Examining the bridge/non-bridge verb distinction in Mandarin Chinese

English contrasts bridge verbs, which allow *wh*-movement out of their CP complement, with non-bridge verbs which do not (Erteschik-Shir 1973, Chomsky 1977). For wh-in-situ languages, it has been suggested that the bridge/non-bridge contrast may be weaker or lacking (Goldberg 2006), or may only appear with in-situ wh-adjuncts (e.g. *why*) but not wh-arguments (e.g. *who*) (Tsai 1994). In this study, we examine the bridge/non-bridge distinction in Mandarin, a wh-in-situ language, with a corpus analysis of child-directed speech, and a formal acceptability judgment experiment. We demonstrate that there is no evidence for a bridge/non-bridge contrast in Mandarin for arguments or adjuncts.

Corpus Analysis: We collected the 20 most frequent verbs attested with CP complements (a reasonable estimate of vocabulary size (Diessel & Tomasello, 2001)) in Mandarin CHILDES (Table 1), and searched for uses in long-distance wh-questions. Assuming the Tolerance Principle (Yang 2016), a rule that applies to N items is productive with a maximum of N/ln(N) exceptions; hence, 20 CP-embedding verbs permit 6 unattested exceptions (20/ln(20)=6.67). We found cross-clausal wh-dependencies attested for 19/20 CP-embedding verbs for wh-arguments, and 14/20 for wh-adjuncts, clearing the threshold of productivity for both. Therefore, the corpus analysis predicts no bridge/non-bridge distinction in Mandarin.

Experiment (*Prolific*; N=240): Methods: We tested experimentally the islandhood of CP complements in Mandarin for 14 verbs: 3 labeled as bridge verbs in Tsai (1994) (*shuo* 'say', *cai* 'guess', *renwei* 'think'), 1 labeled as non-bridge (*jide* 'remember'), and the 11 remaining verbs from the corpus analysis that are compatible with a matrix *why*-question. Dependency length (short/mono-clausal vs. long/cross-clausal) and wh-type (argument/who vs. adjunct/why) were manipulated. Example stimuli are shown in (1). Each participant was tested on 8 verbs (2 bridge, 6 unclassified, randomly sampled). Each participant rated 32 critical items and 32 fillers.

Analysis and Results*:* Figures 1 and 2 show the acceptability rating results. We fitted an LMER model predicting the bridge verb sentence acceptability with dependency length, wh-type, and their interaction, and the maximum random effect structure. There is a significant length*wh-type interaction (β=0.050, $p<0.001$), suggesting a larger length penalty for wh-adjunct than wh-argument. For each unclassified verb and wh-type pair, we fitted an LMER model predicting acceptability with verb type (unclassified vs. bridge), dependency length, their interaction, and the maximal random effect structure allowing convergence. Table 2 shows the interaction term estimates. Negative estimates suggest larger length effects for the unclassified verbs (i.e., a bridge effect). We found no bridge effect except for wh-argument crossing *jide* 'remember', contrary to Tsai's (1994) claim that non-brdige verbs restrict wh-adjuncts. A Bayes Factor analysis (Morey & Rouder 2023) confirmed the null results. This suggests no clear bridge/non-bridge distinction among the tested verbs.

Discussion: We first conducted a corpus analysis of CP-embedding verbs in the Mandarin CHILDES corpus, which suggested that children should have enough input to generalize that all CP-embedding verbs are bridge verbs. We then verified this prediction with an experiment that shows no evidence for bridge/non-bridge distinction in Mandarin. The argument-adjunct asymmetry reported in Tsai (1994) is observed even for bridge verbs, and thus reflects a general penalty on long-distance wh-adjunct questions. Our results render the theoretical machinery that Tsai (1994) introduced to capture bridge effects and the argument-adjunct asymmetry (e.g. the distinction between nominal and non-nominal CPs) unnecessary.

Table 1. Distribution of the 20 most frequent Mandarin CP-embedding verbs in CHILDES

Cross-clausal wh-	Clause-embedding verbs in Mandarin Chinese
Both wh-argument and wh-adjunct attested	*kan* 'see', *shuo* 'say', *zhidao* 'know', *juede* 'feel/think', *gaosu* 'tell', *jiang* 'speak', *xiwang* 'hope', *tingshuo* 'hear', *xiang* 'think', *pa* 'worry', *jide* 'remember', *jiandao* 'see', *cai* 'guess', *ganjue* 'feel'
Only wh-argument	*shuoming* 'explain', *faxian* 'discover', *xihuan* 'like', *haipa* 'fear', *xie* 'write'
Neither	*jiazhuang* 'pretend'

(1) a. wh-adjunct, short/long dependency, verb = *shuo* 'say'

zhushou xiangzhidao junguan (weishenme) **shuo** laoshi (weishenme) chumaile shuishou
assistant wonders officer (why) **say** teacher (why) betrayed sailor

Short: "The assistant wonders why the officer ___ said that the teacher betrayed the sailor"

Long: "The assistant wonders why the officer said that the teacher ___ betrayed the sailor"

b. wh-argument, short/long dependency, verb = *shuo* 'say'

zhushou xiangzhidao (shei/junguan) **shuo** laoshi chumaile (shuishou/shei)
assistant wonders (who/officer) **say** teacher betrayed (sailor/who)

Short: "The assistant wonders who ___ said that the teacher betrayed the sailor"

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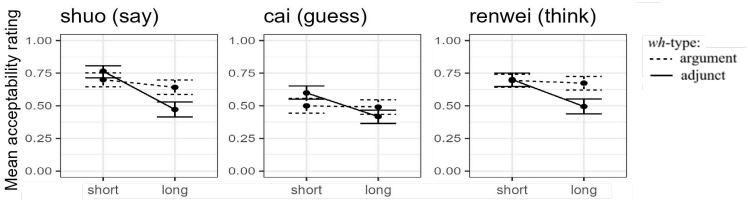

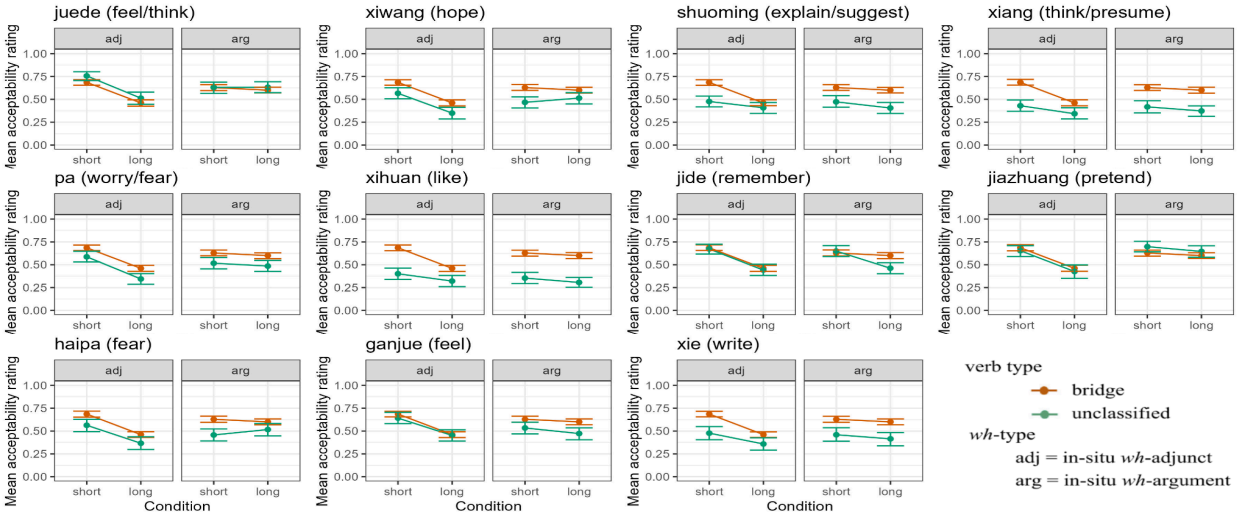

*Table 2. Regression model outputs and Bayes Factor estimates for the verb type*length term*

Verbs		*juede*	*xiwang*	*shuoming*	*xiang*	*pa*	*xihuan*	*jide*	*jiazhuang*	*haipa*	*ganjue*	*xie*
Argument	β	0.0099	0.021	-0.010	-0.0023	0.00028	-0.0074	-0.039	-0.008	0.020	-0.0069	-0.0069
	SE	0.012	0.012	0.010	0.012	0.011	0.012	0.012	0.013	0.011	0.012	0.014
	p	0.42	0.094	0.34	0.85	0.98	0.53	<0.01	0.53	0.086	0.55	0.63
	BF	0.12	0.35	0.15	0.12	0.11	0.13		0.14		0.15	0.15
Adjunct	β	-0.0044	0.00068	0.040	0.036	-9.8E-05	0.037	-0.001	-0.0019	0.0069	0.0085	0.022
	SE	0.01	0.0098	0.0099	0.011	0.0094	0.011	0.013	0.012	0.013	0.013	0.012
	p	0.67	0.95	<0.001	<0.01	0.99	<0.001	0.94	0.88	0.58	0.50	0.082
	BF	0.11	0.12			0.12		0.12	0.13	0.16	0.18	

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English contrasts bridge verbs, which allow *wh*-movement out of their CP complement, with non-bridge verbs which do not, (1), (Erteschik-Shir 1973, Chomsky 1977); a similar contrast has been identified for wh-in-situ languages like Thai, (Goldberg 2006). This distinction has been attributed to the semantics of CP-embedding verbs (Kiparsky & Kiparsky 1970, Stowell 1981, Kastner 2015). By contrast, Heuser, Martinez, & Yang 2023 (HMY) attributes the distinction to a failed generalization during learning: the proportion of bridge verbs among CP-embedding verbs in English is too low for children to productively generalize to the class. HMY's account predicts that no verb is inherently non-bridge, hence there should be languages in which the proportion of verbs used as bridge verbs does allow for generalization, resulting in all CP-embedding verbs being learned as bridge verbs. The wh-movement languages Shupamem (Schurr et al. 2021) and Limbum (Keupdjio 2020) have been claimed as such based on consultant work. We show that Mandarin, a wh-in-situ language, also lacks a bridge/non-bridge distinction, contrary to Tsai 1994, and thus provides support for HMY's account.

Corpus Analysis: We collected the 20 most frequent verbs attested with a CP complement in Mandarin CHILDES, (a reasonable estimate of vocabulary size, Diessel & Tomasello 2001), Table 1, and searched for uses in long-distance wh-questions. Assuming the Tolerance Principle (Yang 2016), a rule that applies to N items is productive with a maximum of N/ln(N) exceptions; hence, 20 CP-embedding verbs permit 6 unattested exceptions (20/ln(20)=6.67). We found cross-clausal wh-dependencies attested for 19/20 CP-embedding verbs for wh-arguments, and 14/20 for wh-adjuncts, clearing the threshold of productivity for both. Therefore, the corpus analysis predicts no bridge/non-bridge distinction in Mandarin for either wh-type..

Experiment (*Prolific*; N=240): Methods: We tested the islandhood of CP complements in Mandarin for 14 verbs: 3 claimed to be bridge verbs in Tsai 1994 (*shuo* 'say', *cai* 'guess', *renwei* 'think'), 1 claimed as a non-bridge verb in Tsai 1994, (*jide* 'remember'), and 11 additional verbs from the corpus analysis, only 4 of which pattern as bridge verbs in English (Richter & Chaves 2020). (These 11 were chosen for compatibility with a matrix *why*-question). Dependency length (short/mono-clausal vs. long/cross-clausal) and wh-type (argument/who vs. adjunct/why) were manipulated; example stimuli are shown in (2). Each participant was tested on 8 verbs (2 bridge, 6 unclassified, randomly sampled), and each rated 32 critical items and 32 fillers.

Analysis and Results*:* Figure 1 shows the acceptability rating results. For each unclassified verb and wh-type pair, we fitted an LMER model predicting acceptability with verb type (unclassified vs. bridge), dependency length, their interaction, and the maximal random effect structure allowing convergence. Table 2 shows the interaction term estimates. Negative estimates suggest larger length effects for the unclassified verbs (i.e., a bridge effect). We found no bridge effect, except for wh-argument *shei* `who' crossing *jide* 'remember', contrary to Tsai's 1994 claim that non-bridge verbs restrict only wh-adjuncts in Mandarin. A Bayes Factor analysis using the BayesFactor R package (Morey & Rouder 2023) confirmed the null results. This supports the absence of a bridge/non-bridge distinction among the tested verbs.

Discussion: The corpus analysis suggests that children have enough input to generalize that all CP-embedding verbs are bridge verbs in Mandarin, and the experiment confirms the lack of a clear bridge/non-bridge distinction in Mandarin. Our results support HMY's acquisition-based account for the bridge effect, and challenge any account based on *a priori* ties between the conceptual or lexical semantic properties of verbs and their permeability to extraction.

(1) What did John say/*complain that he had to do __ this evening? (Chomsky 1977: [42])

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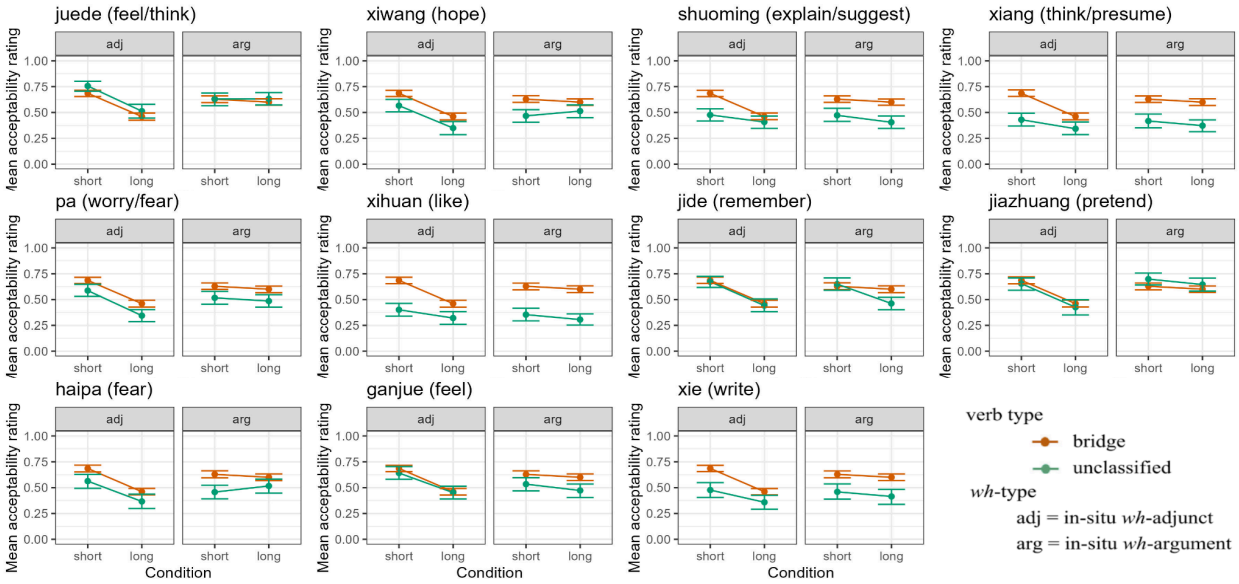

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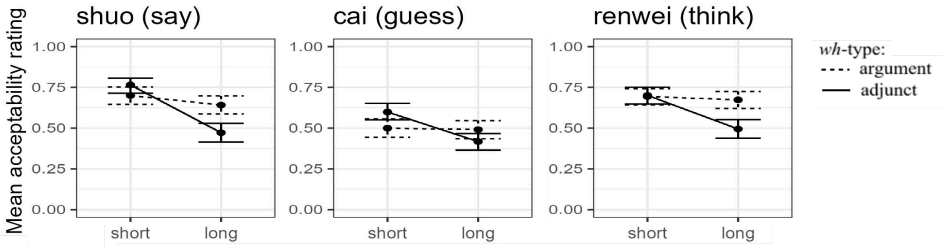

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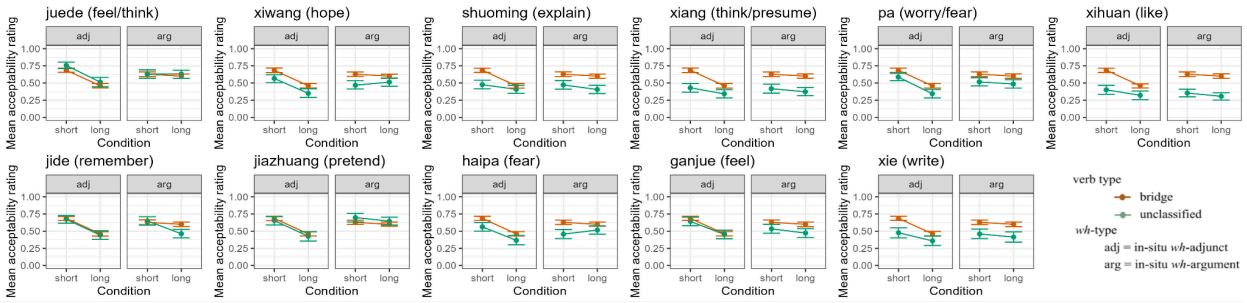

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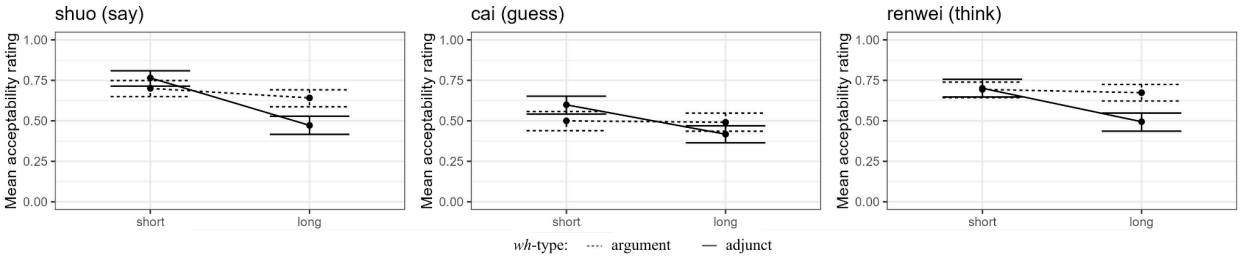

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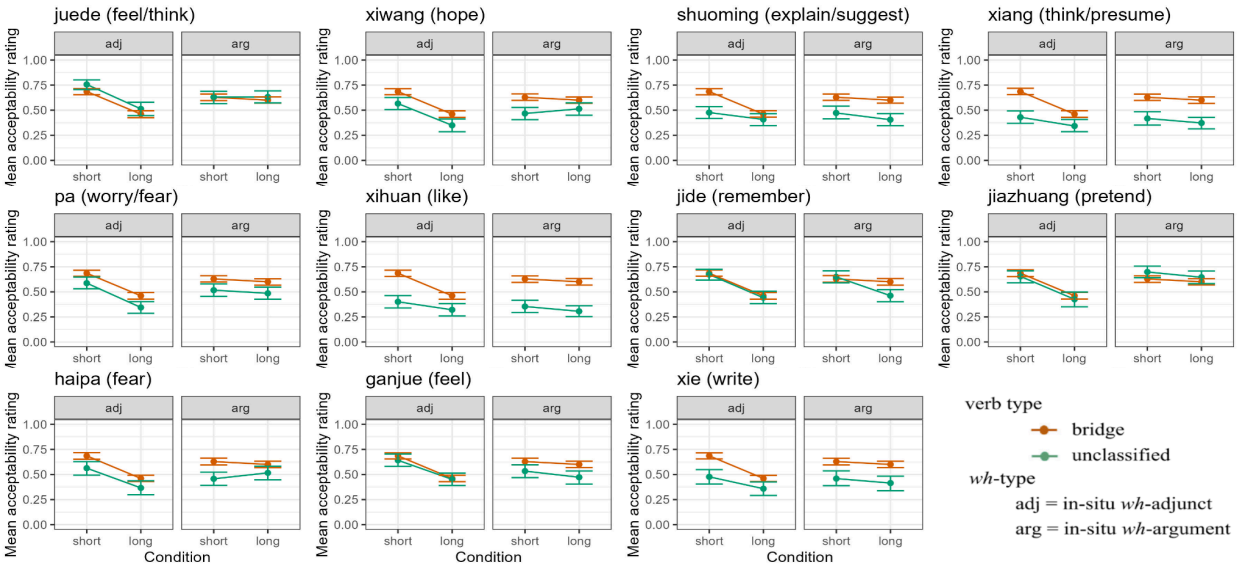

*Table 2. Regression model outputs and Bayes Factor estimates for the verb type*length term*

Verbs		*juede*	*xiwang*	*shuoming*	*xiang*	*pa*	*xihuan*	*jide*	*jiazhuang*	*haipa*	*ganjue*	*xie*
Argument	β	0.0099	0.021	-0.010	-0.0023	0.00028	-0.0074	-0.039	-0.008	0.020	-0.0069	-0.0069
	SE	0.012	0.012	0.010	0.012	0.011	0.012	0.012	0.013	0.011	0.012	0.014
	p	0.42	0.094	0.34	0.85	0.98	0.53	<0.01	0.53	0.086	0.55	0.63
	BF	0.12	0.35	0.15	0.12	0.11	0.13		0.14		0.15	0.15
Adjunct	β	-0.0044	0.00068	0.040	0.036	-9.8E-05	0.037	-0.001	-0.0019	0.0069	0.0085	0.022
	SE	0.01	0.0098	0.0099	0.011	0.0094	0.011	0.013	0.012	0.013	0.013	0.012
	p	0.67	0.95	<0.001	<0.01	0.99	<0.001	0.94	0.88	0.58	0.50	0.082
	BF	0.11	0.12			0.12		0.12	0.13	0.16	0.18	

References: [1] Erteschik-Shir (1973) *On the nature of island constraints* [2] Chomsky (1977) *On wh-movement* [3] Goldberg (2006) *Constructions at work* [4] Tsai (1994) *On nominal island and LF extraction in Chinese* [5] Yang (2005) *On productivity* [6] Diessel & Tomasello (2001)

Introduction: Certain clause-embedding verbs allow *wh*-movement out of their CP complements (e.g. *think*: *Who do you think that John saw __*?), while others do not (e.g. *pretend*: **Who do you pretend that John saw __*?). The former are called "bridge verbs", and the latter "non-bridge verbs". The bridge/non-bridge contrast is well attested in English [1,2], but less clear cross-linguistically. Some suggest that the bridge/non-bridge contrast may be weaker or lacking in wh-in-situ languages [3], while [4] suggests that non-bridge verbs restrict in-situ wh-adjuncts (e.g. *why*) but not wh-arguments (e.g. *who*). In this study, we examine the bridge/non-bridge distinction in Mandarin Chinese, a wh-in-situ language, with a corpus analysis and a formal acceptability judgment experiment. We show that unlike in English and contrary to the generalization in [4], there is no evidence for a bridge/non-bridge contrast in Mandarin.

Corpus Analysis: We collected the 20 most frequent verbs attested with CP complements (a reasonable estimate of vocabulary size [6]) in Mandarin CHILDES (Table 1), and searched for uses in which their complement contains an in-situ wh-argument or wh-adjunct with matrix scope.

We collected the most frequent 20 verbs attested with CP complements in the Mandarin CHILDES corpus (Table 1), and searched for whether the complements of these verbs contain wh-in-situs taking matrix scope. Cross-clausal wh-dependencies are attested with 19 verbs for wh-arguments, and 14 for wh-adjuncts. Assuming the Tolerance Principle (TP) [5], a rule that applies to N items can remain productive with a maximum of N/ln(N) exceptions. With 1 and 6 exceptions out of 20 respectively, (covert) cross-clausal wh-argument and wh-adjunct movement should remain productive, predicting no bridge/non-bridge distinction in Mandarin.

Experiment (*Prolific*; N=240): *Methods and Procedures*: We experimentally tested the islandhood of clausal complements in Mandarin. We tested 14 verbs in total: 3 are labeled as bridge verbs by [4] (the only classification of Mandarin bridge verbs that we know of in the past literature): *shuo* (say), *cai* (guess), and *renwei* (think). We also tested all unclassified verbs in Table 1 compatible with matrix *why*-questions. Dependency length (short/mono-clausal vs. long/cross-clausal) and wh-type (argument/who vs. adjunct/why) are manipulated. Example stimuli are shown in (1). A total of 32 lexicalizations were created. Each participant was tested on 8 verbs (2 bridge and 6 unclassified verbs randomly sampled), each appearing once in each condition. Each participant rated 32 critical items and 32 fillers. *Analysis and Results:* Figures 1 and 2 show the ratings for the bridge verbs and the unclassified verbs. We fitted an LMER model predicting the acceptability of bridge verb sentences with fixed effects of dependency length, wh-type, and their interaction, and the maximum random effect structure. There is a significant length*wh-type interaction (β=0.050, t=6.60, $p<0.001$), suggesting a larger length penalty for wh-adjunct dependencies than wh-argument. For each unclassified verb and wh-type pair, we fitted an LMER model predicting acceptability with verb type (unclassified vs. bridge), dependency length, their interaction, and the maximum random effect structure allowing convergence. Table 2 shows the estimates for the interaction term. A negative effect suggests a larger extraction penalty than the bridge verbs (i.e., a bridge effect). We found a bridge effect only for wh-argument crossing *jide* (remember); four verbs displayed significant or marginal "anti-bridge effects", and all other verbs showed no effect. A Bayes Factor analysis further confirmed the null results. The results suggest no clear bridge/non-bridge distinction between the three bridge verbs and the unclassified verbs tested. Crucially, even the verbs not attested with cross-clausal wh-dependencies in the corpus analysis displayed no bridge effect.

Discussion: In this study, we first conducted a corpus analysis of clause-embedding verbs in the Mandarin CHILDES corpus, the result of which suggests that children should have enough input to generalize that all clause-embedding verbs are bridge verbs; we then verified this prediction with an experiment that shows no evidence for bridge/non-bridge distinction in Mandarin. the argument-adjunct asymmetry reported in [4] is observed even for bridge verbs, and thus reflects a general penalty on long-distance (covert) wh-adjunct movements, and is orthogonal to the bridge effect. Our results render the theoretical machinery introduced by [4] to capture bridge effects and the argument-adjunct asymmetry (e.g. the distinction between nominal and non-nominal CPs) unnecessary.

References: [1] Erteschik-Shir (1973) *On the nature of island constraints* [2] Chomsky (1977) *On wh-movement* [3] Goldberg (2006) *Constructions at work* [4] Tsai (1994) *On nominal island and LF extraction in Chinese* [5] Yang (2005) *On productivity*

Table 1. Distribution of the 20 most frequent Mandarin clause-embedding verbs in CHILDES.

Cross-clausal wh-attested	Clause-embedding verbs in Mandarin Chinese
Both wh-argument and wh-adjunct	*kan* 'see', *shuo* 'say', *zhidao* 'know', *juede* 'feel/think', *gaosu* 'tell', *jiang* 'speak', *xiwang* 'hope', *tingshuo* 'hear', *xiang* 'think', *pa* 'worry', *jide* 'remember', *jiandao* 'see', *cai* 'guess', *ganjue* 'feel'
Only wh-argument	*shuoming* 'explain', *faxian* 'discover', *xihuan* 'like', *haipa* 'fear', *xie* 'write'
Neither	*jiazhuang* 'pretend'

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Only wh-argument	*shuoming* (explain), *faxian* (discover), *xihuan* (like), *haipa* (fear), *xie* (write)
Neither	*jiazhuang* (pretend)

(1) a. wh-adjunct, short/long dependency, verb = *shuo* (say)
zhushou xiangzhidao junguan (weishenme) **shuo** laoshi (weishenme) chumaile shuishou
assistant wonders officer (why) **say** teacher (why) betrayed sailor
Short: "The assistant wonders why the officer ___ said that the teacher betrayed the sailor"
Long: "The assistant wonders why the officer said that the teacher ___ betrayed the sailor"

b. wh-argument, short/long dependency, verb = *shuo* (say)
zhushou xiangzhidao (shei/junguan) **shuo** laoshi chumaile (shuishou/shei)
assistant wonders (who/officer) **say** teacher betrayed (sailor/who)
Short: "The assistant wonders who ___ said that the teacher betrayed the sailor"
Long: "The assistant wonders who the officer said that the teacher betrayed __"

Figure 1. Ratings for the three bridge verbs.

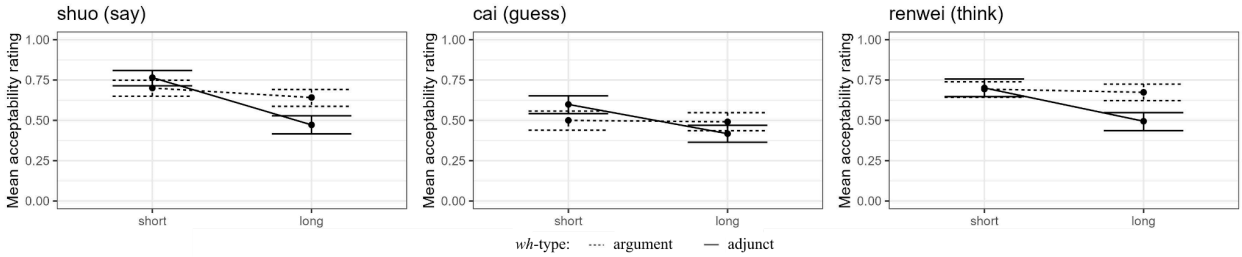

Figure 2. Comparisons between the unclassified verbs and the bridge verbs.

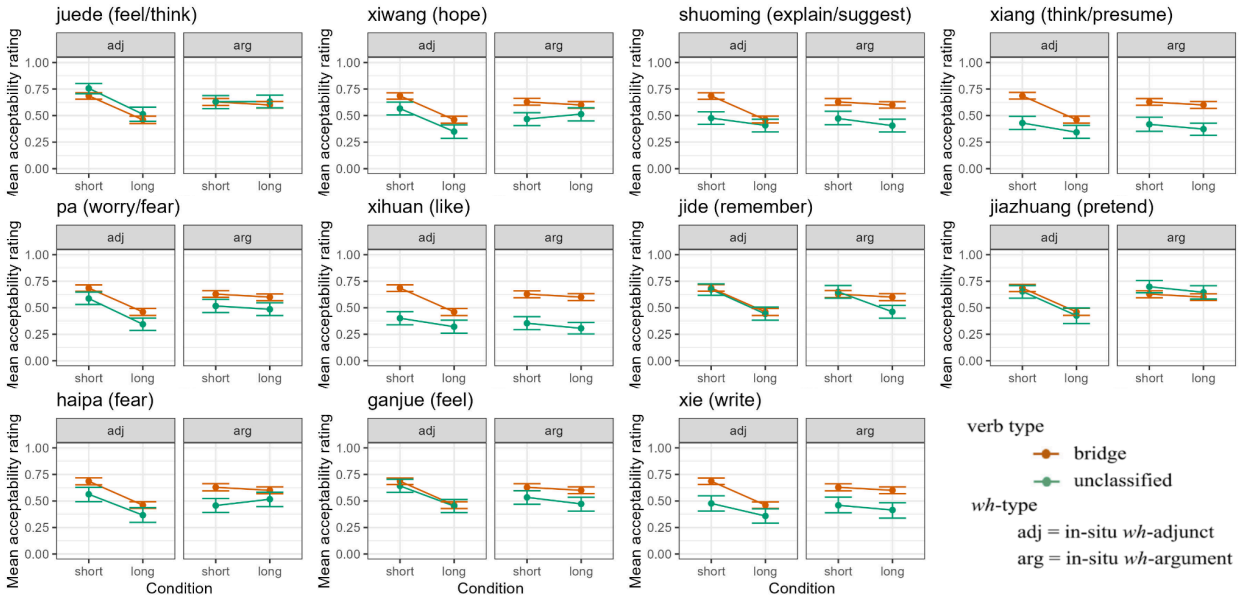

*Table 2. Regression model outputs and Bayes Factor estimates for the verb type*length term*

Verbs		*juede*	*xiwang*	*shuoming*	*xiang*	*pa*	*xihuan*	*jide*	*jiazhuang*	*haipa*	*ganjue*	*xie*
Argument	β	0.0099	0.021	-0.010	-0.0023	0.00028	-0.0074	-0.039	-0.008	0.020	-0.0069	-0.0069
	SE	0.012	0.012	0.010	0.012	0.011	0.012	0.012	0.013	0.011	0.012	0.014
	p	0.42	0.094	0.34	0.85	0.98	0.53	<0.01	0.53	0.086	0.55	0.63
	BF	0.12	0.35	0.15	0.12	0.11	0.13		0.14		0.15	0.15
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	SE	0.01	0.0098	0.0099	0.011	0.0094	0.011	0.013	0.012	0.013	0.013	0.012
	p	0.67	0.95	<0.001	<0.01	0.99	<0.001	0.94	0.88	0.58	0.50	0.082
	BF	0.11	0.12			0.12		0.12	0.13	0.16	0.18	

(1) 20 most frequent Mandarin CP-embedding verbs in CHILDES (bolded tested experimentally)
a. Both cross-clausal wh-argument and wh-adjunct attested: *kan* 'see', ***shuo*** 'say', *zhidao* 'know', *juede* 'feel/think', *gaosu* 'tell', *jiang* 'speak', *xiwang* 'hope', *tingshuo* 'hear', *xiang* 'think', *pa* 'worry', *jide* 'remember', *jiandao* 'see', *cai* 'guess', *ganjue* 'feel'
b. Only wh-argument: *shuoming* 'explain', *faxian* 'discover', *xihuan* 'like', *haipa* 'fear', *xie* 'write'
c. Neither attested: *jiazhuang* 'pretend'

<u>Experiment (*Prolific*; N=240)</u>: Methods: We tested experimentally the islandhood of CP complements in Mandarin for 14 verbs: 3 labeled as bridge verbs in [4] (*shuo* 'say', *cai* 'guess', *renwei* 'think'), 1 labeled as non-bridge in [4] (*jide* 'remember'), and the 11 remaining verbs from

the corpus analysis that are compatible with a matrix *why*-question. Dependency length (short/mono-clausal vs. long/cross-clausal) and wh-type (argument/who vs. adjunct/why) were manipulated. Example stimuli are shown in (1). A total of 32 lexicalizations were created. Each participant was tested on 8 verbs (2 bridge, 6 randomly sampled unclassified), each appearing once in each condition. Each participant rated 32 critical items and 32 fillers. **Analysis and Results***:* Figures 1 and 2 show the ratings for the bridge verbs and unclassified verbs. We fitted an LMER model predicting the acceptability of bridge verb sentences with fixed effects of dependency length, wh-type, and their interaction, and the maximum random effect structure. There is a significant length*wh-type interaction (β=0.050, t=6.60, p<0.001), suggesting a larger length penalty for wh-adjunct dependencies than wh-argument. For each unclassified verb and wh-type pair, we fitted an LMER model predicting acceptability with verb type (unclassified vs. bridge), dependency length, their interaction, and the maximum random effect structure allowing convergence. Table 2 shows the estimates for the interaction term. A negative effect suggests a larger extraction penalty than for the bridge verbs (i.e., a bridge effect). We found a bridge effect only for wh-argument crossing *jide* `remember'; 4 verbs displayed significant or marginal "anti-bridge effects"; all other verbs showed no effect. A Bayes Factor analysis using the BayesFactor R Package [7] further confirmed the null results. The results suggest no clear bridge/non-bridge distinction between the three bridge verbs and the unclassified verbs tested, including those lacking a cross-clausal wh-dependency in the corpus analysis.