Selection properties of Mandarin attitude verbs and consequences for syntactic bootstrapping

Introduction. Attitude verbs (*think, want*...) describe abstract mental states that lack reliable correlates in the physical world. In many languages, these verbs can be divided into two semantic classes – belief (*think*) and desire (*want*) verbs – with distinct c-selection properties. For example, in English, belief verbs generally select finite complements, and desire verbs nonfinite complements. This correlation is interesting not only for formal reasons, but also from an acquisition angle: a learner who uses "syntactic bootstrapping" [1, 2] could exploit an attitude verb's c-selection properties to infer its meaning, thus explaining how the verb's meaning is learned in the absence of physical cues. However, morphosyntactically-poor languages like Mandarin Chinese present a challenge for this view.

In this corpus study, we look at c-selection properties of Mandarin attitude verbs and consequences for syntactic bootstrapping. Mandarin allows null arguments and has a relatively impoverished verbal morphology, which raises questions as to whether it makes a finiteness contrast [3, 4, a.o.] and whether its belief and desire verbs differ at all in selectional terms. We argue that even if there might be little syntactic difference at the individual token level, *the overall syntactic profile of Mandarin belief and desire verbs still differ in ways that make syntactic bootstrapping viable*. In particular, we show that, at an abstract level, the syntactic profiles of Mandarin belief and desire verbs converge with their counterparts in languages with richer morphosyntax (e.g. English, Romance) [5-7]: *belief verbs, but not desire verbs, select clauses with syntactic hallmarks of declarative main clauses* [8, 9]. This makes possible a version of the syntactic bootstrapping hypothesis for attitude verbs, namely the "declarative main clause hypothesis" (ibid.), according to which learners assign belief semantics to verbs whose complements syntactically resemble declarative main clauses in their language.

Properties of attitude verb complements. We argue that Mandarin has syntactic properties that generally distinguish the clausal complements of belief verbs from those of desire verbs. The literature on Mandarin syntax has shown that, unlike desire verbs' complements, belief verbs' complements allow **overt subjects** (1a) (as does desire verb *yao* "want," an exception (1b)), **modal auxiliaries** (2), and **certain aspect markers**, e.g. progressive *zai*, experiential *guo*, negative perfective *mei*(*you*) (3) (see [3]; *pace* [4]). Importantly, these properties also broadly distinguish declarative main clauses from other clause types like imperatives.

	Belief verbs	Desire verbs
(1)	a. Lisi renwei (Min) chi-su. L think M eat-vegetarian 'Lisi thinks that Min is vegetarian.'	b. Lisi {xiang (*Min)/yao Min}chi-su. L want M want M eat-vegetarian *Intended*: 'Lisi wants Min to be vegetarian.
(2)	a. Lisi renwei Min {hui/ keneng}qu paobu. L think M will might go run 'Lisi thinks that Min will/might go running.'	b. Lisi {xiang/yao}(*hui/*keneng) qu paobu. L want want will might go run *Intended*: 'In all of Lisi's desire worlds, it will/might be the case that he goes running.'
(3)	a. Lisi renwei Min zai shuijiao. L think M PROG sleep 'Lisi thinks that Min is sleeping.'	b. Lisi {xiang/yao} *(zai) shuijiao. Lisi want want PROG sleep. *Intended*: 'Lisi wants to be sleeping.'

However, since these properties are all *optional*, in the right context, at the individual token level, the complements of belief and desire verbs can be superficially identical. Further, across tokens, there could still be little or no observable difference between the complements of belief verbs and those of desire verbs. If so, syntactic bootstrapping would be unviable.

CHILDES corpus study. We looked at whether complements of Mandarin belief and desire verbs are different enough at a corpus level for syntactic bootstrapping to be viable. Pooling child-ambient speech data from three CHILDES corpora (Beijing, Context, and Chang1 [10], age range=1;9--6;5), we extracted utterances containing belief and desire verbs, and annotated their clausal complements (2,146 total) for presence of overt subjects, modals, and aspect markers. We repeated the same annotation for declarative main clauses in a 5% random sample of utterances in each corpus (1,022 declarative main clauses).

We find that as a whole, (i) these syntactic properties are distributed distinctly across belief and desire verb complements, (ii) clauses selected by belief, but not desire verbs pattern like declarative main clauses (Fig. 1). Hence, *belief and desire verbs are distinguished in Mandarin by the overall distribution of syntactic features in their complements*, in the same way as in morphologically richer languages: *complements of belief verbs resemble declarative main clauses, while those of desire verbs do not*. Hence, if learners can pick up on these c-selectional cues, they should be able to use syntactic bootstrapping to learn attitude verb meanings, even in a morphologically impoverished language like Mandarin.

Figure 1. Most frequent 7 verbs in CHILDES corpus study

% of clausal complements with …		Overt subjects	Modals	Aspect markers	Tokens
Belief verbs	*shuo* 'to say'	60.2%	7.8%	3.6%	613
	zhidao 'to know'	59.2%	11.5%	1.1%	174
	jiang 'to say'	16.7%	1.9%	0.0%	54
Desire verbs	*yao* 'to want/need'	5.2%	0.1%	0.1%	852
	ai 'to love'	0.6%	0.0%	0.0%	161
	xihuan 'to like'	0.0%	0.0%	0.0%	34
Ambiguous	*xiang* 'to think, to want'	16.0%	24.3%	0.0%	206
Declarative main clauses with …		51.6%	8.3%	5.2%	1022

Chinese Treebank corpus study. To cross-check the results of the CHILDES study, we ran the same analysis on the Chinese Treebank [11], intended as a proxy of formal varieties of Mandarin. We obtained similar results (Fig. 2): (i) the same syntactic properties are distributed distinctly across the complements of belief and desire verbs; (ii) belief verbs' complements pattern like declarative main clauses, while desire verbs' do not.

Figure 2. Selected verbs from Chinese Treebank corpus study

% of clausal complements with …		Overt subjects	Modals	Aspect markers	Tokens
Belief verbs	*shuo* 'to say'	81.8%	16.3%	12.7%	3297
	renwei 'to think'	85.6%	25.0%	7.3%	1142
	biaoshi 'to express'	73.2%	25.4%	7.9%	1117
	zhidao 'to know'	73.8%	15.5%	16.5%	503
Desire verbs	*yao* 'to want'	0.5%	0.7%	0.5%	2936
	yaoqiu 'to request'	4.9%	3.3%	0.3%	368
Ambiguous	*xiang* 'to think, to want'	25.8%	12.2%	2.5%	683
Declarative main clauses with …		81.4%	9.7%	15.0%	32700

Conclusion. Clauses selected by Mandarin belief and desire verbs have distinct syntactic profiles, not only in principle, but also in aggregation in child-ambient speech: belief verbs' complements syntactically resemble declarative main clauses, but desire verbs' do not. To the extent that Mandarin learners are sensitive to the overall profile of these clausal complements, they can apply syntactic bootstrapping to distinguish the meanings of these verbs. In ongoing work, we will further test the viability of syntactic bootstrapping by applying a computational learning model to the CHILDES data.

Selected references.

[1] Gleitman, Lila R., et al. 2005. Hard words. *Language Learning and Development* 1:23–64.

[2] Landau, Barbara, and Lila R. Gleitman. 1985. *Language and experience: Evidence from the blind child*. Harvard University Press.

[3] Huang, C.-T. James. 1982. Logical relations in Chinese and the theory of grammar. Doctoral dissertation, MIT.

[4] Hu, Jianhua, et al. 2001. Is there a finite vs. nonfinite distinction in Chinese? *Linguistics* 39:1117–1148.

[5] Bolinger, Dwight. 1968. *Aspects of Language*. New York: Harcourt, Brace, and World.

[6] Hooper, Joan. B. 1975. On assertive predicates. In *Syntax and Semantics* 4, ed. John Kimball. 91-124.

[7] Farkas, Donka. 1985. *Intensional Descriptions and the Romance Subjunctive Mood*. New York: Garland.

[8] Hacquard, Valentine. 2014. Bootstrapping attitudes. In *Semantics and Linguistic Theory*, volume 24, 330–352.

[9] Harrigan, Kaitlyn, et al. 2016. Syntactic bootstrapping in the acquisition of attitude verbs: *think*, *want* and *hope*. In *Proceedings of WCCFL 33*, ed. Kyeong-min Kim et al. Cascadilla Proceedings Project.

[10] MacWhinney, Brian. 2014. *The CHILDES project: Tools for analyzing talk, Volumes I & II.* Lawrence Erlbaum Associates.

[11] Xue, Nianwen, et al. 2010. *Chinese Treebank 7.0*. Linguistic Data Consortium.