

The syntax of Chinese attitude verbs: complications and implications for language acquisition

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Attitude verbs

- Verbs that typically describe some mental state.
- Attested cross-linguistically.
- Form several smaller, distinct semantic classes.



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The learning challenge: attitude verbs describe abstract, hard-to-observe mental states

“Belief” verbs

think

know

believe

guess

say



“Desire” verbs

want

prefer

love

like

Dora ***thinks*** *Kim went to bed.*

Express commitment to truth of
“Kim went to bed”

Dora ***wants*** *Kim to go to bed.*

Express preference for
“Kim goes to bed”

How might a child figure out these meaning differences?



Via Elmhurst College

“I **think** Kim went to bed.”

Gleitman 1990; Gillette et al. 1999

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Syntactic bootstrapping: learning semantics from syntax

Verb meanings can be tricky to observe, but syntax is relatively easy to observe.

Infer semantics using syntax.

Gleitman & Landau 1985; Gleitman 1990; Gillette et al. 1999; Hacquard & Lidz 2019; Huang et al. 2018, 2022, to appear; also Fisher 1996; Lee & Naigles 2008

Interesting points of connections with research on formal syntax and semantics: Verb meanings are robustly correlated with syntax.

Zwicky 1971, Levin 1993, Villalta 2008, White & Rawlins 2015, etc.

But syntactic bootstrapping requires a very important assumption

Namely, there are morphosyntactic differences that are easy for a child to observe.

But languages can vary widely in their morphosyntax. **Is this assumption actually valid?**

If not:

1. Learners might draw the **wrong morphosyntactic conclusions**, e.g. about argument structure, subcategorization, case.
2. Learners using syntactic bootstrapping as a learning strategy further risk drawing **the wrong semantic conclusions**.

This talk: are syntactic differences truly easier to observe?

Mandarin Chinese: two features of clausal syntax might make it **difficult to differentiate between complement clauses**.

1. Absence of inflectional morphology
2. Wh-in situ (also in situ A-not-A, *haishi* 還是 “or”)

Complications for learning the distinctions between:

1. Belief and desire verbs (**semantic distinction**)
2. Antirogative vs. responsive verbs (**syntactic distinction**)

This talk

However, analysis of child-ambient speech reveals distributional differences for these verbs.

- **There are overt differences that learners could observe and leverage, even in a language like Mandarin.**

Along the way, we will see that **pragmatics (speech act-related cues)** can play an important role in helping learners learn the right semantics and syntax.

Learning verb meanings: whether a verb has belief or desire semantics

(Huang, White, Liao, Hacquard & Lidz 2022; Huang, Liao, Hacquard, & Lidz 2018)

Outline

- The syntax of belief complements and declarative main clauses
- A syntactic bootstrapping account
- The problem posed by Mandarin Chinese syntax
- How serious is the problem? Corpus analysis and a computational model of syntactic bootstrapping

Cross-linguistically, belief and desire verbs are differentiated morphosyntactically

Cross-linguistically, belief and desire verbs are differentiated morphosyntactically

*Dora **pense** que Kim **est** au lit.*

“Dora **thinks** that Kim **is.IND** in bed.”

*Dora **veut** que Kim **soit** au lit.*

“Dora **wants** Kim **be.SUBJ** in bed.”

	Complement clause of belief verbs	Complement clause of desire verbs
English	Finite	Non-finite
French (and Romance)	Indicative	Subjunctive

Belief clauses resemble declarative sentences

Declaratives

Dora *thinks* Kim went to bed.

Kim went to bed.

Dora *pense* que Kim est au lit.

Kim est au lit.

“Dora *thinks* that Kim is.IND in bed.”

“Kim is.IND in bed.”

	Complement clause of belief verbs	Complement clause of desire verbs	Declarative sentences
English	Finite	Non-finite	Finite
French (and Romance)	Indicative	Subjunctive	Indicative

Syntactic bootstrapping: learning semantics from syntax

Specifically: **learn verb semantics from clausal syntax.**

Proposal

If a verb has an complement clause that looks like a declarative sentence, that verb is a **belief** verb.

If not, it is a **desire** verb.

Why? A role for pragmatics

“Dora thinks Kim went to bed.”

“Dora wants Kim to go to bed.”

“Kim went to bed.”

Direct assertion

Huang, White, Liao, Hacquard & Lidz 2022; Huang, Liao, Hacquard, & Lidz 2018; Hacquard & Lidz, 2019

Why? A role for pragmatics

*“Dora thinks **Kim went to bed.**”*

“Dora wants Kim to go to bed.”

**Indirect assertion of
“Kim went to bed”**

*“**Kim went to bed.**”*

Huang, White, Liao, Hacquard & Lidz 2022; Huang, Liao, Hacquard, & Lidz 2018; Hacquard & Lidz, 2019

Why? A role for pragmatics

*“Dora **thinks** Kim went to bed.”*

“Dora wants Kim to go to bed.”

**Indirect assertion of
“Kim went to bed”**

→ *Think* expresses truth judgments

“Kim went to bed.”

A syntactic bootstrapping account requires belief and desire clauses to look distinct

Proposal

- If a verb has an complement clause that looks like a declarative sentence, that verb is a **belief** verb.
- If not, it is a **desire** verb.

The requirement is easily satisfied in languages with finiteness and mood morphology.

But what about a language that lacks such morphology, like Mandarin?

Hallmarks of Mandarin declarative sentences and belief clauses vs. desire clauses

	Declarative sentences	Complement of belief verbs
Overt subjects	Optional	Optional
Modals	Optional	Optional
Aspect markers	Optional	Optional

Problem: overt subjects, modals, and aspect markers are all optional – they can be omitted in the right context.

Mandarin Chinese

我 覺得 他們 可能 吃過 水果

Wo **juede** tamen keneng chi-guo shuiguo.

I feel/think they might eat-EXP fruit

“I **think** they might have eaten fruit.” (**Belief**)

Mandarin Chinese

	Subject	Modal	Aspect	
我	覺得	他們	可能	吃過 水果
Wo	juede	tamen	keneng	chi-guo shuiguo.
I	feel/think	they	might	eat-EXP fruit

“I **think** **they** **might** **have** eaten fruit.” (Belief)

我	喜歡	吃	水果
Wo	xihuan	chi	shuiguo.
I	like	eat	fruit

“I **like** to eat fruit.” (Desire)

他們	可能	吃過	水果
Tamen	keneng	chi-guo	shuiguo.
they	might	eat-EXP	fruit

“**They** **might** **have** eaten fruit.” (Declarative)

Mandarin Chinese

我 覺得 吃 水果
Wo **juede** chi shuiguo.
I feel/think eat fruit
“I **think** [they] eat fruit.”

我 喜歡 吃 水果
Wo **xihuan** chi shuiguo.
I like eat fruit
“I **like** to eat fruit.”

A solution

Learners can track the **overall distribution** of various morphosyntactic features.

Perhaps belief clauses and desire clauses **look different in aggregation**.

1. Is this the case?
2. If there is differentiation between belief and desire clauses, are the differences enough for the learner?

Q1: Are the clauses differentiated in the input?

我 覺得 他們 可能 吃過 水果 我 喜歡 吃 水果
Wo juede shuiguo.
I feel/think fruit

5 child-directed speech corpora in CHILDES
(Beijing, Chang1, Context, Zhou1, Zhou2)

~4,200 tokens of attitude verbs with complement clauses
~1,600 declarative sentences

Tamen keneng chi-guo shuiguo.
they might eat-EXP fruit

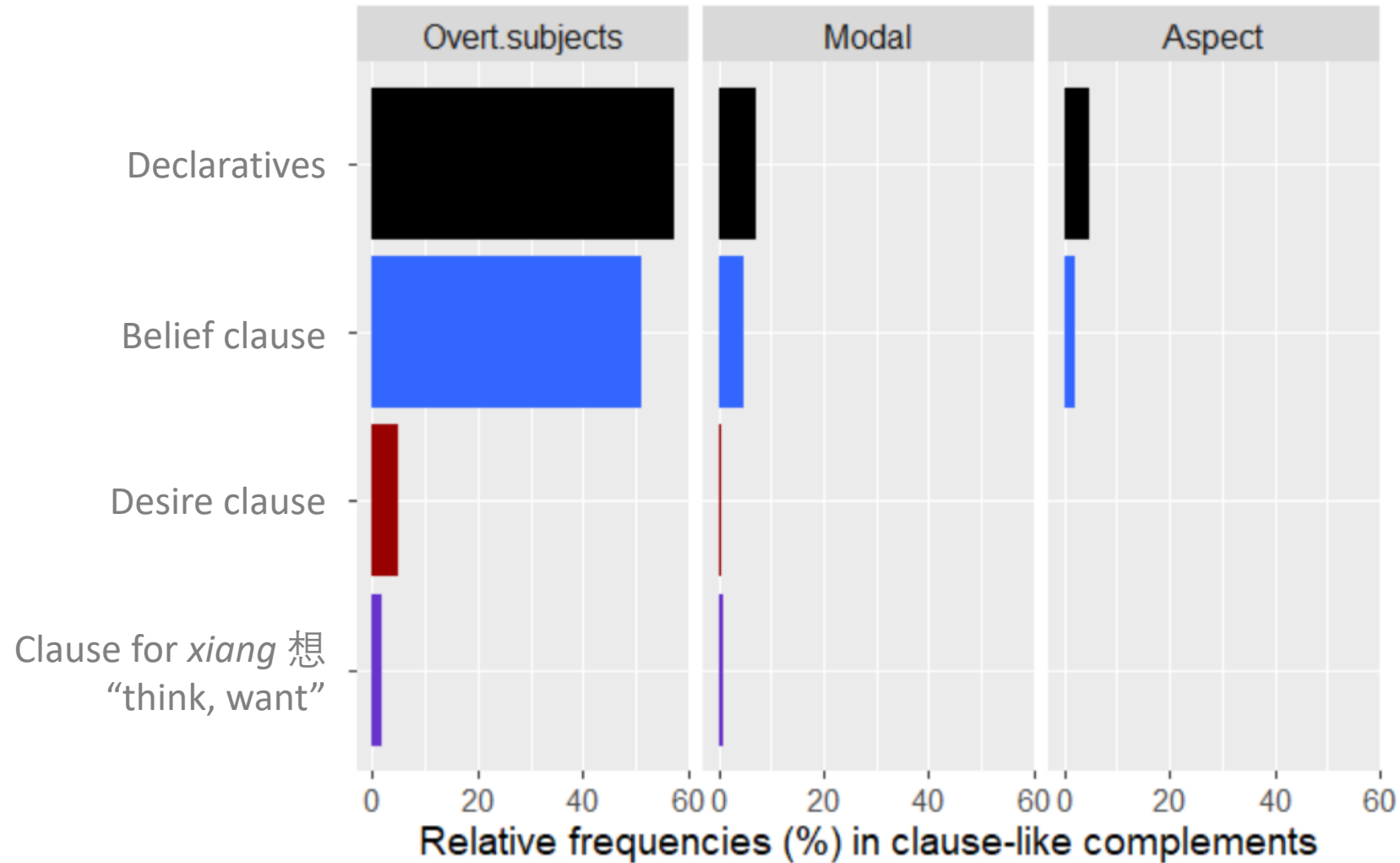
If the clauses are differentiated in the input,
syntactic bootstrapping is feasible

我	覺得	他們	可能	吃過	水果	我	喜歡	吃	水果
Wo	juede	tamen	keneng	chi-guo	shuiguo.	Wo	xihuan	chi	shuiguo.
I	feel/think	they	might	eat-EXP	fruit	I	like	eat	fruit

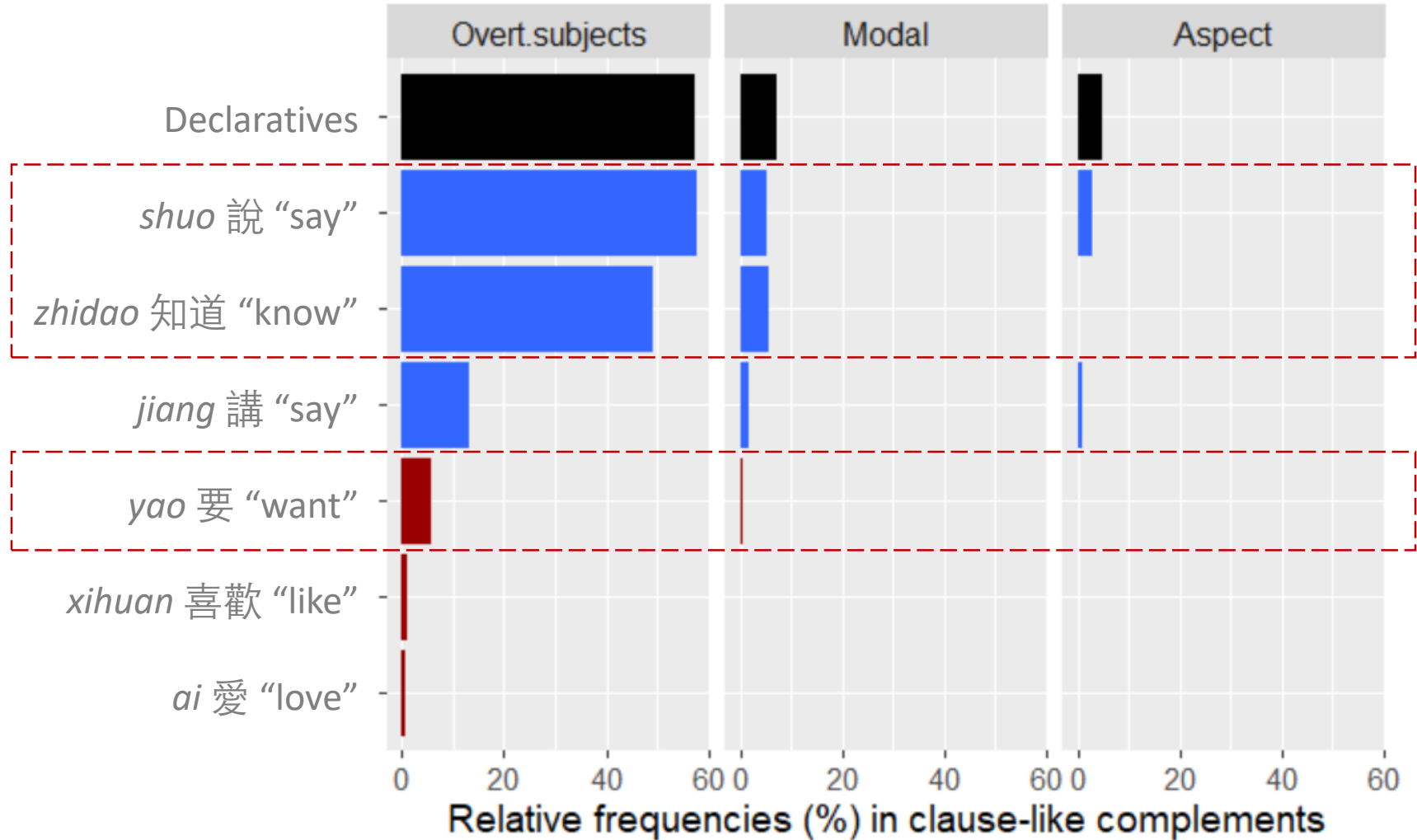
Each token coded for presence of
overt subject, modal, aspect markers

他們	可能	吃過	水果
Tamen	keneng	chi-guo	shuiguo.
they	might	eat-EXP	fruit

Corpus study: results by verb class



Corpus study: results by verb class



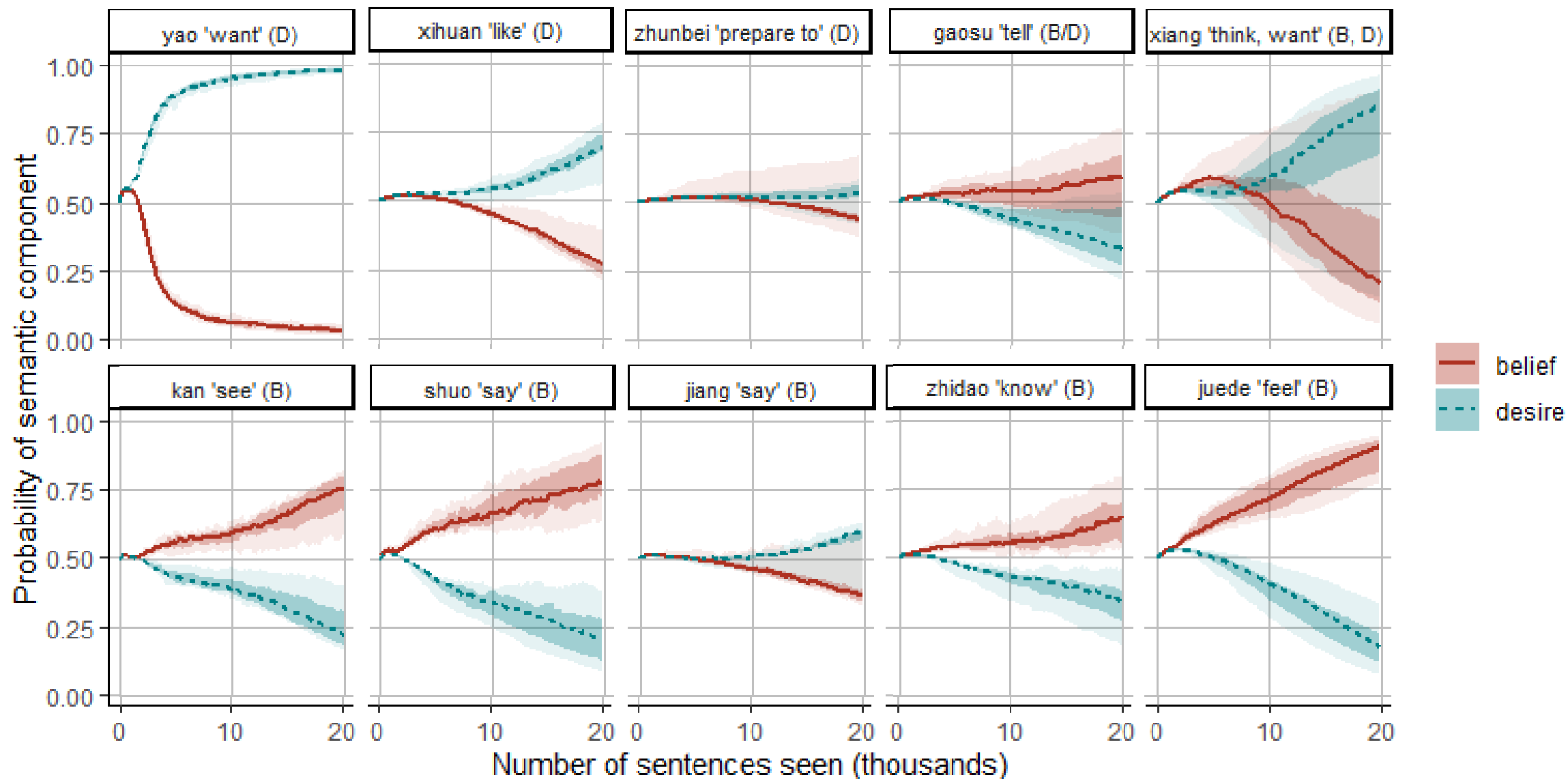
Q2: Do distributional differences guarantee successful learning of verb semantics?

Simulate a learner.

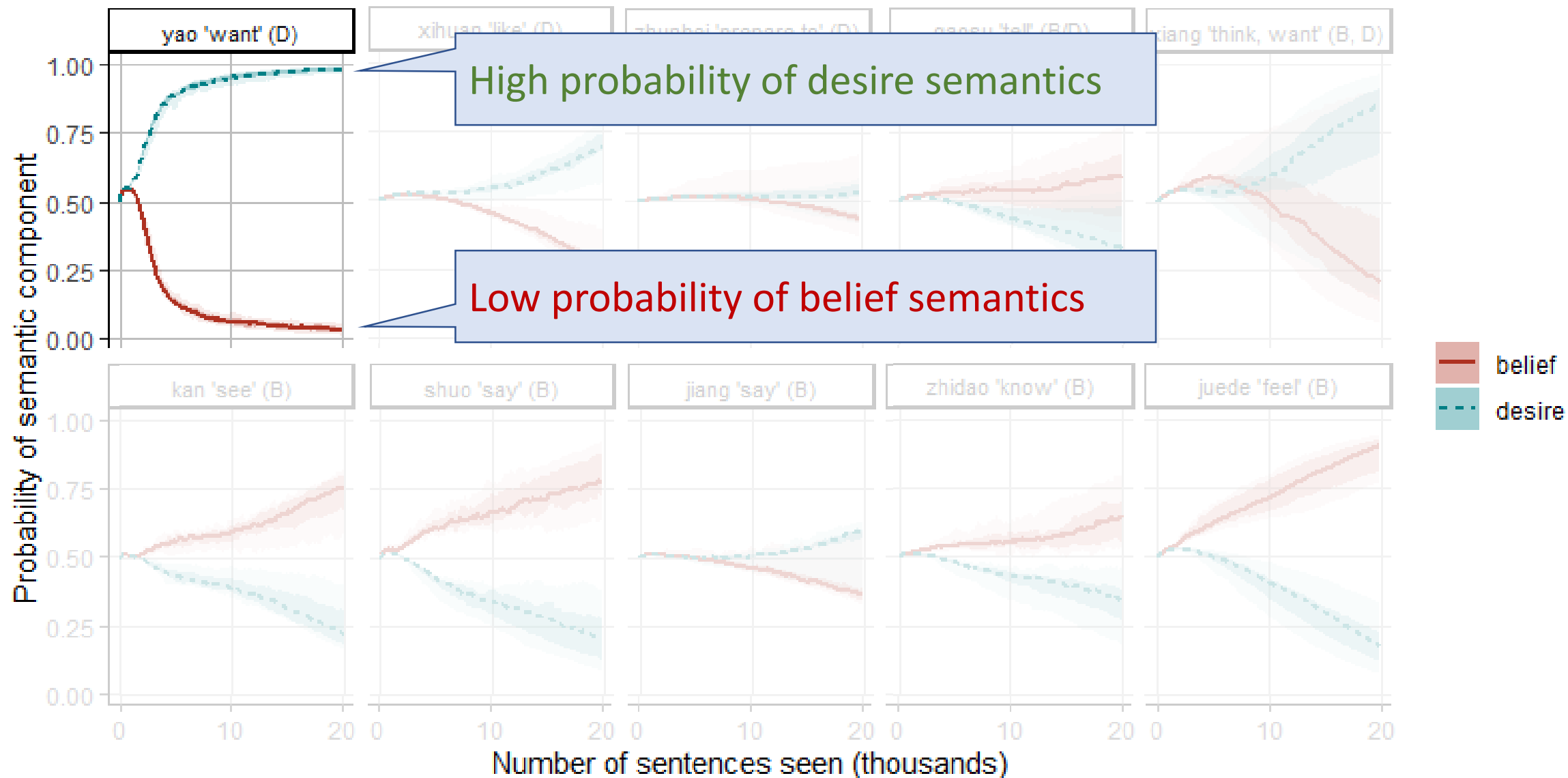
- Adapt a **computational model of syntactic bootstrapping** by White et al. 2018.
- Shown to model acquisition of English attitude verbs, using English child-directed speech data.

Does this “learner” succeed with Mandarin attitude verbs?

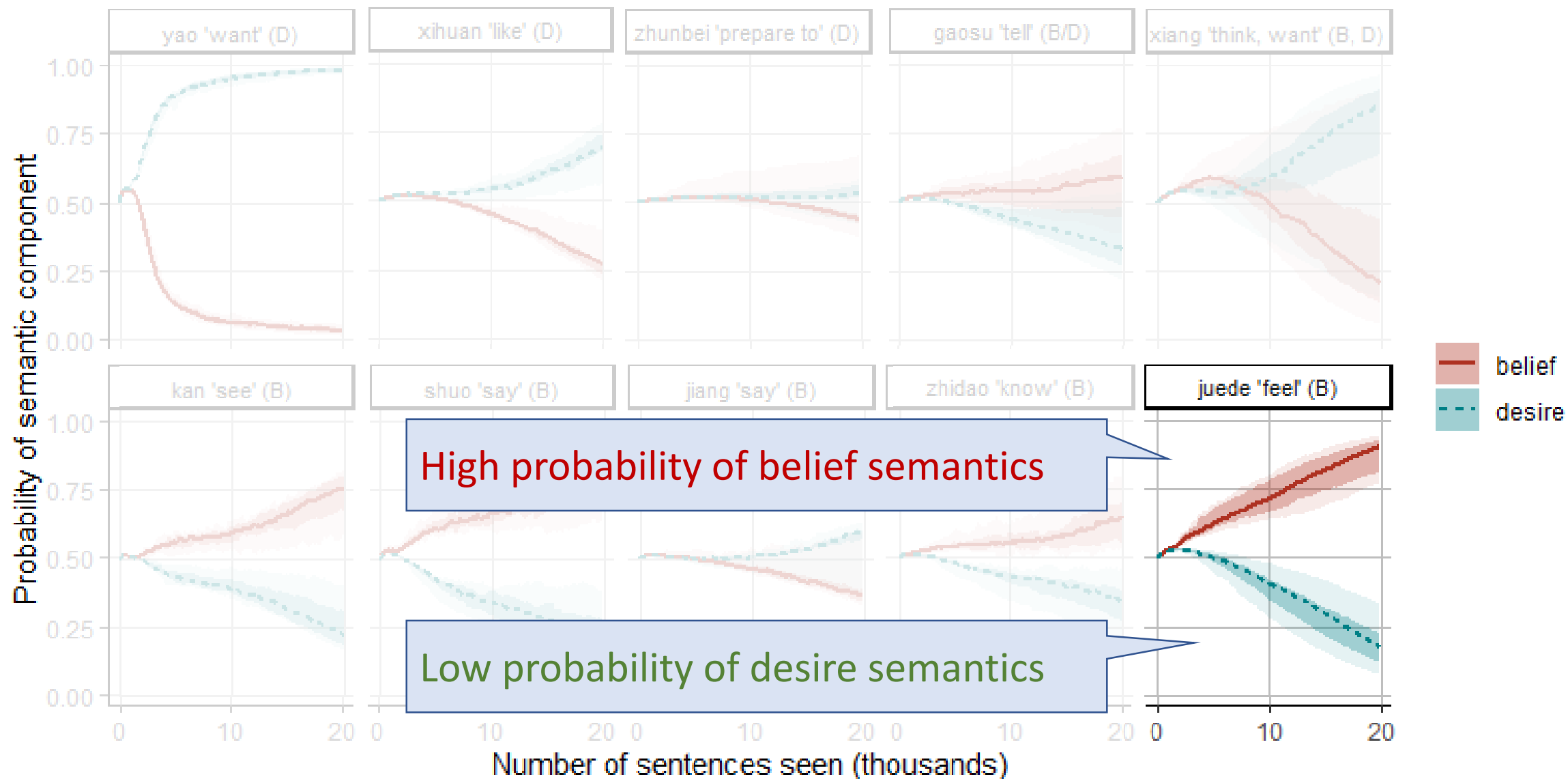
Mandarin results (10 CHILDES corpora)



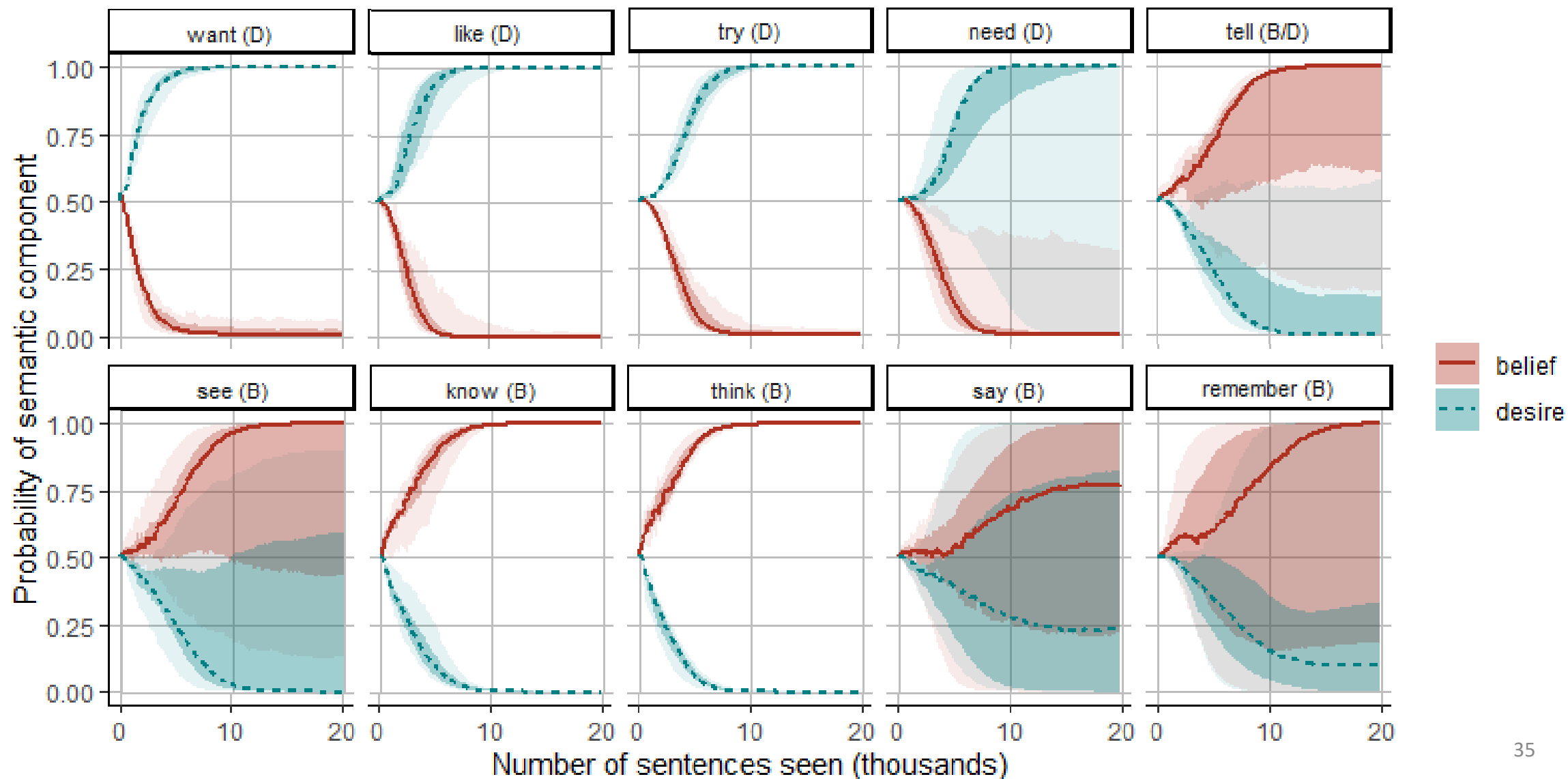
Mandarin results (10 CHILDES corpora)



Mandarin results (10 CHILDES corpora)



English results (replicating White et al. 2018)



Summing up this case study

- Belief and desire verbs turn out to have different morphosyntactic profiles in Mandarin child-ambient speech.
- Computational model shows that these morphosyntactic features can be exploited to learn semantic contrasts in both Mandarin and English – cross-linguistic support.

Learning verb subcategorisation: antirogative and responsive verbs

Huang, Yang, Hacquard & Lidz, to appear; Yang & Huang 2022

Outline

- Wh-in situ and subcategorisation: an ambiguity problem
- Solutions for the ambiguity problem:
 1. A language-neutral strategy involving speech acts
 2. A Mandarin-specific strategy involving the question particle *ma*
- Corpus analysis and results

Belief verbs: antirogativity and responsivity

Antirogative



Responsive



Declarative Dora **thinks** Daddy likes that cake.

Interrogative *Dora **thinks** which cake Daddy likes.

Belief verbs: antirogativity and responsivity

Antirogative



Responsive



Declarative

寶寶覺得爸爸喜歡那個蛋糕。

Baobao juede baba xihuan nàge dangao.

Interrogative

*寶寶覺得爸爸喜歡哪個蛋糕。

*Baobao juede baba xihuan nǎge dangao.

“*Baobao *juede* which cakes Dad likes.”

The problem: A nonce-verb demonstration
What can you infer about subcategorisation?

Dora **blicks** Daddy likes cake

Blick allows declaratives

Dora **blicks** what Daddy likes

Blick allows interrogatives

The problem: A nonce-verb demonstration
What can you infer about subcategorisation?

寶寶 *dan* 爸爸喜歡蛋糕

Baobao ***dan*** baba xihuan dangao

Dan allows declaratives

寶寶 *dan* 爸爸喜歡什麼

Baobao ***dan*** baba xihuan shenme

Q: Does *dan* allow interrogatives?

Why might we hesitate?

Reason 1: uncertainty about the scope of the wh-phrase

寶寶 dan 爸爸喜歡 什麼

Baobao dan baba xihuan shenme

Scoping over the complement clause

“Baobao dans what Daddy likes.”

(Like *zhidao* “know”)

Scoping over the matrix clause

“What does Baobao dan that Daddy likes?” (More like *juede* “think”)

The scope problem extends beyond wh-phrases to *haishi* “or” and A-not-A

寶寶 dan 爸爸喜歡蛋糕 **還是** 麵包

*Baobao dan baba xihuan dangao **haishi** mianbao*

Scoping over the complement clause = interrogative complement

“Baobao dans whether Daddy likes cake or bread.” (Like *zhidao*)

Scoping over the matrix clause = declarative complement

“Does Baobao dan that Daddy likes cake or does Baobao dan that Daddy likes bread?” (More like *juede*)

The scope problem extends beyond wh-phrases to *haishi* “or” and A-not-A

寶寶 dan 爸爸 喜不喜歡 蛋糕

Baobao dan baba xi-bu-xihuan dangao

Scoping over the complement clause = interrogative

“Baobao dans whether or not Daddy likes cake.” Like *zhidao*

Scoping over the matrix clause = declarative complement

“Does Baobao dan that Daddy likes cake, or does Baobao dan that Daddy does not like cake?” More like *juede*

Why might we hesitate?

Reason 2: Certain wh-phrases allow indefinite reading

寶寶 dan 爸爸喜歡什麼

Baobao dan baba xihuan shenme

If *shenme* is a **wh-indefinite (“something”)**, the complement clause is a declarative:

“Baobao dans that Daddy likes something.”

Complement clauses containing wh-phrases are potentially ambiguous in Mandarin

寶寶 dan 爸爸喜歡什麼 *Baobao dan baba xihuan shenme*

Baba xihuan shenme is ambiguous:

1. Interrogative clause
2. Declarative clause that happens to contain a matrix-scope wh-phrase (or *haishi* or A-not-A)
3. Declarative clause that happens to contain a wh-indefinite.

Call such clauses (with wh-phrases, *haishi*, A-not-A) “**potential interrogative**”.

Ambiguity of potential interrogatives →
wrong conclusions about subcategorization

Learners might misanalyse potential interrogatives.

Not Mandarin-specific: This problem applies more generally to Sinitic languages, as well as many other wh-in situ languages, e.g. Malay, Thai, Vietnamese.

Possible consequences beyond learning verb syntax

Researchers have linked **responsive syntax to factive semantics**.

- *Baobao **knows** Dad likes cake* / 寶寶知道爸爸喜歡蛋糕
→ “Dad likes cake” must be true.

(Hintikka 1975; Ginzburg 1995; Egré 2008; cf. Lahiri 2002, White & Rawlins 2018)

Factivity isn't a semantic property that can be easily learned from context.

- Syntactic bootstrapping: **learners might learn factivity using their knowledge of responsivity**.

Dudley 2017; Dudley et al. 2017

How might learners disambiguate potential interrogatives?

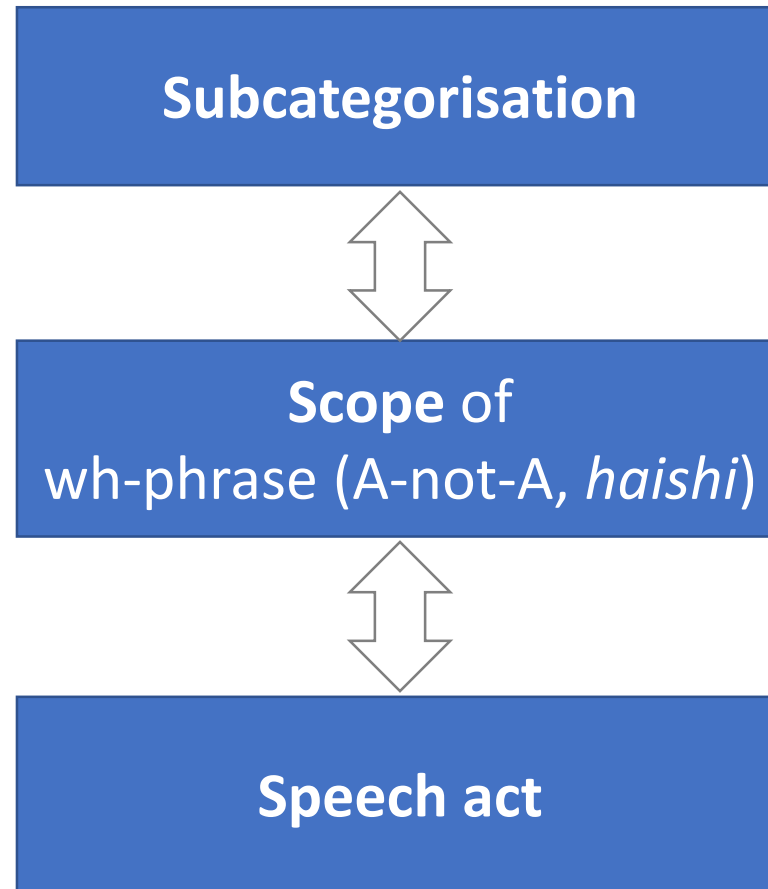
The complement clause *baba xihuan shenme* is ambiguous:

1. Interrogative clause
2. Declarative clause that happens to contain a matrix-scope wh-phrase (or *haishi* or A-not-A)
3. Declarative clause that happens to contain a wh-indefinite.

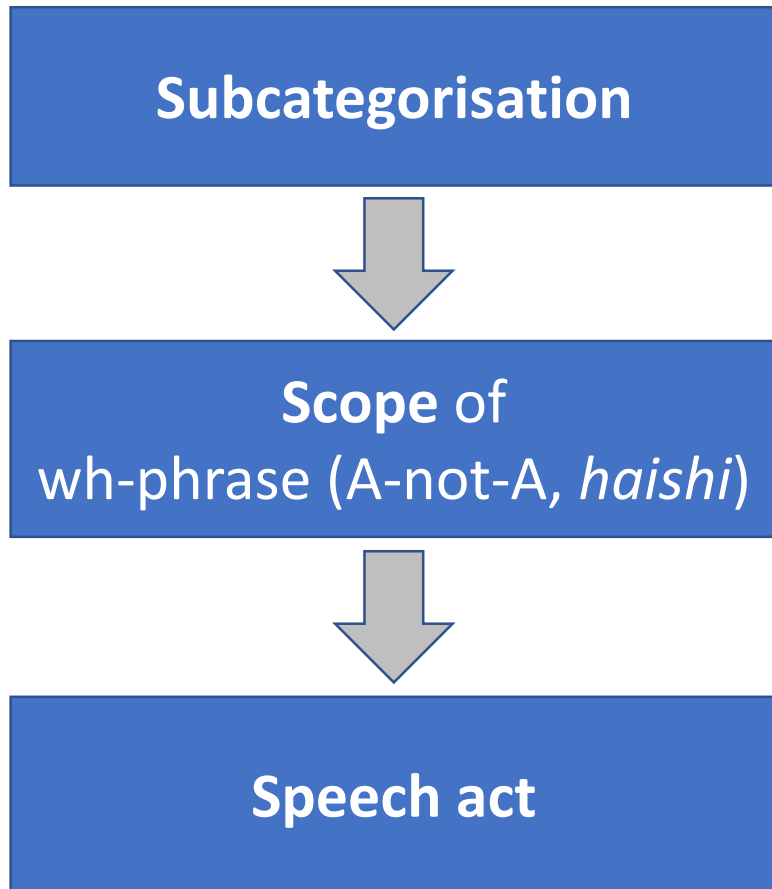
Set aside: wh-indefinites are quite rare (~3% of wh-phrases) in child-ambient speech (Fan 2012).

- A general strategy exploiting speech acts-syntax correlations.
- A Mandarin-specific strategy involving the particle *ma* 嗎.

A solution for getting around ambiguity:
exploit syntax–speech acts correlations



A solution for getting around ambiguity: exploit syntax–speech acts correlations



Antirogative **juede** 覺得 allows
only declaratives

寶寶覺得爸爸喜歡什麼?

Baobao **juede** baba xihuan **shenme**

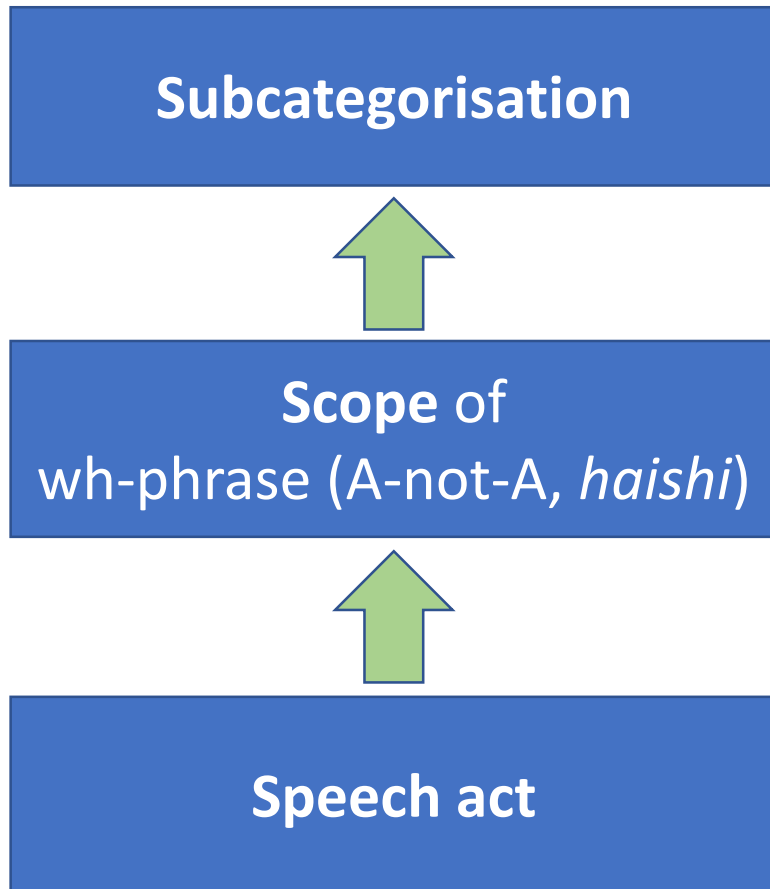
Baobao **think** daddy like **what**

“**What** does Baobao **think** Daddy likes?”

Wh-phrase scopes high.

→ **Likely to be wh-questions.**

A solution for getting around ambiguity: exploit syntax–speech acts correlations



Antirogative **juede** 覺得 allows
only declaratives

寶寶覺得爸爸喜歡什麼?

Baobao **juede** baba xihuan **shenme**

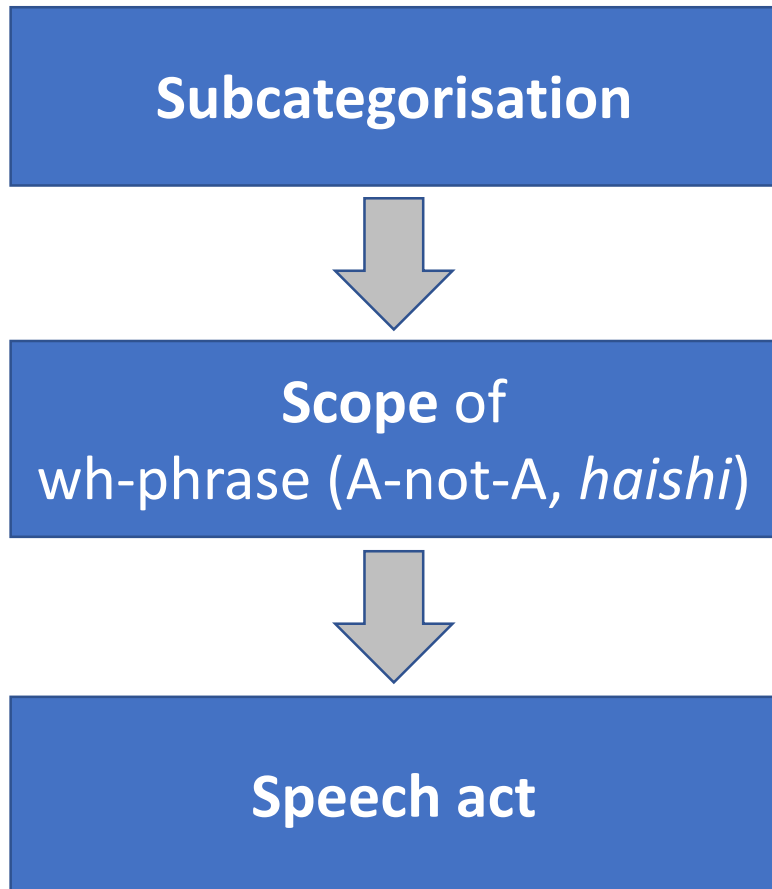
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Wh-phrase scopes high.

→ **Likely to be wh-questions.**

A solution for getting around ambiguity: exploit syntax–speech acts correlations



Responsive **zhidao** 知道 allows
declaratives or interrogatives

寶寶知道爸爸喜歡什麼。

Baobao **zhidao** baba xihuan **shenme**

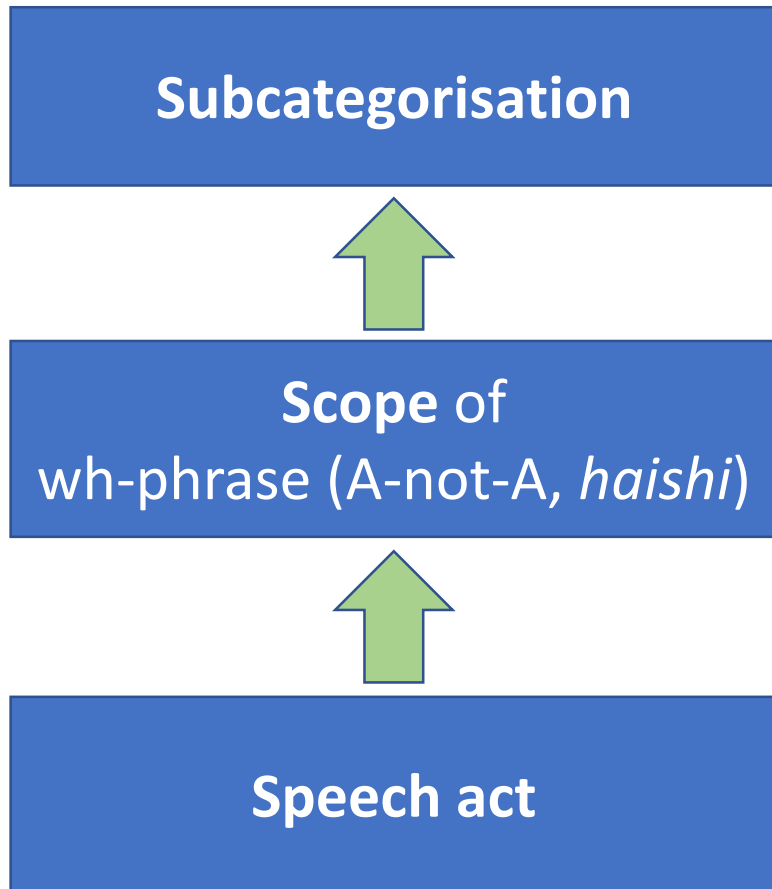
Baobao **know** daddy like **what**

“Baobao **knows what** Daddy likes.”

Wh-phrase doesn't have to take matrix scope.

→ Less likely to be wh-questions.

A solution for getting around ambiguity: exploit syntax–speech acts correlations



Responsive **zhidao** 知道 allows
declaratives or interrogatives

寶寶知道爸爸喜歡什麼。

Baobao **zhidao** baba xihuan **shenme**

Baobao **know** daddy like **what**

“Baobao **knows what** Daddy likes.”

Wh-phrase doesn't have to take matrix scope.

→ Less likely to be wh-questions.

A language-specific solution for getting around ambiguity: yes/no question particle *ma* 嗎

Declarative + *ma* = yes/no question

寶寶喜歡蛋糕嗎?

Baobao xihuan dangao ma

Baobao like cake Q

“Does Baobao like cake?”

***Ma* cannot co-occur** with interrogatives with wh-phrases, A-not-A, or *haishi*.

*誰喜歡蛋糕嗎?

Shei xihuan dangao ma?

Who like cake Q

Intended: “Who likes cake?”

***Ma* tells us that the preceding clause is declarative.**

A language-specific solution for getting around ambiguity: yes/no question particle *ma* 嗎

寶寶知道爸爸喜歡什麼嗎?

Baobao **zhidao** baba xihuan shenme *ma*

Baobao **know** dad like what *Q*

“Does Baobao **know** what Dad likes?”

1. For a learner, *ma*'s presence → Baobao **zhidao** baba xihuan shenme 寶寶知道爸爸喜歡什麼 is declarative.
2. The wh-phrase scopes over the complement clause only.
3. **Zhidao** allows interrogative complements.

A language-specific solution for getting around ambiguity: yes/no question particle *ma* 嗎

寶寶覺得爸爸喜歡什麼?

Baobao **juede** baba xihuan shenme

Baobao **think** dad like what

“What does Baobao **think** Dad likes?”

Juede+potential interrogative is a wh-question, so *ma* must be absent.

1. For a learner: *ma*'s absence → the wh-phrase scopes over the main clause.
2. **Juede** only allows declarative complements.

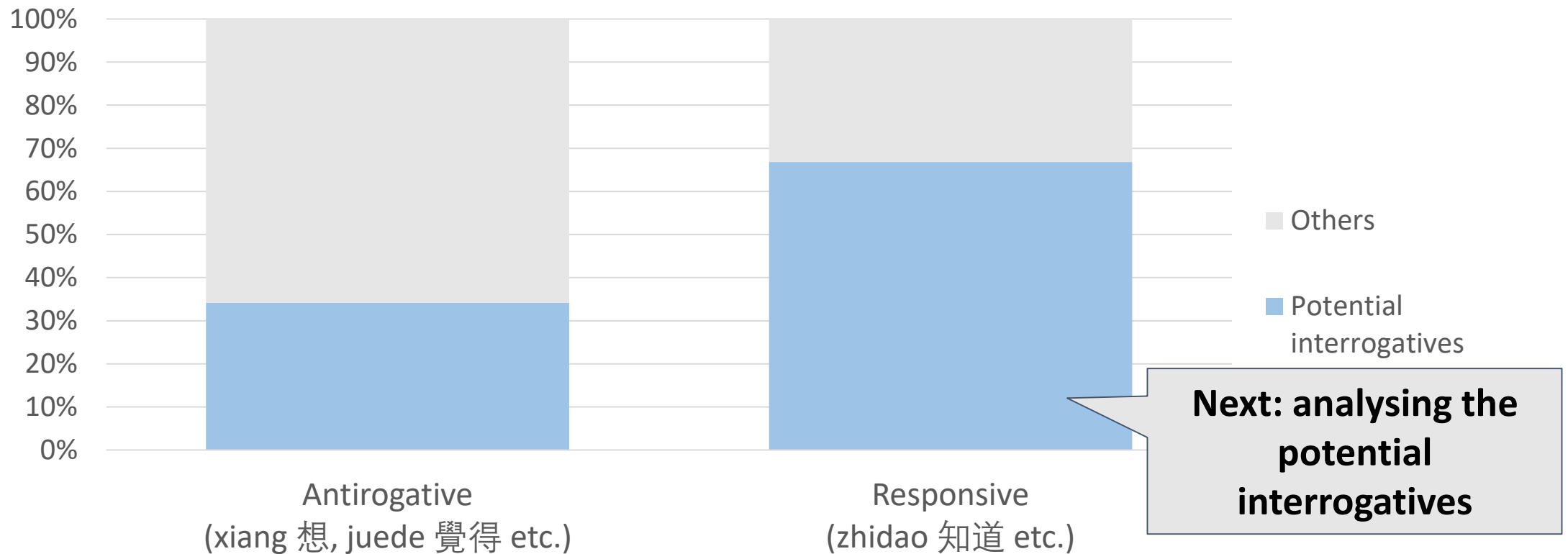
Predictions from a corpus perspective

4 child-directed speech corpora in CHILDES
(Beijing, Chang1, Context, Zhou1)

- 468 tokens of non-communicative belief verbs
1. **(anti)rogative**: *xiang* 想 “think/want”, *yiwei* 以為 “falsely believe”,
juede 覺得 “think, feel”, *renwei* 認為 “think”,
 2. **responsive**: *zhidao* 知道 “know”, *faxian* 發現 “discover”)

Ambiguity problem is real: potential interrogatives co-occur with both antirogatives and responsives

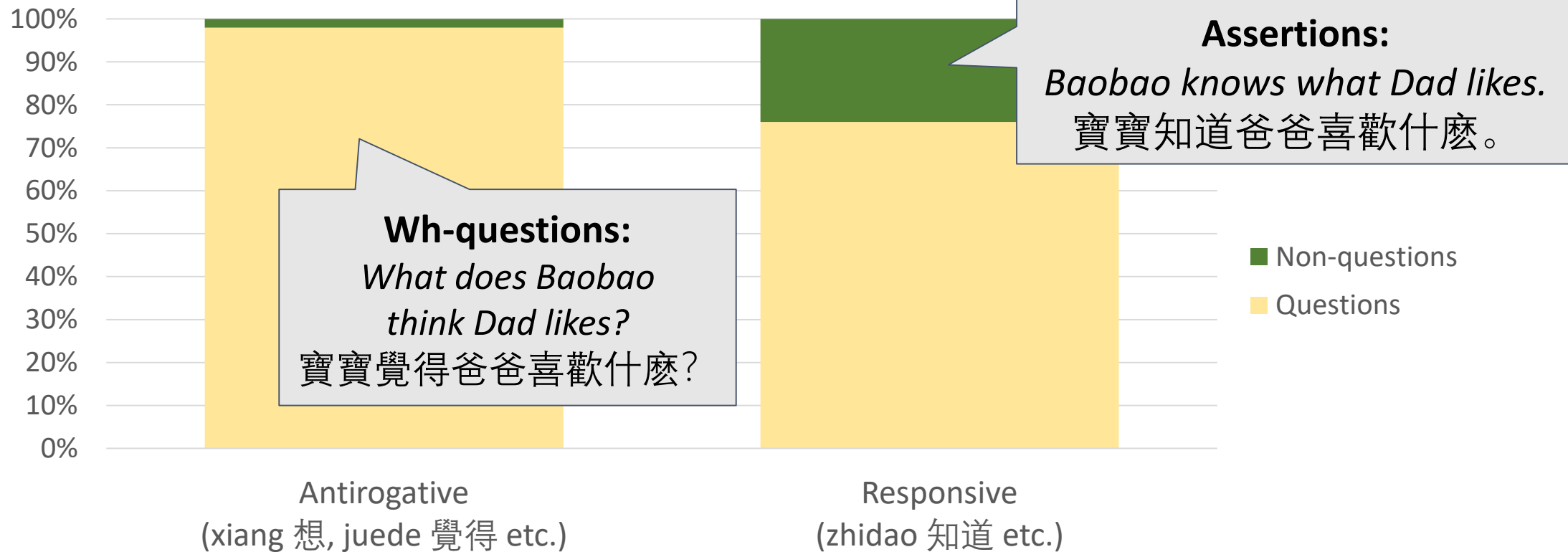
% of all complement clauses



Prediction 1: antirogative+potential interrogatives strongly associated with question speech acts

% of potential
interrogatives

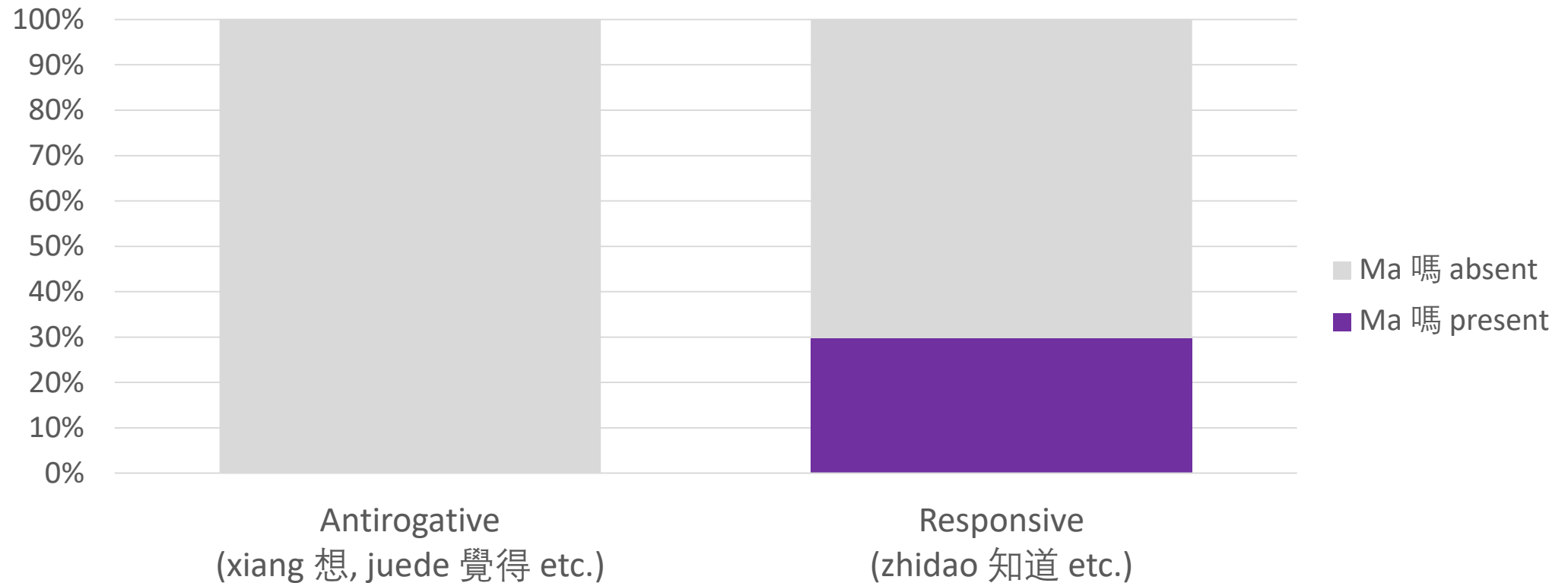
$\chi^2(1)=19.7, p<.001$



Prediction 2: only responsive+potential interrogatives appears with *ma*

% of potential
interrogatives

$\chi^2(1)=32.8, p<.001$



Summing up this case study

Mandarin interrogative complements are indeed string identical to declarative complements with *wh*-phrases (*haishi*, A-not-A) are.

However, in child-ambient speech, the sentences containing these complements can be differentiated quite clearly through their speech acts and the distribution of the particle *ma*.

Discussion and conclusion

The problem with attitude verbs and Mandarin

Mandarin's morphosyntax potentially obscures certain important syntactic differences within the class of attitude verbs.

- Belief and desire verbs (*juede* “think” vs. *yao* “want”)
- Antirogative and responsive verbs (*juede* “think” vs. *zhidao* “know”)

Obvious problems for learning verb syntax + further complications for learning verb semantics (under syntactic bootstrapping)

However, input turns out to be fairly rich

For belief and desire verbs:

- Clear differences in rates of overt subjects, modals, etc.

For antirogative vs. responsive verbs:

- Clear differences in speech acts and distribution of *ma*

In principle, **Mandarin learners sensitive to these distributional differences can master these distinctions.**

The case studies also highlight the role of speech acts in the learning of attitude verbs

For belief and desire verbs:

- Correlation between **assertions** and declarative syntax helps learners infer the correct semantics

(Hacquard & Lidz 2019, Harrigan et al. 2019, and Huang et al. 2018, 2022)

For antirogative vs. responsive verbs:

- Learners might use **speech acts** to infer subcategorisation properties.

Speech acts could support the acquisition of verb semantics and syntax.

Broader cross-linguistic consequences

Original question: syntactic bootstrapping assumes that the syntax of attitude verbs is relatively easy to observe. Is that the case?

Yes – even for a language like Mandarin Chinese.

- Note that lack of inflectional morphology and wh-in situ are not just unique to Mandarin: these are **areal features** and found in languages outside of East Asia.

Good news for syntactic bootstrapping as a cross-linguistically viable learning strategy.

Next steps

- Experiments to see if speakers are indeed sensitive to these cues (e.g. human simulation paradigms, child language experiments).
- Examine the role of other non-syntactic cues, e.g. prosody, context.

Gryllia et al. 2020

Thank you!

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- Special thanks to my collaborators and research assistance by Yuhan (Claire) Zhang.