Selection properties of Mandarin attitude verbs and consequences for syntactic bootstrapping

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University of Maryland
Selection Fest, 10-11 November 2017
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

**Belief verbs** *(Representational)*
- Think
- Know
- Say
- Believe
- Guess

**Desire verbs** *(Preferentials)*
- Prefer
- Want
- Love
- Demand
But how does a child learn that these attitude verbs mean different things?

“Mary \textit{thinks} they will leave.”

“Mary \textit{wants} them to leave.”
Verb meanings from physical context?

“Thomas kicked the ball.”

Image source: Jay's Brick Blog
What’s the difference between the two situational contexts?

**Context #1**

“Mary thinks they will leave.”

**Context #2**

“Mary wants them to leave.”

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

Belief verbs (Representational)
- Think
- Know
- Say
- Believe
- Guess

Desire verbs ( Preferentials)
- Prefer
- Want
- Love
- Demand
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 house

Desire 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** today
   - **Belief 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

<table>
<thead>
<tr>
<th>Language</th>
<th>Clause selected by belief verb</th>
<th>Clause selected by desire verb</th>
<th>Declarative main clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Finite</td>
<td>Non-finite</td>
<td>Finite</td>
</tr>
<tr>
<td>Spanish (and other Romance)</td>
<td>Indicative</td>
<td>Subjunctive</td>
<td>Indicative</td>
</tr>
<tr>
<td>German</td>
<td>V2 possible</td>
<td>No V2</td>
<td>V2</td>
</tr>
</tbody>
</table>
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 thinks they will leave.”

“Mary wants 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.”  “Mary wants them to leave.”

“They will leave.”
(Declarative main clause)
Assign belief / desire semantics to the verb

“Mary \textit{thinks} they will leave.”

Belief semantics

“Mary \textit{wants} them to leave.”

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

1. Wo zhidao chi shuigu.  2. Wo ai chi shuigu.
I know eat fruit  I love eat fruit
“I know [I/(s)he/it/we/you/they] eat fruit.”  “I love to 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 shuiguuo.
   past they might eat-EXP fruit
   “In the past, they might have eaten fruit.”

Belief verbs

ii. Wo zhidaao tamen keneng chi-guo shuiguuo.
    I know they might eat-EXP fruit
    “I know they might have eaten fruit.”
Overt subject

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
    “I know they might have eaten fruit.”
Modal

**Declarative main clause**

i. Yiqian tamen **keneng** chi-guo shuiguuo.
   past they **might** eat-EXP fruit
   “In the past, they might have eaten fruit.”

**Belief verbs**

ii. Wo **zhidao** tamen **keneng** chi-guo shuiguuo.
   I know they **might** eat-EXP fruit
   “I **know** they might have eaten fruit.”
Aspect

**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

   “**I know** they might have eaten fruit.”
Desire and belief verbs select different complements

**Belief verbs**

i. *Wo zhidaotamen keneng chiguoshuiguuo.*
   I know they might eat-EXP fruit
   “I know they might have eaten fruit.”

**Desire verbs**

ii. *Wo ai tamen keneng chiguoshuiguuo.*
    I love they might eat-EXP fruit
    “??I love 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

   “I **know** they might have eaten fruit.”

**Desire verbs**

ii. Wo **ai** chi shuiguo.
    
    I **love** eat fruit

   “I **love** to eat fruit.”
This generalization appear to be fairly robust across attitude verbs...

<table>
<thead>
<tr>
<th>Verb class (belief / desire / other)</th>
<th>Overt subject</th>
<th>Modal auxiliary/adverb</th>
<th>Aspect markers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Declarative) main clause</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td><em>faxian “discover”; huaiyi “doubt”; juede “feel”; renwei “think”; xiang-1 “think”; shuo “say”; xiangxin “believe”; zhidaol “know”; danxin “worry”; jiang “say”; mingbai “understand”; yiwei “falsely believe”</em></td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td><em>Xihuan “like”; taoyan “dislike”; yao-1 “want/need”</em></td>
<td>OK</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td><em>Ai “love”; xiang-2 “want”; gan “dare”; yao-2 “FUT”</em></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td><em>Dasuan “plan”; zhunbei “get ready to”</em></td>
<td>Disputed</td>
<td>Only yao “FUT”?</td>
<td>*</td>
</tr>
<tr>
<td><em>Xiwang “hope”</em></td>
<td>OK</td>
<td>OK</td>
<td>?</td>
</tr>
</tbody>
</table>
... but exceptions exist

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<td>OK</td>
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<td>OK</td>
<td>?</td>
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</table>
Further, these properties are all optional

**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  zhidaao  tamen  keneng  chi-guo  shuiguo.
    I  know  they  might  eat-EXP  fruit

    “I know they might have eaten fruit.”
Further, these properties are all optional

**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 zhidaotamen keneng chi shuiguo.
    I know they might eat fruit

   “I know they might have eaten fruit.”
Further, these properties are all optional

**Declarative main clause**

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

**Belief verbs**

ii. Wo zhidaotamen chi shuiguo.
    I know they eat fruit
    “I know they eat fruit.”
Further, these properties are all optional

**Declarative main clause**

i. Yiqian  
   past  
   “In the past, [they] ate fruit.”

**Belief verbs**

ii. Wo  
    “I know [they] eat fruit.”
At the individual token level, belief and desire complements might be superficially identical

**Belief verbs**

i. Wo  **zhidao**  chi  **shuiguuo**.
   
   I  know  eat  fruit
   
   “I know [they] eat fruit.”

**Desire verbs**

ii. Wo  **ai**  chi  **shuiguuo**.
   
   I  love  eat  fruit
   
   “I love to eat fruit.”
A comment about finiteness

Complements of belief verbs are *in principle* 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.

• But let’s not worry about the finiteness debate now.

Empirical question: *In the input*, 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

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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Attitude verbs</th>
<th>Main clauses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All child-ambient utterances containing relevant attitude predicates</td>
<td>5% random sample of child-ambient utterances</td>
</tr>
<tr>
<td>Number of tokens</td>
<td>~6,000</td>
<td>~6,100</td>
</tr>
<tr>
<td>What was coded</td>
<td>Attitude verb’s complement: clause, VP, NP, etc.</td>
<td>Clause type: declarative, interrogative, etc.</td>
</tr>
<tr>
<td></td>
<td>Within the complement:</td>
<td>Within the main clause:</td>
</tr>
<tr>
<td></td>
<td>• Overt subject</td>
<td>• Overt subject</td>
</tr>
<tr>
<td></td>
<td>• Modal auxiliary/adverb</td>
<td>• Modal auxiliary/adverb</td>
</tr>
<tr>
<td></td>
<td>• Aspect</td>
<td>• Aspect</td>
</tr>
<tr>
<td></td>
<td>• Etc.</td>
<td>• etc.</td>
</tr>
<tr>
<td>What was analyzed</td>
<td>~2,500 clause-like complements</td>
<td>1,131 declarative main clauses</td>
</tr>
<tr>
<td></td>
<td>• NP and other complements excluded</td>
<td>• Disfluencies, interrogatives and imperatives etc. excluded</td>
</tr>
</tbody>
</table>
CHILDES corpus study: results by verb class

<table>
<thead>
<tr>
<th>Verb</th>
<th>Overt subject</th>
<th>Modal</th>
<th>Aspect</th>
<th>Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decl. main clauses</td>
<td>53.1</td>
<td>8.5</td>
<td>5.1</td>
<td>1131</td>
</tr>
<tr>
<td>Belief verbs</td>
<td>58.3</td>
<td>8.2</td>
<td>2.7</td>
<td>927</td>
</tr>
<tr>
<td>Desire verbs</td>
<td>5.0</td>
<td>0.3</td>
<td>0.1</td>
<td>1333</td>
</tr>
<tr>
<td>Ambiguous (xiang &quot;think/want&quot;)</td>
<td>8.8</td>
<td>19.2</td>
<td>0.0</td>
<td>260</td>
</tr>
</tbody>
</table>

 Tokens

Frequency (%)
Confidence intervals: results by verb class
CHILDES corpus study: results by verb

<table>
<thead>
<tr>
<th>Verb</th>
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<td>53.1</td>
<td>8.5</td>
<td>5.1</td>
<td>1131</td>
</tr>
<tr>
<td>shuo &quot;say&quot;</td>
<td>61.1</td>
<td>8.2</td>
<td>3.4</td>
<td>643</td>
</tr>
<tr>
<td>zhidao &quot;know&quot;</td>
<td>58.9</td>
<td>11.1</td>
<td>1.7</td>
<td>180</td>
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<tr>
<td>jiang &quot;tell&quot;</td>
<td>23.7</td>
<td>2.6</td>
<td>0.0</td>
<td>76</td>
</tr>
<tr>
<td>yao &quot;want/need&quot;</td>
<td>6.1</td>
<td>0.4</td>
<td>0.1</td>
<td>1084</td>
</tr>
<tr>
<td>xihuan &quot;like&quot;</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>52</td>
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<tr>
<td>xiang &quot;think/want&quot;</td>
<td>8.8</td>
<td>19.2</td>
<td>0.0</td>
<td>260</td>
</tr>
</tbody>
</table>

Tokens:

- 1131
- 643
- 180
- 76
- 1084
- 52
- 260
CHILDES corpus study: results by verb

Tamen yao ni chi shuiguo.
'‘They want you to eat fruit.’
Confidence intervals: results by verb

Baseline

Belief verbs

Desire verbs

Ambiguous

Decl. main clause
shuo "say"
zhidao "know"
jiang "tell"
yao "want/need"
xihuan "like"
xiang "think/want"

Frequency (%)

Overt subject
Modal
Aspect
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

<table>
<thead>
<tr>
<th>Verb</th>
<th>Overt subject</th>
<th>Modal</th>
<th>Aspect</th>
<th>Tokens</th>
</tr>
</thead>
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<tr>
<td>Decl. main clauses</td>
<td>77.9</td>
<td>8.7</td>
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<tr>
<td>Belief verbs</td>
<td>71.8</td>
<td>17.5</td>
<td>9.9</td>
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<tr>
<td>Desire verbs</td>
<td>1.9</td>
<td>1.0</td>
<td>0.5</td>
<td>3625</td>
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<tr>
<td>&quot;Hope&quot; and ambiguous</td>
<td>37.8</td>
<td>22.9</td>
<td>2.1</td>
<td>1397</td>
</tr>
</tbody>
</table>
Chinese Penn Treebank: results by verb

<table>
<thead>
<tr>
<th>Verb</th>
<th>Frequency (%)</th>
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<tbody>
<tr>
<td>Overt subject</td>
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<td></td>
</tr>
<tr>
<td>Decl. main clause</td>
<td>77.9</td>
<td>69910</td>
</tr>
<tr>
<td>shuo &quot;say&quot;</td>
<td>70.8</td>
<td>5221</td>
</tr>
<tr>
<td>biaoshi &quot;say&quot;</td>
<td>68.9</td>
<td>1621</td>
</tr>
<tr>
<td>renwei &quot;think&quot;</td>
<td>80.2</td>
<td>1525</td>
</tr>
<tr>
<td>zhidao &quot;know&quot;</td>
<td>71.7</td>
<td>586</td>
</tr>
<tr>
<td>juede &quot;feel&quot;</td>
<td>61.2</td>
<td>549</td>
</tr>
<tr>
<td>yao &quot;want/need&quot;</td>
<td>0.6</td>
<td>2942</td>
</tr>
<tr>
<td>yaoqiu &quot;request&quot;</td>
<td>7.3</td>
<td>384</td>
</tr>
<tr>
<td>xuyao &quot;need&quot;</td>
<td>8.1</td>
<td>298</td>
</tr>
<tr>
<td>xiang &quot;think/want&quot;</td>
<td>28.7</td>
<td>738</td>
</tr>
<tr>
<td>xiwang &quot;hope&quot;</td>
<td>48.0</td>
<td>659</td>
</tr>
<tr>
<td>Modal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belief verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>8.7</td>
<td>12.2</td>
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<tr>
<td>Desire verbs</td>
<td></td>
<td></td>
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<tr>
<td>Baseline</td>
<td>14.7</td>
<td>11.0</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.2</td>
<td>6.4</td>
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<table>
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Syntactic bootstrapping for attitude verbs

“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... 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?
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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