Selection properties of Mandarin attitude verbs and consequences for syntactic bootstrapping

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What this talk is about

We have heard a lot about selection in the adult grammar.

This talk is about selection in the context of a younger population.

One classic problem of language acquisition: How do we learn the meaning of words?

A particularly tricky problem:

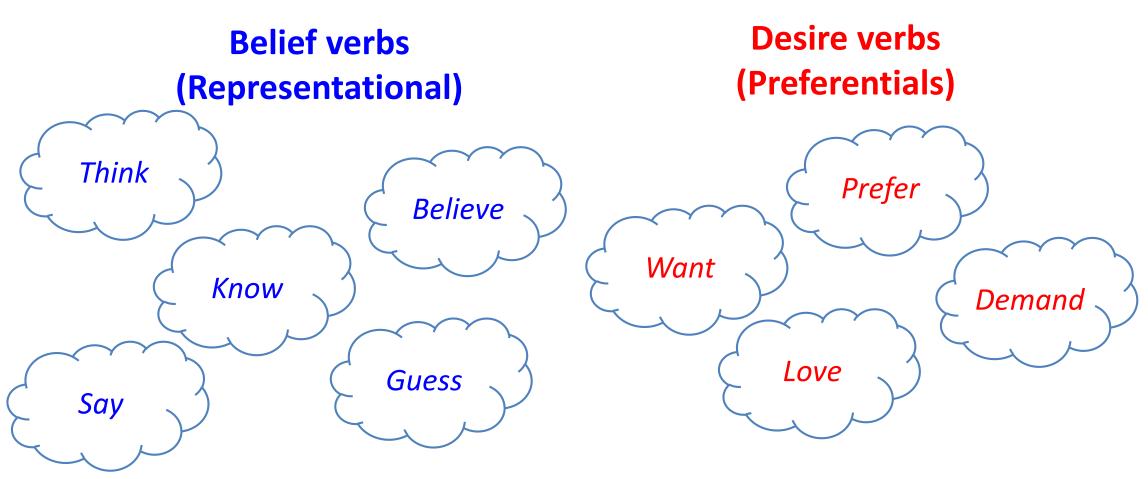
How do we learn the meaning of attitude verbs?

Proposal: learners make use of syntactic cues.

Specifically, selectional cues.

We will look at a worst-case scenario.

Attitude verbs can be classified into two semantic classes



But how does a child learn that these attitude verbs mean different things?

"Mary thinks they will leave."

"Mary wants them to leave."

Verb meanings from physical context?

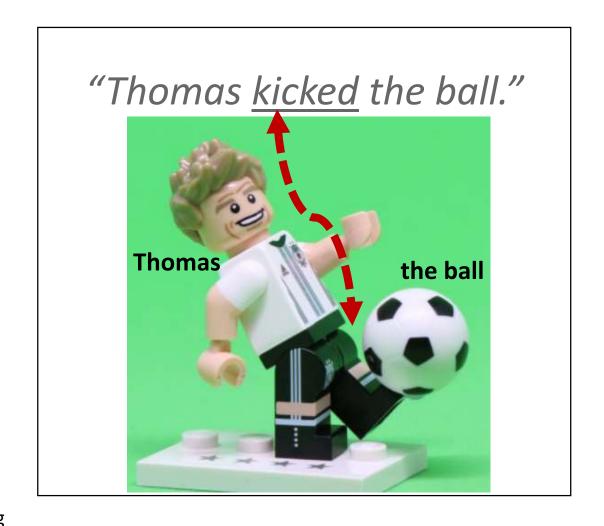


Image source: Jay's Brick Blog

What's the difference between the two situational contexts?





Gilette et al. 1999; Gleitman et al. 2005, a.o.

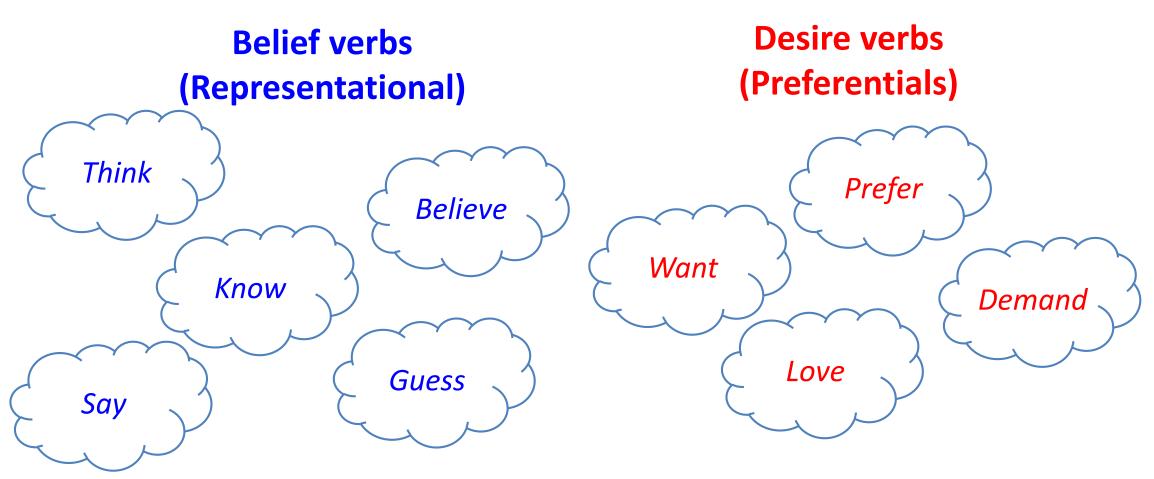
Proposal: syntactic bootstrapping

Gleitman 1990; Gleitman et al. 2005

"Learners use syntactic properties of X to deduce semantics of X."

- 1. What might these syntactic properties be, in the case of attitude verbs?
- 2. Are these properties reliable in the input?
- 3. Can a child detect these properties?
- 4. Does the child use these properties to learn semantic differences between attitude verbs?

Idea: c-selection



English: finite vs. non-finite clauses

i. Mary thinks they will leave.'

Belief verb

ii. Mary wants them to leave.'

Desire verb

Spanish: indicative vs. subjunctive

- i. Creo que Peter va a la casa.
 I.think that Peter go.PRES.IND to the house
 Belief verb: 'I think Peter is going to the house.'
- ii. Quiero que Peter vaya a la casa.I.want that Peter go.PRES.SBJ to the houseDesire verb: 'I want Peter to go to the house.'

(Bolinger 1968, Hooper 1975, a.o.)

German: optional vs. impossible embedded V2

- i. Maria denkt, dass Peter kommt heute.Maria thinks that Peter comes todayBelief verb: 'Mary thinks Peter is coming today.'
- ii. *Maria will, dass Peter kommt heute.

 Maria wants that Peter comes today

 Desire verb: 'Mary wants Peter to come today.'

 (OK: "... Peter heute kommt.")

 (see Scheffler 2008)

A solution around the problem of morphosyntactic variation

	Clause selected by belief verb	Clause selected by desire verb	Declarative main clause
English	Finite	Non-finite	Finite
Spanish (and other Romance)	Indicative	Subjunctive	Indicative
German	V2 possible	No V2	V2

Declarative main clause syntax hypothesis

e.g. Hacquard 2014; Harrigan 2015; White et al. 2017; Hacquard & Lidz, to appear

- "Assign belief semantics to verbs whose clausal complements are syntactically similar to declarative main clauses."

 See also Dayal & Grimshaw 2009; Hooper and Thompson 1973; Haegeman 2012 and earlier work
- Declarative main clauses are typically used for making assertions to express a judgment of truth, as do these verbs.

 Learners use selection properties of attitude verbs to learn verb semantics.

How the declarative main clause syntax hypothesis might work

"Mary <u>thinks</u> they will leave." "Mary <u>wants</u> them to leave."

Compare clausal complements with declarative main clauses

"Mary thinks they will leave."

"Mary wants them to leave."

"They will leave."

(Declarative main clause)

Observe morphosyntactic similarities in one of the complement types

"Mary thinks they will leave."

"They will leave."

(Declarative main clause)

Assign belief / desire semantics to the verb

"Mary thinks **they will** leave."

"Mary wants them to leave."

Belief semantics

Desire semantics

"They will leave."

(Declarative main clause)

Proposal: syntactic bootstrapping

Hacquard 2014; Harrigan 2015; White et al. 2017; Hacquard & Lidz, to appear

"Learners use syntactic properties of X to deduce semantics of X."

- 1. What might these syntactic properties be, in the case of attitude verbs?
 - If verb selects a clausal complement that resembles a declarative main clause, assign belief semantics to the verb. If not, assign desire semantics.
- 2. Are these properties reliable in the input? Yes, at least in the previously-reviewed Indo-European languages...

The hypothesis presupposes that the relevant morphosyntactic differences are observable

What if your language had...

- No tense morphology
- No case morphology
- No mood morphology
- No clear evidence for verb movement
- No clear finiteness distinction Hu et al. 2001; Grano 2015, a.o.
- And allows null arguments?

(see also Lee & Naigles 2005 re: general feasibility of syntactic bootstrapping in Mandarin)



Learning attitude verb meanings in a morphosyntactically-poor language

```
    Wo zhidao chi shuiguo.
    Wo ai chi shuiguo.
    I know eat fruit
    I love eat fruit
    "I know [I/(s)he/it/we/you/they]
    eat fruit."
    (subject of "eat" omitted)
    Belief semantics
    Desire semantics
```

Outline

- Clausal syntax in a morphosyntactically-poor language: Mandarin Chinese
 - Declarative main clauses
 - Complements of belief and desire verbs
- Corpus studies: how feasible is syntactic bootstrapping with the declarative main clause hypothesis in Mandarin?
- Next steps and conclusion

Hallmarks of Mandarin declarative main clauses

While Mandarin has minimal verbal morphology and null arguments, there are some syntactic properties associated with declarative main clauses:

- Overt subjects
- Modal auxiliaries and adverbs
- Aspect markers

What about complement clauses?

Generalization: there is a correspondence between belief verbs and the presence of the following properties in the complement clause.

- Overt subjects
- Modal auxiliaries and adverbs
- Aspect markers

Examples

Declarative main clause

i. Yiqian tamen keneng chi-guo shuiguo.past they might eat-EXP fruit"In the past, they might have eaten fruit."

Belief verbs

ii. Wo zhidao tamen keneng chi-guo shuiguo.l know they might eat-EXP fruit

[&]quot;I know they might have eaten fruit."

Overt subject

Declarative main clause

i. Yiqian <u>tamen</u> keneng chi-guo shuiguo.past they might eat-EXP fruit

"In the past, they might have eaten fruit."

Belief verbs

ii. Wo zhidao <u>tamen</u> keneng chi-guo shuiguo.l know they might eat-EXP fruit

[&]quot;I know they might have eaten fruit."

Modal

Declarative main clause

Yiqian tamen <u>keneng</u> chi-guo shuiguo.
 past they might eat-EXP fruit
 "In the past, they might have eaten fruit."

Belief verbs

ii. Wo zhidao tamen <u>keneng</u> chi-guo shuiguo.I know they <u>might</u> eat-EXP fruit

[&]quot;I know they might have eaten fruit."

Aspect

Declarative main clause

Yiqian tamen keneng chi-guo shuiguo.
 past they might eat-EXP fruit
 "In the past, they might have eaten fruit."

Belief verbs

ii. Wo zhidao tamen keneng chi-guo shuiguo.I know they might eat-EXP fruit

[&]quot;I know they might have eaten fruit."

Desire and belief verbs select different complements

Belief verbs

```
i. Wo zhidao tamen keneng chi-guo shuiguo.I know they might eat-EXP fruit
```

Desire verbs

```
ii. *? Wo ai tamen keneng chi-guo shuiguo.I love they might eat-EXP fruit
```

"??I love they might have eaten fruit."

[&]quot;I know they might have eaten fruit."

Desire and belief verbs select different complements

Belief verbs

```
i. Wo zhidao tamen keneng chi-guo shuiguo.I know they might eat-EXP fruit
```

Desire verbs

ii. Wo ai chi shuiguo. I love eat fruit

"I love to eat fruit."

[&]quot;I know they might have eaten fruit."

This generalization appear to be fairly robust across attitude verbs...

Verb class (belief / desire / other)	Overt subject	Modal auxiliary/adverb	Aspect markers
(Declarative) main clause	ОК	ОК	ОК
faxian "discover"; huaiyi "doubt"; juede "feel"; renwei "think"; xiang-1 "think"; shuo "say"; xiangxin "believe"; zhidao "know"; danxin "worry"; jiang "say"; mingbai "understand"; yiwei "falsely believe"	ОК	ОК	ОК
Xihuan "like"; taoyan "dislike"; yao-1 "want/need"	ОК	*	*
Ai "love"; xiang-2 "want"; gan "dare"; yao-2 "FUT"	*	*	*
Dasuan "plan"; zhunbei "get ready to"	Disputed	Only yao "FUT"?	*
Xiwang "hope"	ОК	ОК	?

... but exceptions exist

Verb class (belief / desire / other)	Overt subject	Modal auxiliary/adverb	Aspect markers
(Declarative) main clause	ОК	ОК	ОК
faxian "discover"; huaiyi "doubt"; juede "feel"; renwei "think"; xiang-1 "think"; shuo "say"; xiangxin "believe"; zhidao "know"; danxin "worry"; jiang "say"; mingbai "understand"; yiwei "falsely believe"	ОК	OK	ОК
Xihuan "like"; taoyan "dislike"; yao-1 "want/need"	<mark>OK</mark>	*	*
Ai "love"; xiang-2 "want"; gan "dare"; yao-2 "FUT"	*	*	*
Dasuan "plan"; zhunbei "get ready to"	<u>Disputed</u>	Only yao "FUT"?	*
Xiwang "hope"	ОК	ОК	?

Declarative main clause

i. Yiqian tamen keneng chi-guo shuiguo.past they might eat-EXP fruit"In the past, they might have eaten fruit."

Belief verbs

ii. Wo zhidao tamen keneng chi-guo shuiguo.I know they might eat-EXP fruit

[&]quot;I know they might have eaten fruit."

Declarative main clause

i. Yiqian tamen keneng chi shuiguo.past they might eat fruit

"In the past, it might be the case that they ate fruit."

Belief verbs

ii. Wo zhidao tamen keneng chi shuiguo.I know they might eat fruit

[&]quot;I know they might have eaten fruit."

Declarative main clause

i. Yiqian tamen chi shuiguo.past they eat fruit"In the past, they ate fruit."

Belief verbs

ii. Wo zhidao tamen chi shuiguo.I know they eat fruit

"I know they eat fruit."

Declarative main clause

i. Yiqian chi shuiguo.past eat fruit

"In the past, [they] ate fruit."

Belief verbs

ii. Wo zhidao chi shuiguo.

I know eat fruit

"I know [they] eat fruit."

At the individual token level, belief and desire complements might be superficially identical

Belief verbs

```
i. Wo zhidao chi shuiguo.I know eat fruit
```

"I know [they] eat fruit."

Desire verbs

ii. Wo ai chi shuiguo.

I love eat fruit

"I love to eat fruit."

A comment about finiteness

Complements of belief verbs are <u>in principle</u> more similar to declarative main clauses than to the complements of desire verbs.

Consistent with the assumption that Chinese clauses make a finiteness distinction.

- Belief verbs select for finite complements, desire verbs non-finite ones.
 e.g. C.-T. J. Huang 1982, 1989; Li 1990, T.-H. J. Lin 2011, N. Huang 2015, under review; pace Hu et al. 2001, Grano 2015
- But let's not worry about the finiteness debate now.

Empirical question: <u>In the input</u>, do complements of belief verbs resemble declarative main clauses more than complements of desire verbs?

If so, the declarative main clause syntax hypothesis can work in Mandarin.

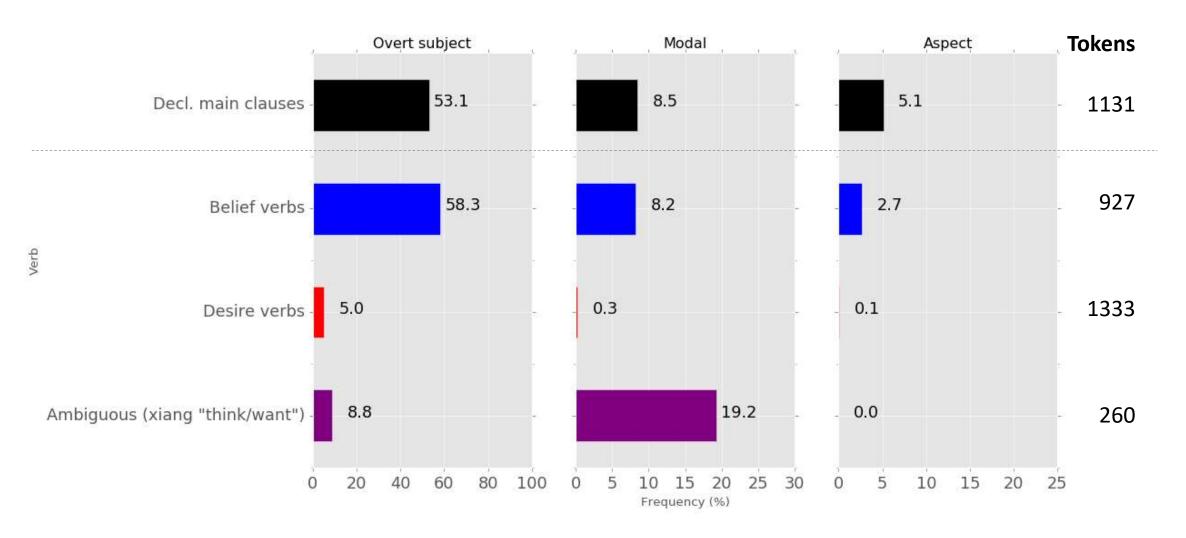
CHILDES corpora properties

Corpus	Age	Number of children	Description	Total utterances
Beijing	1;9.3- 2;2.7	10	Longitudinal study in naturalistic settings Tardif 1993, 1996	91,288
Context	2	25	Cross-sectional study with single observations of 25 Mandarin-speaking children Tardif, Gelman, and Xu 1999	24,007
Chang	3-6	24	Toy play and narratives Chang 1998	5,798
Zhou1	3-6	15	Play sessions with mother	11,694

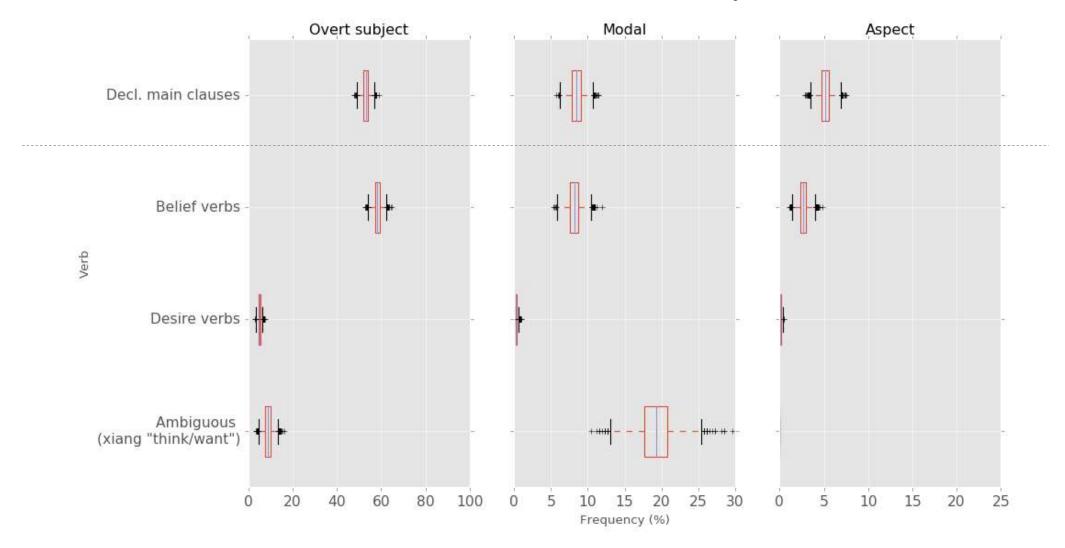
Methodology

	Attitude verbs	Main clauses	
Sample	All child-ambient utterances containing relevant attitude predicates	5% random sample of child-ambient utterances	
Number of tokens	~6,000	~6,100	
What was coded	Attitude verb's complement: clause, VP, NP, etc. Within the complement: Overt subject Modal auxiliary/adverb Aspect Etc.	Clause type: declarative, interrogative, Within the main clause: Overt subject Modal auxiliary/adverb Aspect etc.	
What was analyzed	~2,500 clause-like complements• NP and other complements excluded	1,131 declarative main clausesDisfluencies, interrogatives and imperatives etc. excluded	

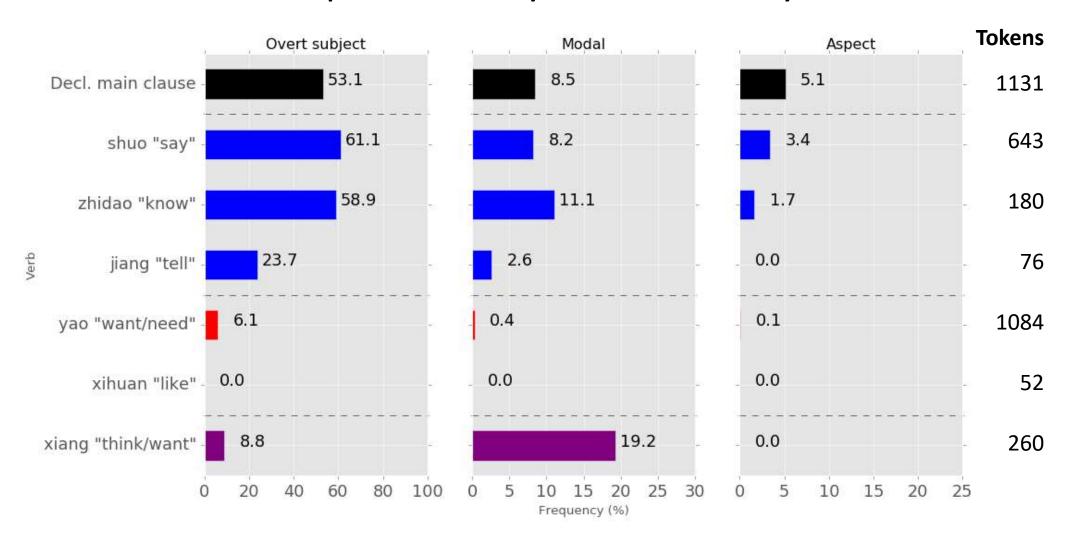
CHILDES corpus study: results by verb class



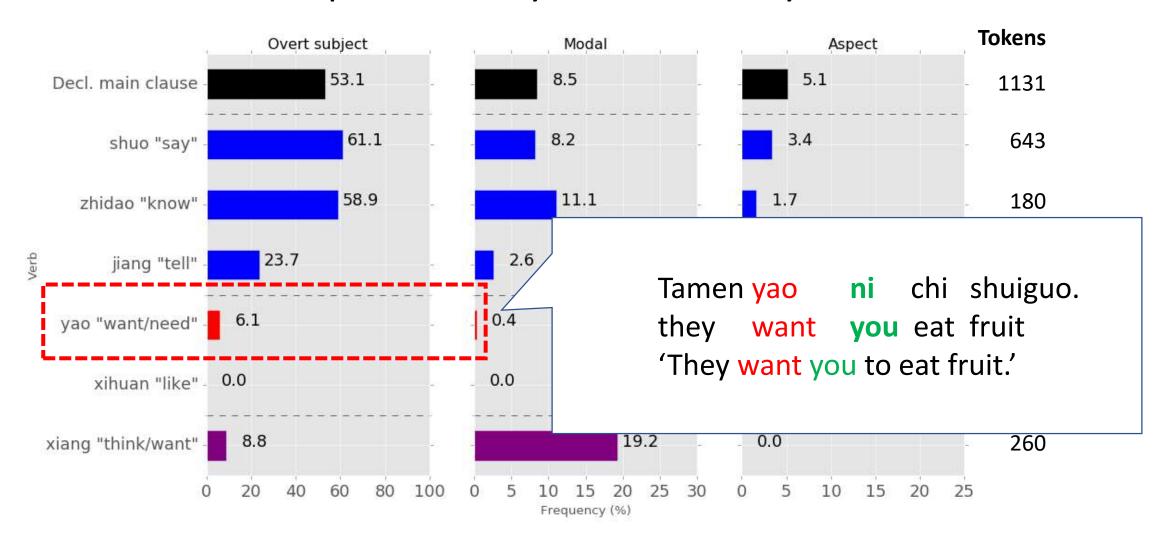
Confidence intervals: results by verb class



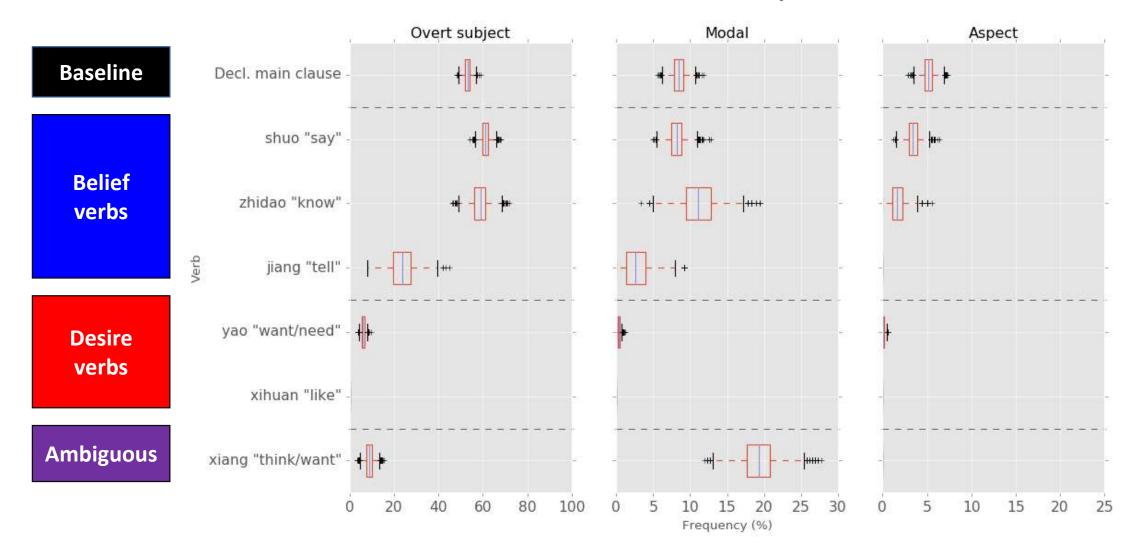
CHILDES corpus study: results by verb



CHILDES corpus study: results by verb



Confidence intervals: results by verb



How representative are our results?

Perhaps the resemblance between complements of belief verbs and declarative main clauses is accidental, e.g. an artifact of ...

- ... the choice of corpora / data collection
- ... the choice of annotation standards

Solution: look at another corpus that was independently annotated.

The Chinese Penn Treebank (v7.0, Xue et al. 2010)

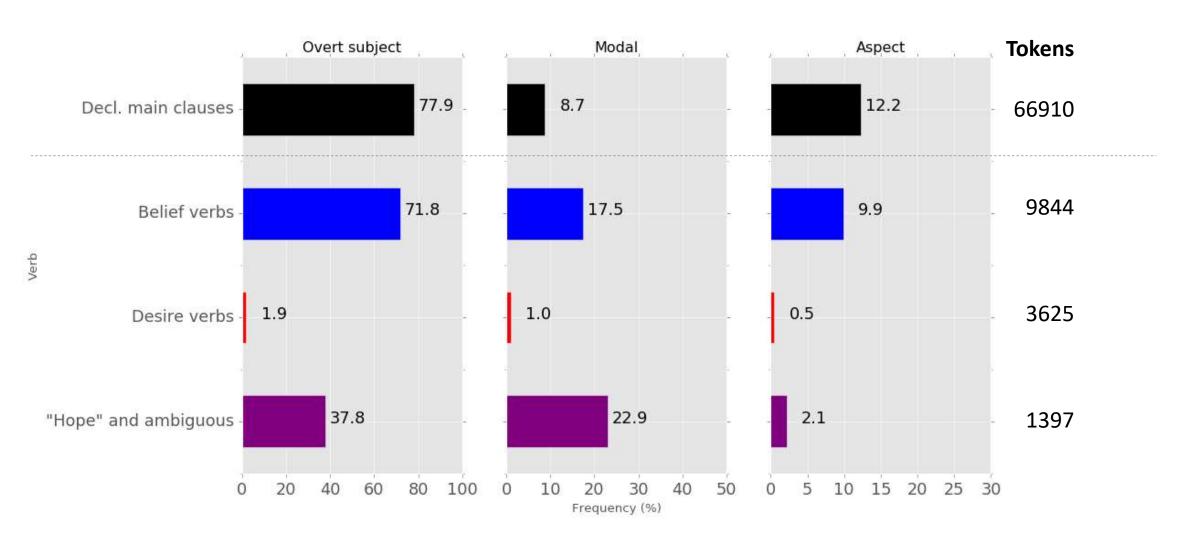
Fully-bracketed corpus of 51,447 sentences of Mandarin Chinese.

Note that a sentence can be formed by conjoining multiple clauses.

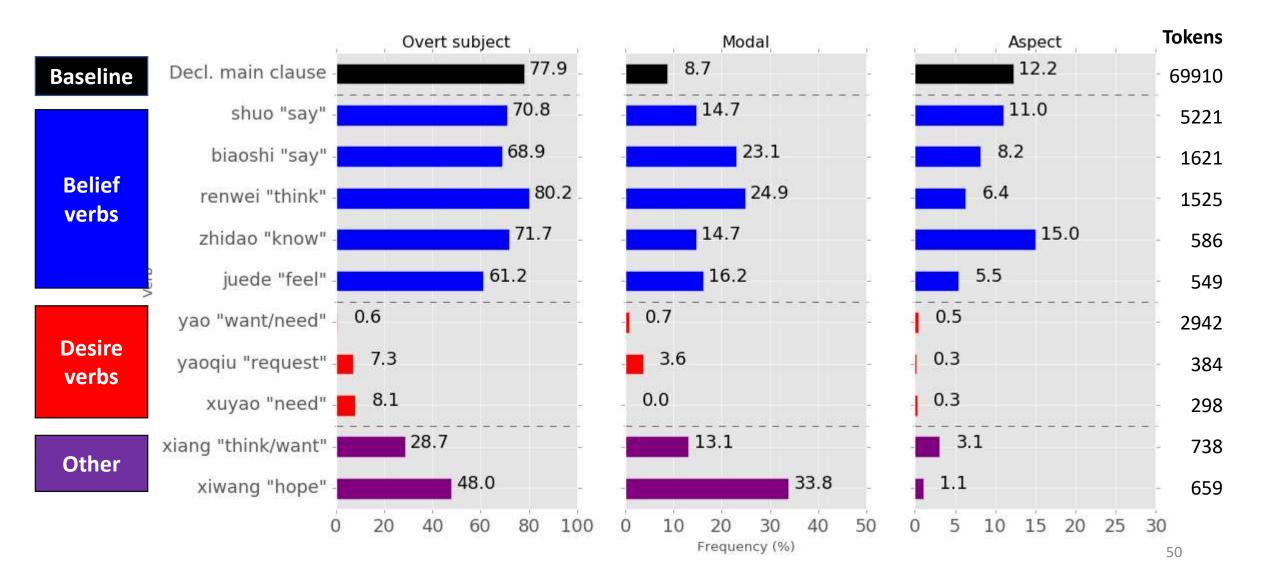
Bias toward written and/or formal registers: newswire, magazines, broadcast news and conversations, newsgroup and blogs.

We wrote a script to read the annotations to determine if a clause has declarative force or not, and if it contains an overt subject, modal, or aspect marker.

Chinese Penn Treebank: results by verb class



Chinese Penn Treebank: results by verb



Syntactic bootstrapping for attitude verbs

"Learners use syntactic properties of X to deduce semantics of X."

- What might these syntactic properties be, in the case of attitude verbs?
 If verb selects a clausal complement that resembles a declarative main clause, assign belief semantics to the verb. If not, assign desire semantics.
- 2. Are these properties reliable in the input? Yes, at least in the previously-reviewed Indo-European languages... and Mandarin Chinese

Implications beyond Mandarin

Mandarin: worst case for the declarative main clause syntax hypothesis.

• If it can work with Mandarin, it should work with morphologically-richer languages.

If other typologically-similar languages (little verbal morphology, null arguments) also exhibit similar patterns in the profiles of their clauses:

• Then the same syntactic bootstrapping account should also in these languages.

Open questions

- 3. Are these properties detectable by the child? Can we test the hypothesis with an actual model of syntactic bootstrapping?
- We are in the process of modeling the acquisition process with the Mandarin datasets, building on White et al. 2017 for English.

- 4. Do Mandarin-learning children actually use these syntactic cues to learn semantic differences between belief and desire verbs?
- Building on Harrigan 2015, Harrigan et al. 2016, 2017, Lidz et al. 2016 on English.

Conclusion

Although Mandarin has minimal verbal morphology and null arguments...

- ... belief and desire verbs **in principle** select clausal complements with distinct syntactic profiles.
- This fact about selection manifests itself in the input in aggregation.
- In terms of overall profile, belief verbs' complements resemble declarative main clauses, but desire verbs' complements do not.

If learners are sensitive to the **overall** profile of these clausal complements:

- Syntactic bootstrapping the declarative main clause syntax hypothesis can help them learn a semantic distinction within attitude verbs and assign semantics correctly.
- This is feasible even in a language with impoverished morphosyntax.

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