?

## Learning to identify questions in early speech to children

Yu'an Yang, Daniel Goodhue, Valentine Hacquard, Jeffrey Lidz

University of Maryland, College Park


Commit22

# Clause types

Cross-linguistically, there are different clause types:

(1) Is that Bert? — Interrogative

(2) That's Bert! — Declarative

(3) Look at Bert! — Imperative

# Speech acts

These clause types are used to perform different speech acts:

(4) Is that Bert? Interrogative$\sim$ Question

(5) That's Bert! Declarative $\sim$ Assertion

(6) Look at Bert! Imperative $\sim$ Request/Command

Sadock & Zwicky 1985; König & Siemund 2007; Krifka 2008; Portner 2018, a.o

# Puzzle: part 1

(7) Is that Bert?

(8) That's Bert!

- How do children figure out which features associate with interrogatives?

# Challenge

We cannot 'build in' certain features (e.g. subject-aux inversion) into interrogativity, because:

- The surface features of interrogatives differs from language to language:
- Even in English, subject-aux inversion is not always the feature for interrogatives:

Mandarin

(9) Xiaxue le.
Snow Asp
"It is snowing."

(10) Xiaxue le ma.
Snow Asp Q
"Is it snowing?"

# Challenge

We cannot 'build in' certain features (e.g. subject-aux inversion) into interrogativity, because:

- The surface features of interrogatives differs from language to language:
- Even in English, subject-aux inversion is not always the feature for interrogatives:

(11) What did you eat?

(12) Who ate the cake?

# Puzzle: part 2

(13) Is that Bert?

(14) That's Bert!

- Even if children can use the morpho-syntactic features to cluster sentences in some way, how do they figure out that a certain group of sentences are interrogatives?

# Challenge

One possibility is to use the speech act information:

(15) Is that Bert?
[$_{\text{ActP}}$? Is [$_{\text{CmP}}$ $\vdash$ t$_{is}$ [$_{\text{TP}}$ that t$_{is}$ Bert ]]]

(16) That's Bert!
[$_{\text{ActP}}$ . [$_{\text{CmP}}$ $\vdash$ [$_{\text{TP}}$ that is Bert ]]]

ActP might help children identify which group of sentences are interrogatives.

- But how do children figure out the speech act information?
  - Adults use clause type information (i.e. (15) is an interrogative and therefore a question)
  - Circular: children need speech act information to identify clause types, but to identify speech act, we use clause type information.

# Challenge

One possibility is to use the speech act information:

(17) Is that Bert?
[$_{\text{ActP}}$? Is [$_{\text{CmP}}$ $\vdash$ t$_{is}$ [$_{\text{TP}}$ that t$_{is}$ Bert ]]]

(18) That's Bert!
[$_{\text{ActP}}$ . [$_{\text{CmP}}$ $\vdash$ [$_{\text{TP}}$ that is Bert ]]]

ActP might help children identify which group of sentences are interrogatives.

- But how do children figure out the speech act information?
  - Adults use clause type information (i.e. (15) is an interrogative and therefore a question)
  - Circular: children need speech act information to identify clause types, but to identify speech act, we use clause type information.

# Challenge

One possibility is to use the speech act information:

(19) Is that Bert?
[$_{\text{ActP}}$? Is [$_{\text{CmP}}$ $\vdash$ t$_{is}$ [$_{\text{TP}}$ that t$_{is}$ Bert ]]]

(20) That's Bert!
[$_{\text{ActP}}$ . [$_{\text{CmP}}$ $\vdash$ [$_{\text{TP}}$ that is Bert ]]]

ActP might help children identify which group of sentences are interrogatives.

- But how do children figure out the speech act information?
  - Adults use clause type information (i.e. (15) is an interrogative and therefore a question)
  - Circular: children need speech act information to identify clause types, but to identify speech act, we use clause type information.

# Challenge

One possibility is to use the speech act information:

(21) Is that Bert?
[$_{\text{ActP}}$? Is [$_{\text{CmP}}$ $\vdash$ t$_{is}$ [$_{\text{TP}}$ that t$_{is}$ Bert ]]]

(22) That's Bert!
[$_{\text{ActP}}$ . [$_{\text{CmP}}$ $\vdash$ [$_{\text{TP}}$ that is Bert ]]]

ActP might help children identify which group of sentences are interrogatives.

- But how do children figure out the speech act information?
  - Adults use clause type information (i.e. (15) is an interrogative and therefore a question)
  - Circular: children need speech act information to identify clause types, but to identify speech act, we use clause type information.

# Puzzle: part 3

(23) Is that Bert?

(24) That's Bert!

- Are there any other cues for speech act information?

# Challenge

- In adult conversations, questions are used to:
  - Seek information
  - Seek addressee's commitment to some proposition
  - Seek responses
- But when parents talk to pre-linguistic infants who might not be able to respond to utterances, the pragmatics of parents' questions might be different.

Searle 1976; Krifka 2008 a.o.

# Challenge

- In adult conversations, questions are used to:
  - Seek information
  - Seek addressee's commitment to some proposition
  - Seek responses
- But when parents talk to pre-linguistic infants who might not be able to respond to utterances, the pragmatics of parents' questions might be different.

Searle 1976; Krifka 2008 a.o.

# Puzzle: part 4

(25) Is that Bert?

(26) That's Bert!

- Even if children can identify questions, to use speech act information to label groups of sentences, there needs to be a straightforward mapping between speech act and clause types.

# Challenge

But the mapping between clause types and speech acts **might** be noisy:

(27) Questions can be expressed by all kinds of clauses:

a. Is it snowing? — Interrogative

b. It's snowing? — Declarative

c. Tell me if it's snowing! — Imperative

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts $\rightarrow$ circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts $\rightarrow$ circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts $\rightarrow$ circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Interim summary

Children might face several challenges when learning interrogatives:

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem);
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts $\rightarrow$ circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input.

# Developmental timeline

In months:


- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who*, *what*, *where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what*, *who*, *where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Developmental timeline

In months:


- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who, what, where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what, who, where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Developmental timeline

In months:


- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who, what, where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what, who, where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Developmental timeline

In months:


- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who, what, where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what, who, where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Developmental timeline

In months:


- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who*, *what*, *where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what*, *who*, *where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Developmental timeline

In months:




- $<$ 6 mo: Gaze following only after communicative signals
- 12 mo: English-speaking infants show sensitivity to differences in word order
- 18 mo: Children give correct responses to parents' *who*, *what*, *where* questions
- 20 mo: English-speaking children start producing interrogatives (mostly polar and *what*, *who*, *where* questions)
- 24 mo: Anticipate speaker change after interrogatives
- $>$3yo: Understand clause type-speech act mismatches; treat rising declaratives as questions

Geffen & Mintz 2015; Tyack & Ingram 1977; Stromswold 1995; Rowland et al. 2003; Casillas & Frank 2013, 2017, Senju & Csibra 2008, Goodhue et al. 2020, among many others

# Research question

Despite all the challenges, infants seem to know interrogatives and questions around 18 months old;

- How do children learn to identify different clause types and speech acts (especially interrogatives and questions), and the mapping between the two?

# Research question

Despite all the challenges, infants seem to know interrogatives and questions around 18 months old;

- How do children learn to identify different clause types and speech acts (especially interrogatives and questions), and the mapping between the two?

# Patterns in the input

What is the input like?

- The morpho-syntactic features
- Non-linguistic features

# Corpus

- Providence Corpus, CHILDES
- Age Range: 11-18 months
- Both transcript and video
- Sample: One session per month within the age range, 30min/500 utterances in each session (current size: 12h of video/7208 parent utterances)

Demuth et al. 2006; MacWhinney 2000

# Corpus

- Providence Corpus, CHILDES
- Age Range: 11-18 months
- Both transcript and video
- Sample: One session per month within the age range, 30min/500 utterances in each session (current size: 12h of video/7208 parent utterances)

Demuth et al. 2006; MacWhinney 2000

# Corpus

- Providence Corpus, CHILDES
- Age Range: 11-18 months
- Both transcript and video
- Sample: One session per month within the age range, 30min/500 utterances in each session (current size: 12h of video/7208 parent utterances)

Demuth et al. 2006; MacWhinney 2000

# Corpus

- Providence Corpus, CHILDES
- Age Range: 11-18 months
- Both transcript and video
- Sample: One session per month within the age range, 30min/500 utterances in each session (current size: 12h of video/7208 parent utterances)

Demuth et al. 2006; MacWhinney 2000

# Annotation process

- Transcript: clause type, speech act, formal features of each utterance
- Audio: A subset of utterances were manually aligned using PHON; the rest were forced-aligned using Kaldi
- Video: on a second-by-second basis, parents' attentional behaviors toward the child using ELAN, without consulting the transcript

Hedlund & Rose 2020; Povey et al. 2011; Lausberg & Sloetjes 2009

# Formal features

Morpho-syntactic features that potentially could be identified by infants 18 m.o. or younger

# +/− Subject, object

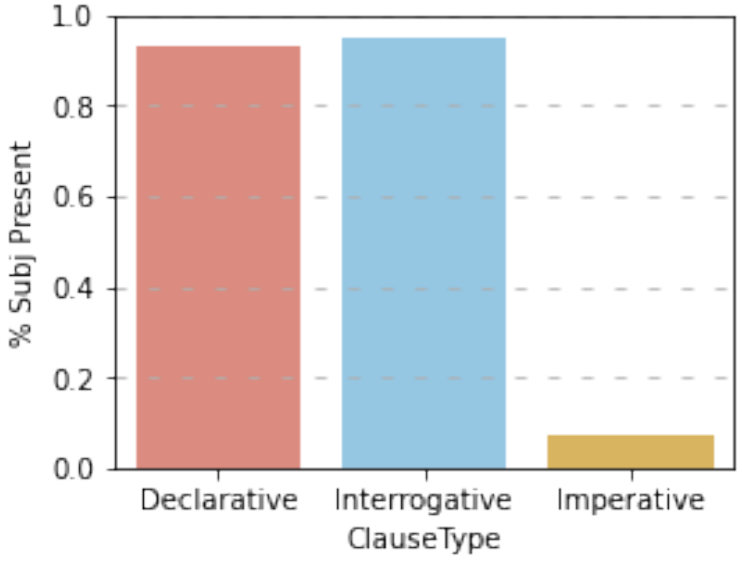
Infants around 18mo can identify subjects and objects of a sentence; but they are not able to represent a fronted *wh* as the object

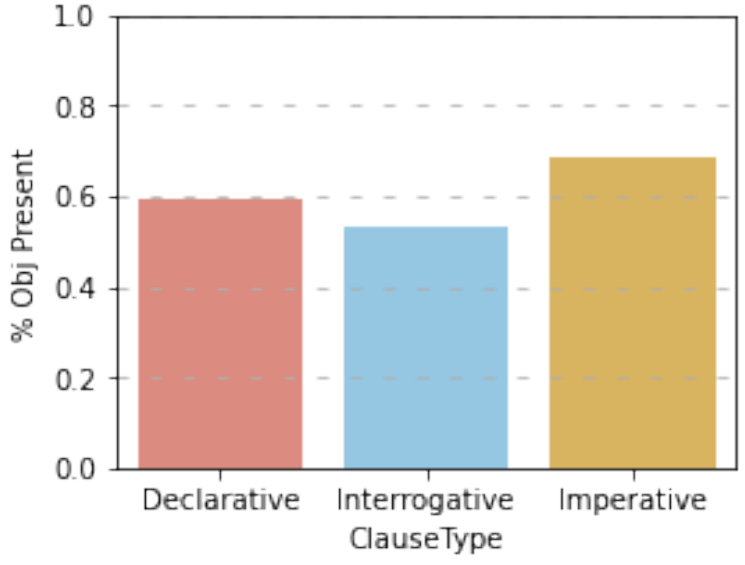
(28) (+) I'll take it. Declarative

(29) (−) Take it. Imperative

(30) (+) find it!

(31) (−) What did you find?



# +/− Verbs, auxiliaries

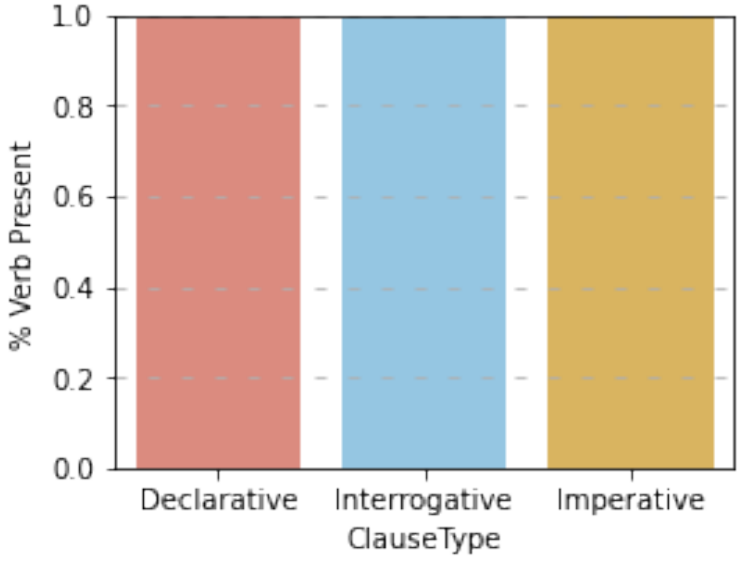
Infants around 18mo are able to identify verbs and auxiliaries in their language

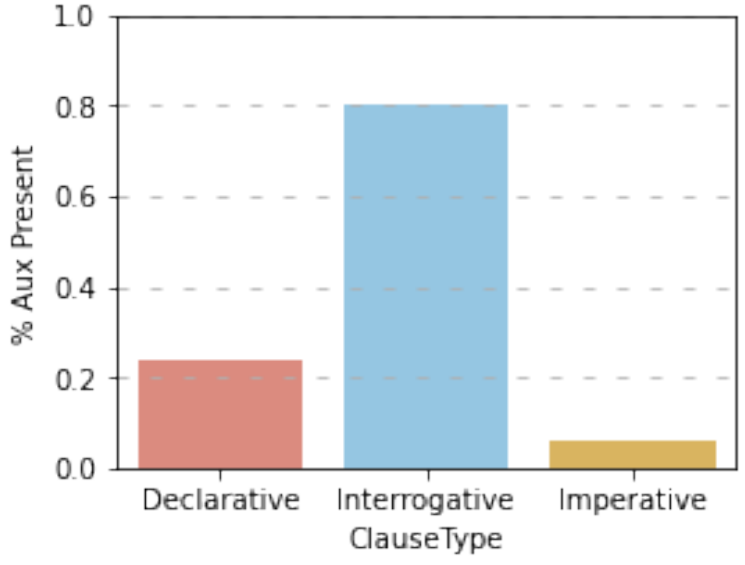
(32) (+) Find Elmo!

(33) (−) Elmo!

(34) (+) Can you find it?

(35) (−) I found it!



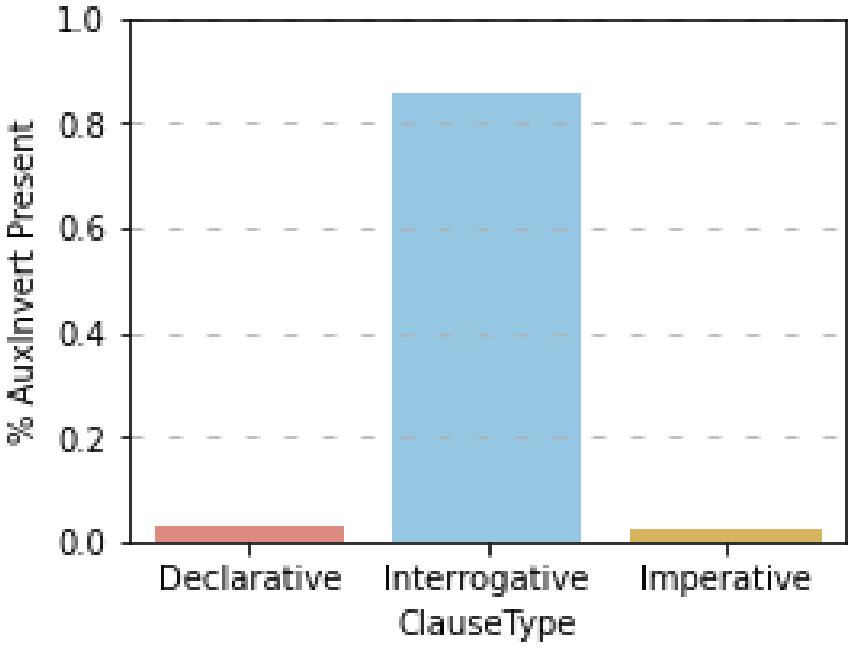



# +/− Verbs, auxiliaries

Infants around 18mo are able to represent the relative position of the subject and the verb

(36) (+) Can you find the ladybug? Interrogative

(37) (−) I can take it. Declarative

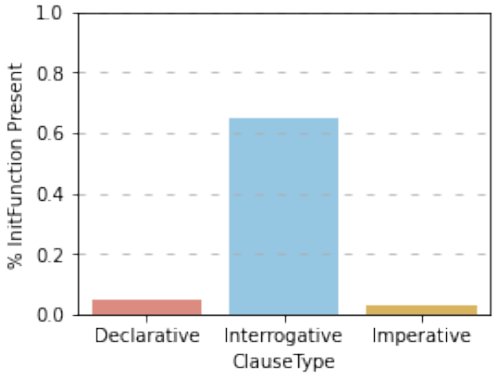


# Unknown functional items

Infants around 18mo might not know *wh*-items, quantifiers, conjunctors (except for *and*), but they might be able to represent them as an unknown functional item.

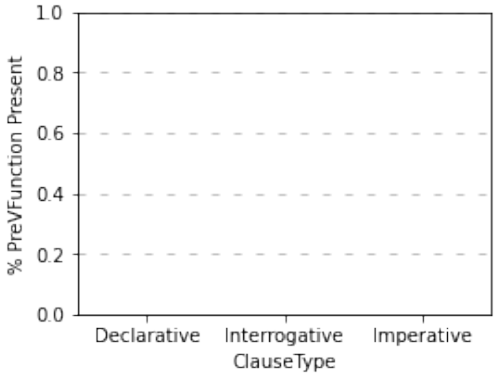
Occur sentence-initially

(38) What did you find?



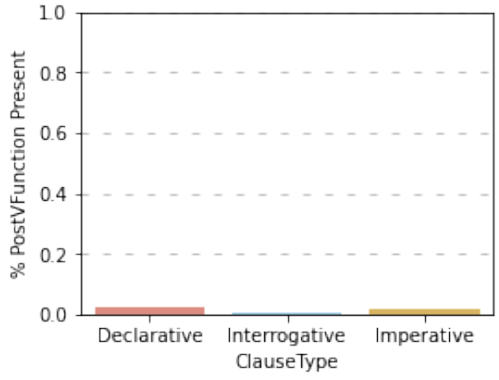

Occur sentence-medially, but before verbs

(39) raccoon **only** comes out at night




Occur after verbs

(40) I know **what**'s wrong.



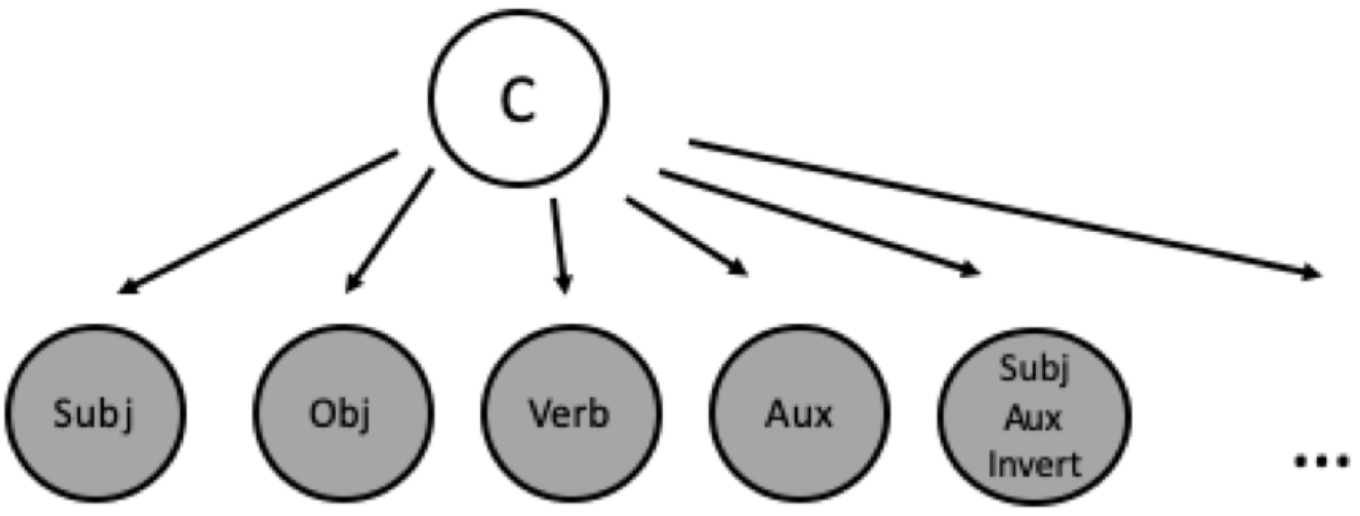
# Formal features: results

| | Interrogative | Declarative | Imperative |
|---|---|---|---|
| Subject | + | + | − |
| Object | no effect | − | no effect |
| Verb | + | + | + |
| Aux | + | no effect | no effect |
| Subj-Aux inversion | + | − | − |
| Initial Item | + | − | − |
| PreV Item | no effect | no effect | no effect |
| PostV Item | no effect | no effect | no effect |

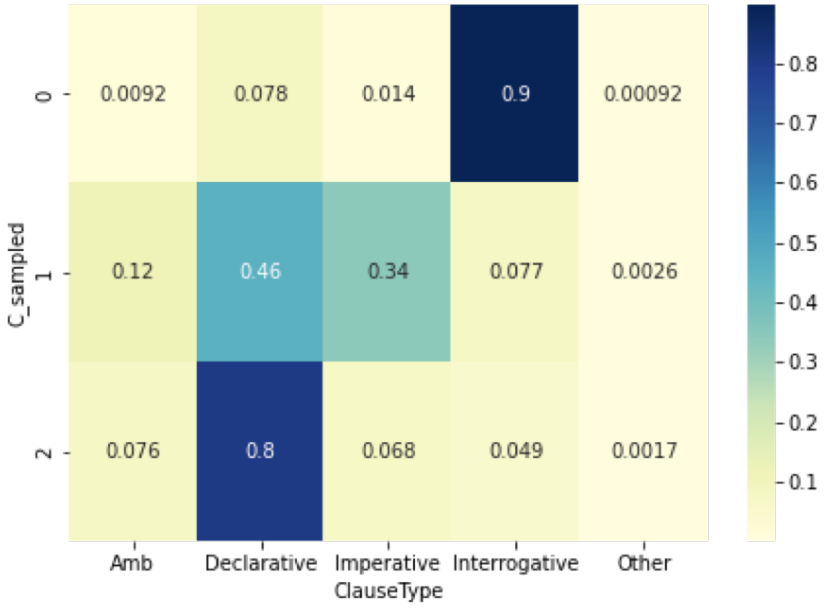
- But can infants learn the clause type categories with these formal features?

# Unsupervised learner

Assume that children have to discover 3 clause types with data from the above formal features:

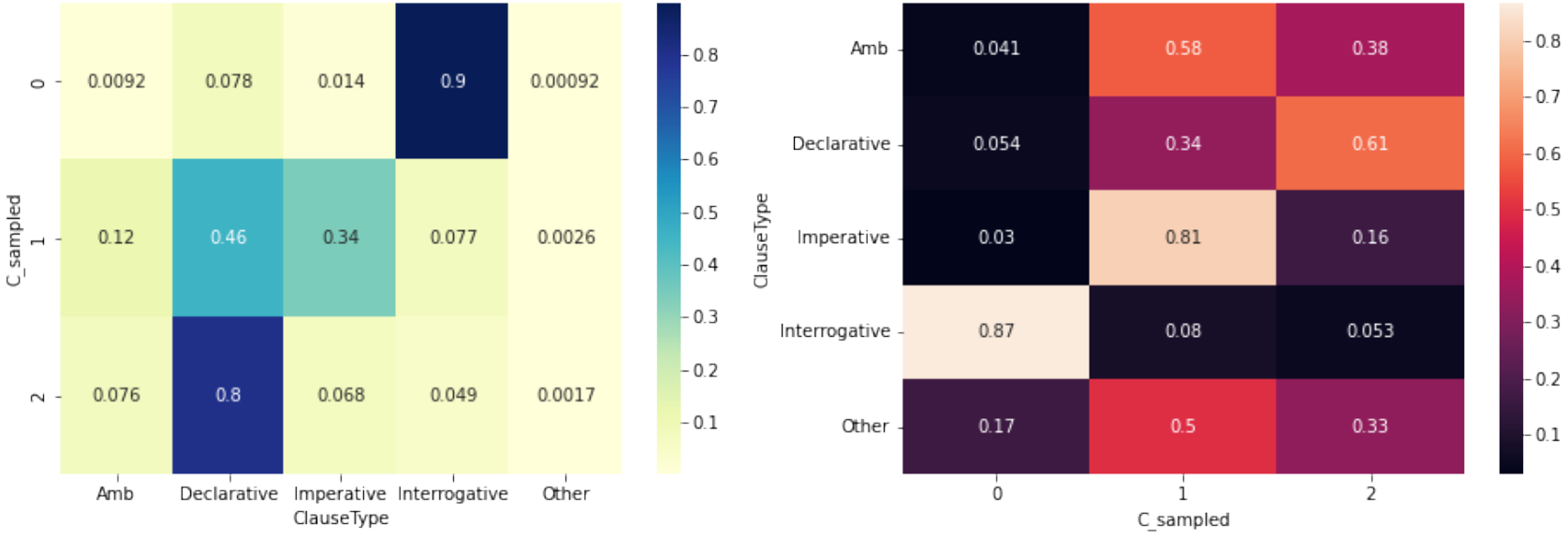


# Unsupervised learning: results




- The learner is able to identify a cluster for declaratives and one for interrogatives

# Unsupervised learner: results




- The majority of interrogatives is put into one cluster by the learner

# Formal features of each learned category

The learner is able to identify the correct set of formal features relevant for identifying clause types:

| Cluster | Features |
|---|---|
| 0 (90% interrogative) | with subj, verb, aux, subj-Aux Inversion, S-initial unknown function word |
| 1 (Declarative/imperative) | without aux, inversion, unknown function words |
| 2 (90% declarative) | with subj, obj, verb; without aux, inversion, or functional words |

# Interim conclusion

The input to infants around 18 months old are informative enough for them to find three groups of sentences

- The majority of interrogatives in parents' speech follow the same pattern: with subject-aux inversion, and sententce-initial unknown functional category

# Interim conclusion

The input to infants around 18 months old are informative enough for them to find three groups of sentences

- The majority of interrogatives in parents' speech follow the same pattern: with subject-aux inversion, and sententce-initial unknown functional category

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts $\rightarrow$ circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input. $\rightarrow$ Is it?

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input. →Is it?

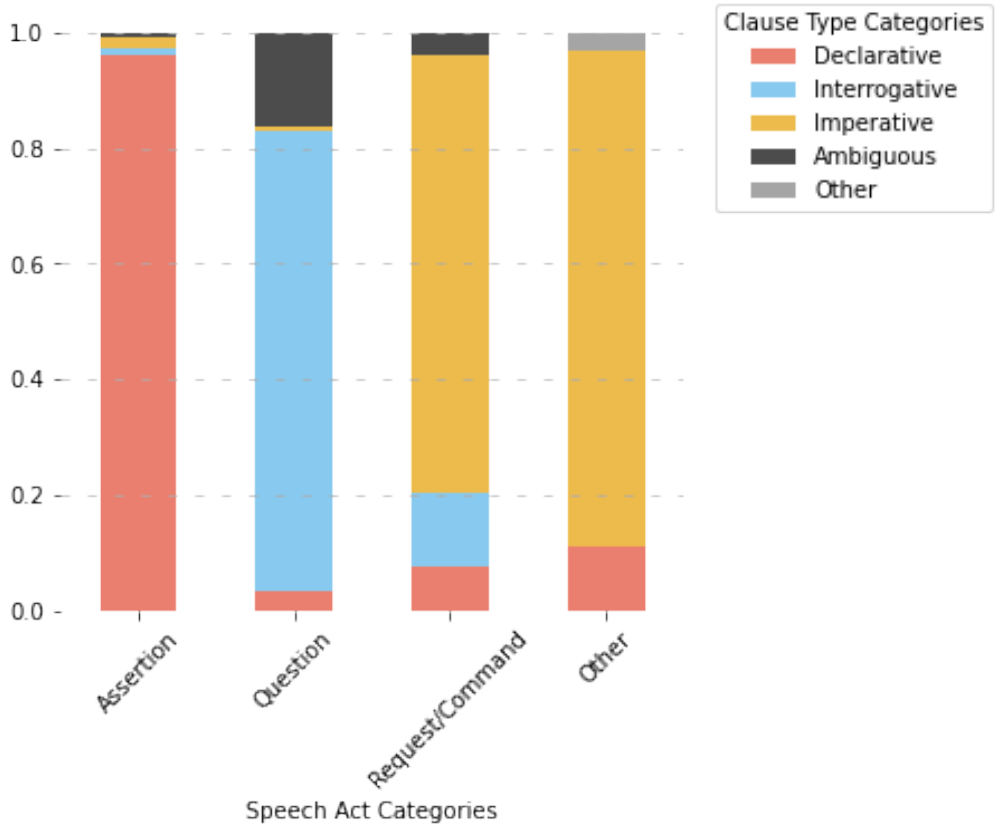
# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts, but the pragmatics of questions might be different when children are pre-linguistic;
  - Even if children could use speech act information, the mapping between speech act and clause type might be noisy in the input. →Is it?

# Mapping

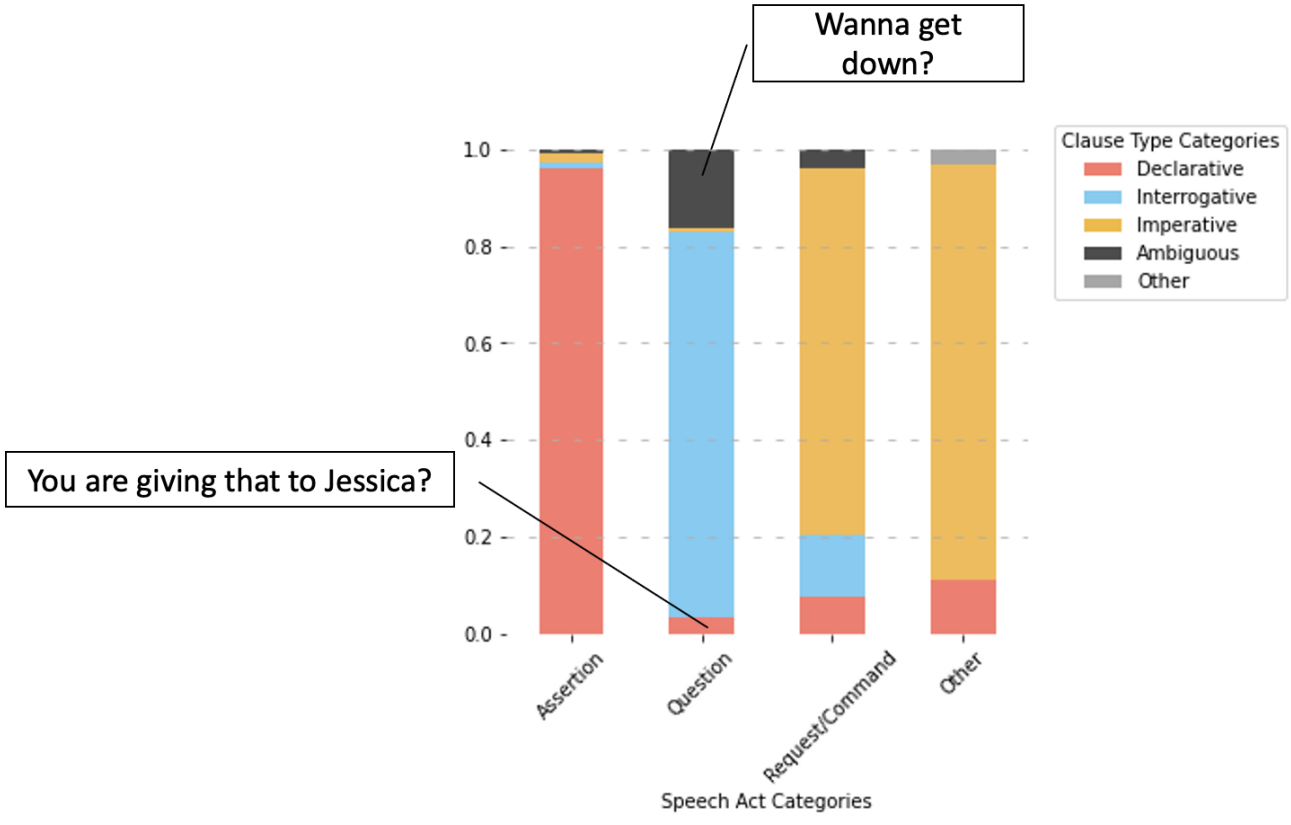
Is the mapping between speech acts and clause types messy?

- Speech acts are predominantly realized by their canonical clause type:



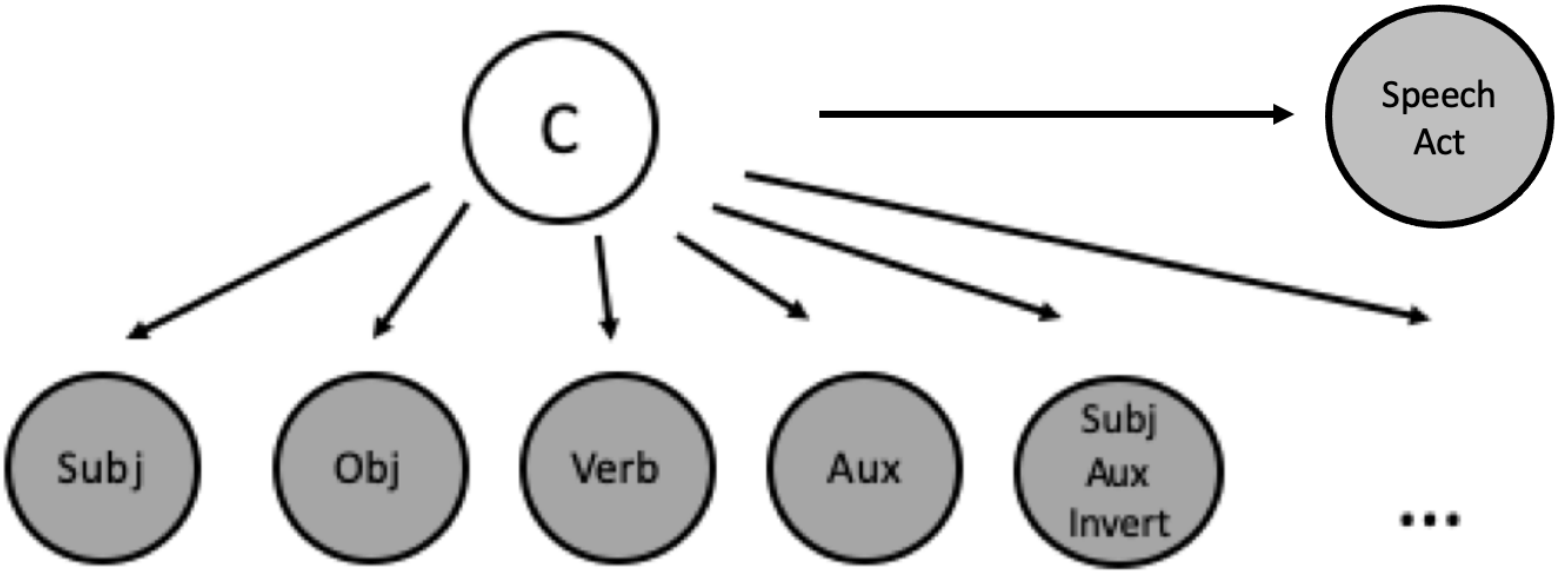
# Mapping

Examples of mismatches:

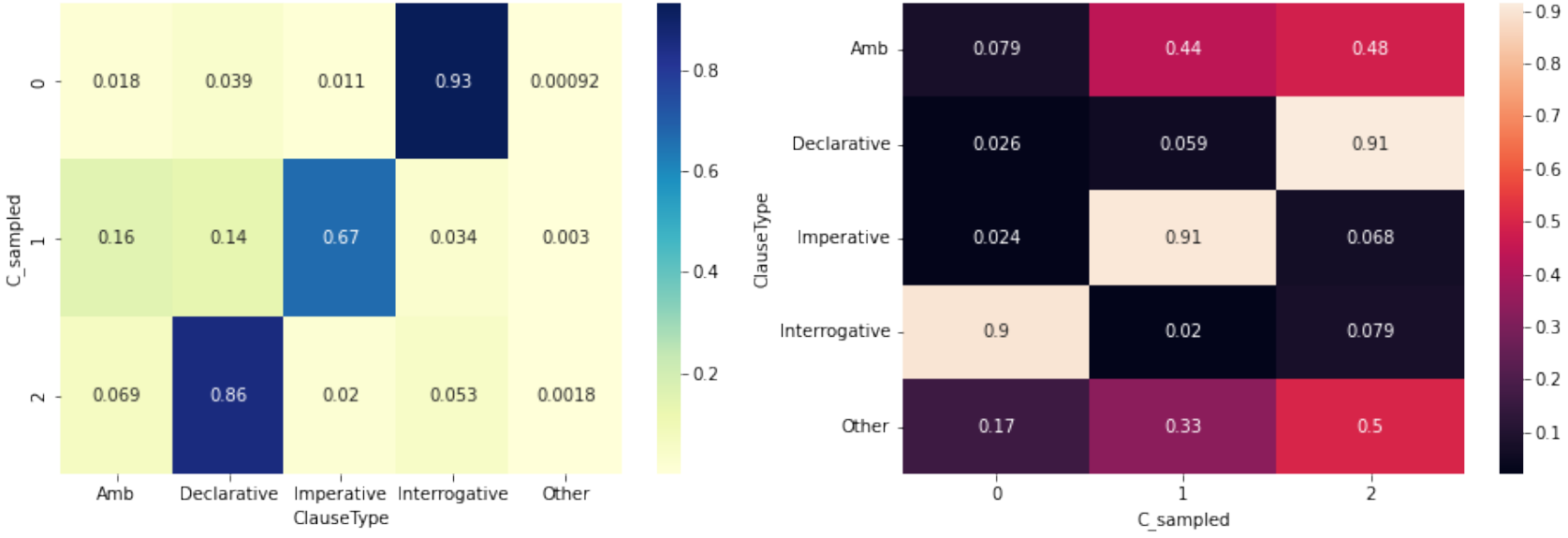


# Unsupervised Learner

Assume that infants have to discover 3 clause types with data from the above formal features, and that they know the speech act category of each utterance:



# Unsupervised learner: results




- The accuracy improves with Speech Act information
- The learner is able to cluster the sentences into three groups roughly corresponding to Declarative, Interrogative, and Imperative sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts
    → Are there any informative non-linguistic features?
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts
    → Are there any informative non-linguistic features?
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;
  - They might be able to use non-linguistic information to figure out speech acts

    → Are there any informative non-linguistic features?
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Non-linguistic features

Information in the pragmatics of social interaction might be helpful for identifying the speech act of the sentence

- Eye gaze pattern of the parent
- Length of pauses after an utterance

# Non-linguistic features

Information in the pragmatics of social interaction might be helpful for identifying the speech act of the sentence

- Eye gaze pattern of the parent
- Length of pauses after an utterance

# Eye gaze

- In social interactions, question $\rightarrow$ someone takes up the next turn
- Eye gaze $\rightarrow$ speaker wants that person to take up the turn
- But do parents still try to pass the turn to the child when the child is pre-linguistic?

Argyle 1972; Kendon 1967; Duncan et al. 1979; Rossano et al. 2009

# Eye gaze

- In social interactions, question $\rightarrow$ someone takes up the next turn
- Eye gaze $\rightarrow$ speaker wants that person to take up the turn
- But do parents still try to pass the turn to the child when the child is pre-linguistic?

Argyle 1972; Kendon 1967; Duncan et al. 1979; Rossano et al. 2009

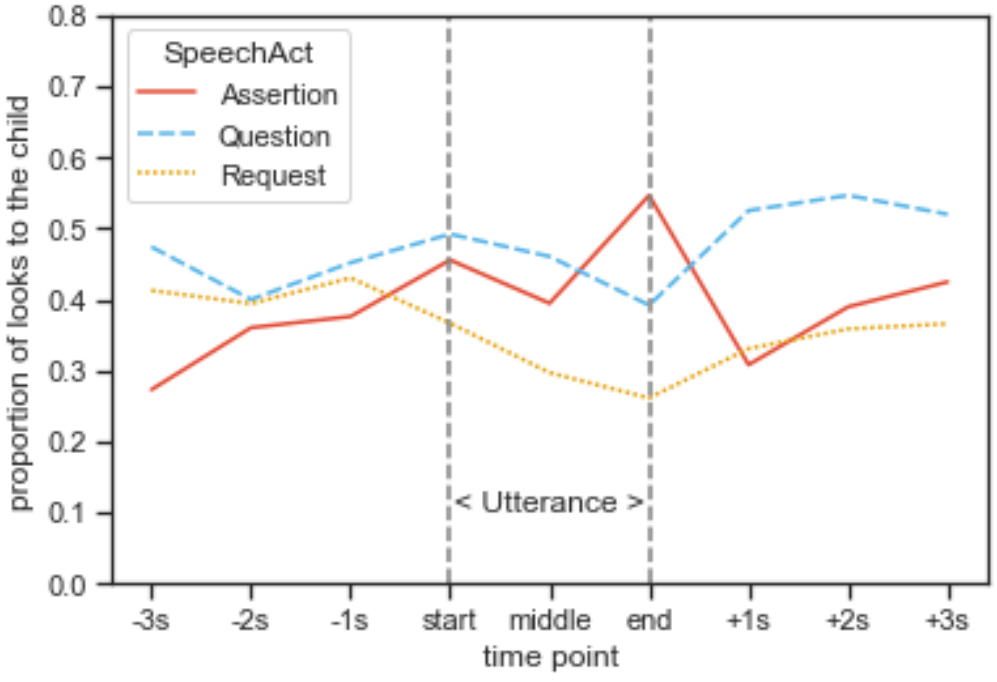
# Eye gaze

- In social interactions, question $\rightarrow$ someone takes up the next turn
- Eye gaze $\rightarrow$ speaker wants that person to take up the turn
- But do parents still try to pass the turn to the child when the child is pre-linguistic?

Argyle 1972; Kendon 1967; Duncan et al. 1979; Rossano et al. 2009

# Eye gaze: results

- Parents behave as if the child can talk: they look at the child longer after questions to appoint the child as the next speaker in turn



# Speech gap

- Questions → elicit responses
- Pauses after utterances → the speaker wants someone to take up the turn
- But would parents still pause if the other speaker is pre-linguistic, and hence might not be able to respond?

Consecutive turn sequences:

(41) Alex's mother: Who's that? [pause] Is that the postman?

# Speech gap

- Questions → elicit responses
- Pauses after utterances → the speaker wants someone to take up the turn
- But would parents still pause if the other speaker is pre-linguistic, and hence might not be able to respond?

Consecutive turn sequences:

(42) Alex's mother: Who's that? [pause] Is that the postman?

# Speech gap

- Questions → elicit responses
- Pauses after utterances → the speaker wants someone to take up the turn
- But would parents still pause if the other speaker is pre-linguistic, and hence might not be able to respond?

Consecutive turn sequences:

(43) Alex's mother: Who's that? [pause] Is that the postman?

# Speech gap

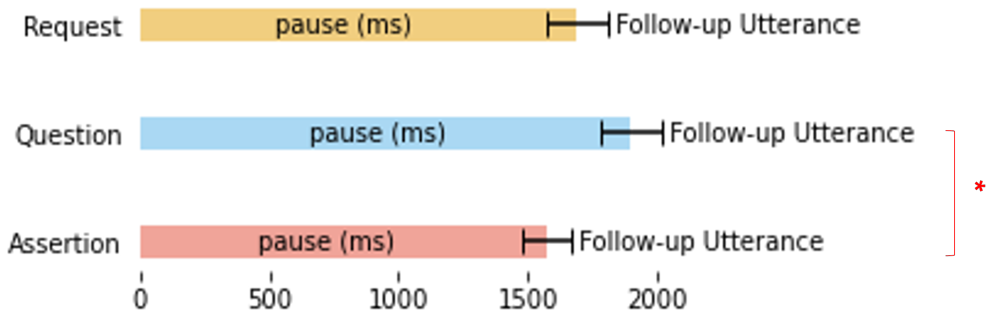
- Questions → elicit responses
- Pauses after utterances → the speaker wants someone to take up the turn
- But would parents still pause if the other speaker is pre-linguistic, and hence might not be able to respond?

Consecutive turn sequences:

(44) Alex's mother: Who's that? [pause] Is that the postman?

# Speech gap: Results

- Parents behave as if the children can talk: they pause longer after questions to solicit answers



# Interim summary

Infants might be able to use non-linguistic cues like speech gap and parents' eye gaze to identify speech acts

- Currently working on an unsupervised learner to use both formal and non-linguistic features to identify clause types and speech acts

# Interim summary

Infants might be able to use non-linguistic cues like speech gap and parents' eye gaze to identify speech acts

- Currently working on an unsupervised learner to use both formal and non-linguistic features to identify clause types and speech acts

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;

    How do children "bootstrap" into identifying speech act and clause type categories?
  - There is information in the input that might be helpful for identifying speech acts
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;

    How do children "bootstrap" into identifying speech act and clause type categories?
  - There is information in the input that might be helpful for identifying speech acts
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;

    How do children "bootstrap" into identifying speech act and clause type categories?
  - There is information in the input that might be helpful for identifying speech acts
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# Recap the challenges

- They need to figure out which morph-syntactic features are associated with interrogatives (clustering problem); ✓
- They need to figure out that one of the groups of the sentences identified could be labeled as interrogatives (labeling problem);
  - To solve the labeling problem, they might need to use speech act information, but adults use clause type information to figure out speech acts → circular;

    How do children "bootstrap" into identifying speech act and clause type categories?
  - There is information in the input that might be helpful for identifying speech acts
  - The mapping between speech act and clause type is consistent enough that if children could identify speech act information independently, they are able to cluster and label the groups of sentences

# The Pragmatic Syntactic Bootstrapping Hypothesis

Children learn to identify speech act (question) and clause type (interrogative) in tandem and mutually informative ways:

- track formal, prosodic, and non-linguistic features in parents' speech
- learn to identify interrogatives by tracking formal regularities in conjunction with their growing knowledge of questionhood and its associated non-linguistic cues;
- learn to identify questions by tracking non-linguistic cues in conjunction with their growing understanding of interrogative syntax.

# The Pragmatic Syntactic Bootstrapping Hypothesis

Children learn to identify speech act (question) and clause type (interrogative) in tandem and mutually informative ways:

- track formal, prosodic, and non-linguistic features in parents' speech
- learn to identify interrogatives by tracking formal regularities in conjunction with their growing knowledge of questionhood and its associated non-linguistic cues;
- learn to identify questions by tracking non-linguistic cues in conjunction with their growing understanding of interrogative syntax.

# The Pragmatic Syntactic Bootstrapping Hypothesis

Children learn to identify speech act (question) and clause type (interrogative) in tandem and mutually informative ways:

- track formal, prosodic, and non-linguistic features in parents' speech
- learn to identify interrogatives by tracking formal regularities in conjunction with their growing knowledge of questionhood and its associated non-linguistic cues;
- learn to identify questions by tracking non-linguistic cues in conjunction with their growing understanding of interrogative syntax.

# On-going work

- Prosody
- We assumed that the unsupervised learner already know there are 3 clause type categories; what if they have to learn the number of categories?
- Build the syntactic-pragmatic bootstrapping learner

# Thanks!


- Mina Hirzel, Anouk Dieuleveut, Tyler Knowlton, Adam Liter, Rachel Rudinger, Naomi Feldman, Thomas Schatz, Alexander Williams
- Audiences at UMD LSLT, Acquisition Lab Meeting, General Meeting
- Our awesome undergraduate RAs: James Burns, Xiaoyu Yang, Ziqing Ji, Rin Gourianova, Luke Burger, Avni Gulrajani

# Questions?

- Slides are posted online at:
  `yu-an.github.io/projects`
- You can also email me:
  yang.yu.an.06@gmail.com

# Bibliography I


Casillas, Marisa & Michael Frank (2013). The development of predictive processes in children's discourse understanding. *Proceedings of the Annual Meeting of the Cognitive Science Society*, vol. 35.

Casillas, Marisa & Michael C. Frank (2017). The development of children's ability to track and predict turn structure in conversation. *Journal of Memory and Language* 92, 234 – 253, URL `http://www.sciencedirect.com/science/article/pii/S0749596X16300596`.

Demuth, Katherine, Jennifer Culbertson & Jennifer Alter (2006). Word-minimality, epenthesis and coda licensing in the early acquisition of english. *Language and Speech* 49:2, 137–173.

Geffen, Susan & Toben H Mintz (2015). Can you believe it? 12-month-olds use word order to distinguish between declaratives and polar interrogatives. *Language Learning and Development* 11:3, 270–284.

Hedlund, Gregory & Yvan Rose (2020). Phon 3.1. `https://phon.ca`.

König, Ekkehard & Peter Siemund (2007). Speech act distinctions in grammar. Shopen, Timothy (ed.), *Language typology and syntactic description*, Cambridge University Press, Cambridge, vol. 2, 276–324.

Krifka, Manfred (2008). Basic notions of information structure. *Acta Linguistica Hungarica* 55:3-4, 243–276.

# Bibliography II


Lausberg, H. & H Sloetjes (2009). *Coding gestural behavior with the NEUROGES-ELAN system*. Max Planck Institute for Psycholinguistics, Nijmegen, URL `https://archive.mpi.nl/tla/elan`.

MacWhinney, Brian (2000). *The CHILDES Project: Tools for analyzing talk. transcription format and programs*, vol. 1. Psychology Press.

Portner, Paul (2018). *Mood*. Oxford University Press, Oxford.

Povey, Daniel, Arnab Ghoshal, Gilles Boulianne, Lukas Burget, Ondrej Glembek, Nagendra Goel, Mirko Hannemann, Petr Motlicek, Yanmin Qian, Petr Schwarz, Jan Silovsky, Georg Stemmer & Karel Vesely (2011). The kaldi speech recognition toolkit. *IEEE 2011 Workshop on Automatic Speech Recognition and Understanding*, IEEE Signal Processing Society. IEEE Catalog No.: CFP11SRW-USB.

Rowland, Caroline F, Julian M Pine, Elena VM Lieven & Anna L Theakston (2003). Determinants of acquisition order in *wh*-questions: Re-evaluating the role of caregiver speech. *Journal of Child Language* 30:3, 609–635.

Sadock, Jerrold M & Arnold M Zwicky (1985). Speech act distinctions in syntax. Shopen, Timothy (ed.), *Language typology and syntactic description*, Cambridge University Press, Cambridge, vol. 1, 155–196.

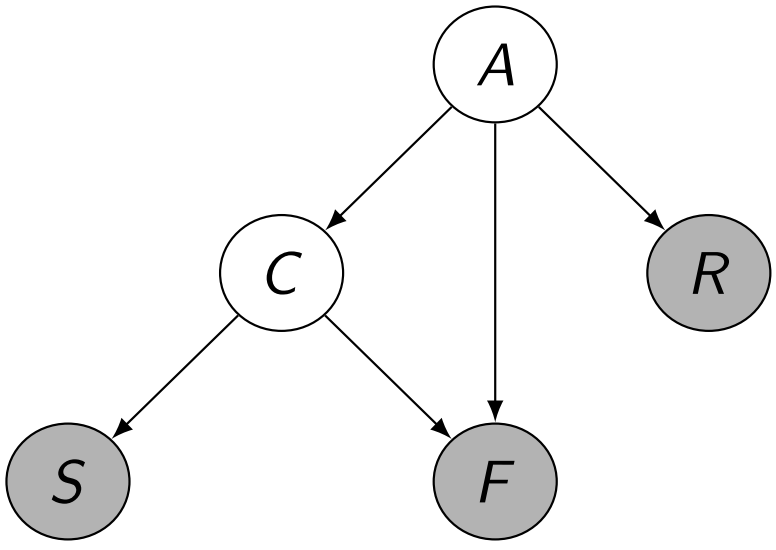
Searle, John R (1976). A classification of illocutionary acts. *Language in Society* 5:1, 1–23.

# Bibliography III

Stromswold, Karin (1995). The acquisition of subject and object wh-questions. *Language Acquisition* 4:1-2, 5–48.

Tyack, Dorothy & David Ingram (1977). Children's production and comprehension of questions. *Journal of Child Language* 4:2, 211–224.

# Graphical Model




- A: Speech Acts
- C: Clause Types
- S: Syntactic features (feature bundle)
- R: Pragmatic features (feature bundle)
- F: prosodic features

- We want to jointly infer A and C given S, R, and F through Gibbs sampling.