The Effects of Syntactic and Semantic Cues on Children' s Verb Acquisition

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Abstract

Purpose This study aims to investigate how grammatical and semantic factors influence the acquisition of novel verbs in Chinese-speaking children. Methods This study employed the preferential pointing paradigm to examine the influence of grammatical and semantic cues on verb acquisition in Chinese-speaking children aged 3-5 years. Results Results indicate that 5-year-old children can use single syntactic cues to acquire novel verbs during verb learning, while 4-year-old children demonstrated the ability to use dual cues, including dual syntactic cues or a combination of syntactic and semantic cues. Limitations This study examined the verb acquisition mechanism in children aged 3-5 years, but 3-year-olds failed to pass the experimental task. Conclusion This study found that 5-year-old children can utilize single syntactic cues to acquire verbs, whereas 4-year-old children require additional semantic or grammatical cues.

Full Text

Effects of Grammatical and Semantic Cues on Verb Acquisition in Children

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Abstract

[**Objective**] This study aims to examine how grammatical and semantic factors affect the acquisition of novel verbs by Chinese-speaking children. [**Methods**] Using the Preferential Pointing Paradigm, we investigated the effects of grammatical and semantic cues on verb acquisition in Mandarin-speaking children aged 3–5 years. [**Results**] The results indicated that 5-year-old children could use a single syntactic cue to acquire novel verbs, whereas 4-year-old children

demonstrated the ability to utilize dual cues, encompassing either double syntactic cues or a combination of syntactic and semantic cues. [**Limitations**] This study examined the mechanisms of verb acquisition in children aged 3–5 years, but 3-year-olds failed to pass the experimental task. [**Conclusions**] This study found that 5-year-old children can use a single syntactic cue to acquire verbs, while 4-year-old children require additional semantic or grammatical cues.

Keywords: verb acquisition, syntactic bootstrapping, mandarin learner, word length

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Corpus-based research has found that Mandarin-speaking children begin producing verbs as early as 8 months of age (Tardif, 2006), yet the mechanisms underlying their lexical acquisition remain unclear. Influenced by Chomskyan syntactic theory, numerous studies have focused on the role of syntax in grammatical cues, an approach known as "syntactic bootstrapping." The syntactic bootstrapping hypothesis proposes that sentence structure can help children identify the meanings of novel words (Gleitman, 1990; Fisher, 1996). For instance, experimental studies have shown that 2-year-old English-speaking children can use syntactic cues to infer the meanings of novel verbs (Fisher & Gleitman, 2002). However, current empirical research on Mandarin indicates that Chinese children cannot utilize syntactic cue words to acquire verbs until age 5 (Ma et al., 2020). Therefore, research on lexical acquisition in Chinese children may need to identify mechanisms that better align with the specific characteristics of Mandarin.

1.1 Syntactic Bootstrapping Effects in English and Western Languages

English and other Indo-European languages typically encode grammar through inflectional morphology (e.g., number, tense), resulting in sentences rich with cue words that children can exploit (Brown, 1957; Fisher & Gleitman, 2002; Shi & Lepage, 2008; Waxman et al., 2009). For example, in English, a word bearing the suffixes *-ed* or *-ing* is likely a verb, while a word preceded by the articles *a*, *an*, or *the* is probably a noun. In a classic study, researchers found that English-speaking children aged 3–5 could determine the meaning of novel words based on *a*, *some*, or *-ing* in sentences (Brown, 1957). Similar results have been observed in French, where Shi and Melançon (2010) used a visual fixation procedure to demonstrate that 14-month-old French infants could categorize target words based on syntactic cue words (e.g., *des* precedes nouns, *je* precedes verbs). These studies show that words that frequently co-occur with verbs or nouns in sentence structures can serve as cue words to help children identify word categories and thus understand their meanings (Brown, 1957; Waxman, 1999; Waxman & Booth, 2001; He & Lidz, 2017; de Carvalho et al., 2019).

1.2 Syntactic Bootstrapping Effects in Mandarin and Comparison with Western Languages

Syntactic bootstrapping effects also exist in Mandarin (Lee & Naigles, 2005; Imai et al., 2008; Ma et al., 2020). Aspect markers constitute the primary grammatical markers used by early Mandarin learners, reflecting whether an action or event is progressive, durative, or experiential (Klein et al., 2000; Li & Shirai, 2000). For example, *zài* (在) indicates a progressive action or event, equivalent to *-ing* in English (Zhang, 2016; Huang et al., 2022). Imai et al. (2008) conducted a cross-cultural comparative study and found that 8-year-old Mandarin-speaking children could use the syntactic structure "Look, Auntie is X-ing an object!" to acquire verbs, though their verb acquisition ability was weaker than that of English- and Japanese-speaking children. More recently, Ma et al. (2020) used the same experimental paradigm and found that 5-year-olds could acquire verbs through the sentence structure "Look, Auntie is X-ing," whereas 3-year-olds could not. This suggests that children under 5 may require additional cues to acquire verbs in Mandarin, a question the present study will explore.

In English, the present progressive *-ing* serves as a reliable marker for verbs. However, research based on Mandarin child-directed speech corpora has found that the progressive aspect marker *zài* co-occurs with verbs and nouns with probabilities of 0.40 and 0.23, respectively, whereas the perfective aspect markers *yòu* (又; 0.60 and 0.03) and *le* (了; 0.46 and 0.12) show higher co-occurrence probabilities with verbs (Ma et al., 2019). This indicates that *zài* is not a reliable syntactic cue word for Mandarin-speaking children. Compared to English, Mandarin more commonly uses perfective aspect to describe events. For example, when seeing someone approaching or leaving, English would express this as "He/She is coming" or "He/She is leaving," whereas Mandarin would say "He came" (他来了) or "He left" (他走了). When describing an action recurring, the structure *yòu…le* (又……了) is frequently used in Mandarin. Few studies have investigated whether children can use perfective aspect to acquire novel verbs.

1.3 Morphological Bootstrapping Effects in Mandarin

Grammar includes not only syntax but also morphology. Mandarin word formation differs from alphabetic languages in the Indo-European family. For instance, early-acquired Mandarin verbs are primarily monosyllabic, while nouns are mainly polysyllabic (predominantly disyllabic) (Tan, 2008). Additional research has found that early-acquired verbs in Mandarin-speaking children have shorter word lengths than nouns (Hao et al., 2015). These findings suggest that target word length may serve as a special cue for Mandarin-speaking children to distinguish word categories. In Ma et al.' s (2020) study, however, all target words were disyllabic. In this case, children might tend to categorize disyllabic words as nouns, thereby affecting their accuracy in verb acquisition. Early-acquired vocabulary in Mandarin consists mainly of monosyllabic verbs and disyllabic nouns, yet no experimental studies have examined whether young

children can utilize this morphological cue to help differentiate word categories.

1.4 Semantic Bootstrapping Effects in Mandarin

Fisher et al. (2020) propose that syntactic bootstrapping may have limitations, and that when children encounter unfamiliar words in complex sentences, they combine semantic cues to make guesses, acquiring novel verbs through confirmation of these guesses. Mahon et al. (2007) identified the semantic bootstrapping effect, whereby providing semantically relevant information facilitates subsequent lexical processing. For example, when presented with the pairs "hand–kick" and "hand–touch," individuals respond faster to the word "touch" than to "kick." Semantically related functions form very small semantic clusters, resulting in minimal competitive interference, such that conceptual priming outweighs competitive interference, ultimately producing a semantic facilitation effect (Mahon & Caramazza, 2009).

Grammar and semantics exhibit mutual facilitation effects (Moyle et al., 2007; Caglar-Ryeng et al., 2019). However, in early developmental stages, grammatical knowledge is limited, and grammar' s facilitative effect on semantics is relatively small. Grammatical knowledge is built upon a certain vocabulary foundation (Bates & Goodman, 2001); for younger children with smaller vocabularies and less grammatical mastery, the possibility of vocabulary acquisition through grammatical facilitation decreases accordingly. Research shows that children undergo more advanced grammatical development around ages 4–6 (Guasti, 2017; Tomblin & Zhang, 2006). Recently, Cao & Lewis (2021) conducted a meta-analysis of nearly 30 years of research on verb learning mechanisms, finding that the effect size of syntactic bootstrapping was small ($d = 0.24$) during the age period from 1 to 4 years and did not change with age. Electrophysiological studies have found that the semantic N400 component emerges around 9 months (Morgan et al., 2020), whereas grammatical processing-related e(E)LAN and P600 components do not appear until children are 30–36 months old (Oberecker & Friederici, 2006; Oberecker et al., 2005). These findings suggest that children aged 4 and younger may require semantic cue support when acquiring verbs, though this theory currently lacks sufficient empirical support.

Among semantic cues, body part information is one of the earliest that children encounter. Chen & Zhu (2014) found that early-learned verbs in Mandarin-speaking children are associated with specific body parts, mostly hand actions. Empirical research further revealed that 2-year-olds can use body part information to accelerate recognition of spoken verbs (Chen & Zhu, 2023). Mandarin verbs lack morphological changes and grammatical markers, and the utilization of semantic information (such as body part information) may constitute an important mechanism for verb processing in native Mandarin speakers, compensating for insufficient grammatical cues. Therefore, this study proposes that providing body part information about action execution facilitates children' s semantic processing, particularly for hand actions, which children encounter most frequently in early development. It should be noted that in other lan-

guages (e.g., English), early-acquired verbs also show specific connections to body parts (Maouene et al., 2008), suggesting this semantic cue may have cross-linguistic universality, though no experimental studies have examined this. The present study uses Mandarin as a case study to provide empirical support for this claim.

In summary, we combined grammatical (syntactic cue words, word length) and semantic cues to examine verb acquisition in Mandarin-speaking children aged 3–5, exploring both universal aspects of early lexical acquisition and Mandarin-specific characteristics. Experiment 1 built upon previous research (Ma et al., 2020) to compare 4- and 5-year-olds'ability to acquire verbs using single syntactic cue words under different word length conditions. Experiment 2 investigated 3- and 4-year-olds' verb acquisition after adding either a syntactic cue word with Mandarin-specific characteristics or a semantic cue word with universal linguistic significance. This study aims to reveal the specific mechanisms of lexical acquisition in Mandarin-speaking children and provide evidence from Sino-Tibetan languages to enrich theories of child language development.

2.1 Participants

Referencing previous lexical acquisition studies (Singh & Quinn, 2021), the interaction effect size for different conditions on vocabulary acquisition was $p = 0.16$ ($f = 0.44$). The present experiment set the effect size at $f = 0.44$, and with parameters of $1 - \beta = 0.95$ and $\alpha = 0.05$, the required sample size for each between-subjects variable level was at least 10 participants. We recruited 49 typically developing children, including 25 in the 5-year-old group (M age = 5.31 years, SD = 0.28, 12 girls) and 24 in the 4-year-old group (M age = 4.65 years, SD = 0.30, 13 girls). All children were native Mandarin speakers. The experiment posed no harm to children, and parental informed consent was obtained.

2.2 Experimental Design

A mixed design was employed with 2 (word length: monosyllabic, disyllabic, within-subjects) × 2 (age: 4 years, 5 years, between-subjects). The dependent variable was participants' accuracy rate.

2.3 Experimental Materials

Following Ma et al. (2020), we created 8 pseudowords as target words based on morphological principles: monosyllabic words *jǐng, kuó, jiòng*, and *fī*; and disyllabic words *dāng pà, móu dǎ, wā mò*, and *shēn zuì*. We also selected the familiar verb *mō* (touch) and the pseudoword *wàn* as materials for the warm-up phase. To exclude the influence of children' s life experience on experimental effects, we selected 18 unfamiliar objects and 18 unfamiliar actions as materials for experimental videos. During selection, two experimenters independently

judged whether each object was sufficiently unfamiliar; only items judged as unfamiliar by both experimenters were included.

Consistent with previous studies (Imai et al., 2008; Ma et al., 2020), we used *zài* (在) as the syntactic cue word embedded in sentence structures to examine children' s ability to acquire verbs using this cue. Given that *yòu···le* (又……了) indicates the reoccurrence of actions and verbs and is generally not used in isolation, it was not employed as a cue word in the single syntactic cue condition.

2.4 Experimental Procedure

This experiment referenced similar studies (e.g., Imai et al., 2005, 2008; Ma et al., 2020) and adopted the Preferential Pointing Paradigm, which is widely used in child lexical acquisition research. Children sat in front of a computer screen and watched video materials. A learning video was presented first, followed by a test phase where two videos were displayed side-by-side. Children were asked to point with their finger to the screen side they believed matched the audio question (see Table 1).

In this experiment, children were presented with a standard event during the learning phase: an actor manipulated an unfamiliar object using an unfamiliar action while audio played: "Look, she is X-ing. Look, she is X-ing!" During the test phase, children were simultaneously shown two different events (left and right sides): an action-same event where the actor used the previous action on another object, and an object-same event where the actor used another action on the previous object. Audio simultaneously played: "Who is X-ing? Which person in the videos is X-ing?" Participants were asked to select the event representing the meaning of "X." If children understood the function of the syntactic cue word *zài*, they would interpret the target word as a verb and select the action-same event during testing. Correct selections were scored as 1, incorrect selections as 0. Finally, the mean accuracy for each experimental condition was calculated; if children could use the cue to acquire verbs, accuracy should be significantly above chance level (0.50).

Table 1 Single-trial procedure for Experiment 1: "Look, she is X-ing. Look, she is X-ing!" → "Who is X-ing? Which person in the videos is X-ing?"

Testing was conducted individually with children in a quiet room by the same experimenter using the same computer. Two practice trials preceded the experiment (one with a familiar action, one with an unfamiliar action) to familiarize children with the procedure. This was followed by 8 experimental trials (4 monosyllabic verbs and 4 disyllabic verbs). The presentation order of monosyllabic and disyllabic verbs was counterbalanced across participants, and the location of target events was balanced across trials.

2.5 Results and Analysis

One-sample t-tests compared children' s verb learning accuracy rates against chance level (0.50) across different experimental conditions. For the 4-year-old group, accuracy rates did not differ significantly from chance in either the monosyllabic condition ($t(23) = 1.39$, $p = 0.18$) or the disyllabic condition ($t(23) = 0.90$, $p = 0.37$). For the 5-year-old group, accuracy rates were significantly above chance in both the monosyllabic condition ($t(24) = 5.68$, $p < 0.001$, Cohen' s $d = 1.14$, 95% CI = [0.20, 0.42]) and the disyllabic condition ($t(24) = 6.41$, $p < 0.001$, Cohen' s $d = 1.28$, 95% CI = [0.22, 0.44]).

A mixed-design ANOVA revealed no significant main effect of word length, $F(1, 47) = 0.03$, $p = 0.87$; a significant main effect of age group, $F(1, 47) = 7.07$, $p = 0.01$, partial $^2 = 0.13$, 95% CI = [0.06, 0.41]; and no significant interaction between age and word length, $F(1, 47) = 0.57$, $p = 0.45$ (see Figure 1 [Figure 1: see original paper]).

Figure 1 Verb acquisition accuracy rates under different target word length conditions

The results of Experiment 1 showed that 5-year-olds could use the cue word *zài* to acquire verbs, whereas 4-year-olds could not, and word length had no effect on their verb acquisition. Can 4-year-olds acquire verbs when the syntactic cue word *yòu···le* is added or when semantic cue words are provided? Experiment 2 will explore this question and continue to examine the role of word length.

3.1.1 Experimental Design

A mixed design was employed with 2 (word length: monosyllabic, disyllabic, within-subjects) × 2 (added cue word: syntactic cue word, semantic cue word, between-subjects). The dependent variable was participants' accuracy rate.

3.1.2 Participants

We recruited 51 typically developing children (M age = 4.50 years, SD = 0.31, 26 girls) who were randomly assigned to different cue word groups: 24 in the syntactic cue group and 27 in the semantic cue group. The sample size exceeded G*Power' s recommended sample size for mixed-effects repeated measures ANOVA (total n = 20 when f = 0.44, $\alpha = 0.05$, 1-$\beta = 0.95$). All children were native Mandarin speakers. The experiment posed no harm to children, and parental informed consent was obtained.

3.1.3 Experimental Materials

The materials were identical to Experiment 1, with only the audio materials in the videos changed. For the added syntactic cue group, the learning phase audio became: "Look, she is X-ing. Look, she X-ed again!" For the added semantic cue group, the learning phase audio became: "Look, she is X-ing with her hand.

Look, she is X-ing with her hand!" Thus, Experiment 2 provided children with dual cues: the syntactic cue group heard *zài* and *yòw···le*, while the semantic cue group heard *zài* and *with hand*.

3.1.4 Experimental Procedure

Identical to Experiment 1.

3.1.5 Results and Analysis

One-sample t-tests compared children' s verb acquisition accuracy rates against chance level (0.50) across different experimental conditions. In the syntactic cue condition, 4-year-olds' accuracy rates were significantly above chance for both monosyllabic ($t(23) = 5.00$, $p < 0.001$, Cohen' s $d = 1.02$, 95% CI = [0.18, 0.44]) and disyllabic words ($t(23) = 4.26$, $p < 0.001$, Cohen' s $d = 0.87$, 95% CI = [0.15, 0.43]). In the semantic cue condition, 4-year-olds' accuracy rates were also significantly above chance for both monosyllabic ($t(26) = 6.67$, $p < 0.001$, Cohen' s $d = 1.28$, 95% CI = [0.26, 0.34]) and disyllabic words ($t(26) = 2.39$, $p = 0.02$, Cohen' s $d = 0.46$, 95% CI = [0.03, 0.34]).

A mixed-design ANOVA revealed a significant main effect of word length, $F(1, 49) = 8.29$, $p = 0.006$, partial $^2 = 0.15$; no significant main effect of cue word type, $F(1, 49) = 0.08$, $p = 0.78$; and a significant interaction between cue word type and word length, $F(1, 49) = 5.27$, $p = 0.03$, partial $^2 = 0.10$. Simple effects analysis showed no significant difference between monosyllabic and disyllabic accuracy rates in the syntactic cue condition, $F(1, 49) = 0.16$, $p = 0.70$. However, in the semantic cue condition, the difference between monosyllabic and disyllabic accuracy rates was significant, $F(1, 49) = 14.22$, $p < 0.001$, partial $^2 = 0.23$, 95% CI = [0.09, 0.28], with higher verb acquisition accuracy in the monosyllabic condition than in the disyllabic condition (see Figure 2 [Figure 2: see original paper]).

Figure 2 Verb acquisition accuracy rates for 4-year-old children under different cue word conditions

The results of Experiment 2a demonstrated that adding either syntactic or semantic cue words facilitated 4-year-olds' verb acquisition. Word length and cue word type jointly influenced 4-year-olds' verb acquisition, with higher accuracy for novel verb acquisition under the combination of semantic cue words and monosyllabic words. Combined with Experiment 1, we found that younger children require more cues for verb acquisition. Can 3-year-olds acquire verbs under these conditions, and what effect does word length have?

3.2.1 Experimental Design

A mixed design was employed with 2 (word length: monosyllabic, disyllabic, within-subjects) × 2 (cue word: syntactic cue word, semantic cue word, between-subjects). The dependent variable was participants' accuracy rate.

3.2.2 Participants

We recruited 53 typically developing children (M age = 3.73 years, SD = 0.23, 24 girls) who were randomly assigned to different cue word groups: 26 in the syntactic cue group and 27 in the semantic cue group. The sample size exceeded G*Power' s recommended sample size for mixed-effects repeated measures ANOVA (total n = 20 when f = 0.44, $\alpha = 0.05$, 1-$\beta = 0.95$). All children were native Mandarin speakers. The experiment posed no harm to children, and parental informed consent was obtained.

3.2.3 Experimental Materials

Identical to Experiment 2a.

3.2.4 Procedure

Identical to Experiment 2a.

3.2.5 Results and Analysis

One-sample t-tests compared children' s verb acquisition accuracy rates against chance level (0.50) across different experimental conditions. In the syntactic cue condition, 3-year-olds' accuracy rates did not differ significantly from chance for either monosyllabic (t(25) = -2.01, p = 0.06) or disyllabic words (t(25) = 0, p = 1). In the semantic cue condition, the 3-year-old group' s accuracy rates were significantly below chance for both monosyllabic (t(26) = -2.22, p = 0.04, Cohen' s d = 0.42, 95% CI = [-0.23, -0.01]) and disyllabic words (t(25) = -5.21, p < 0.001, Cohen' s d = 1.00, 95% CI = [-0.37, -0.16]).

A mixed-design ANOVA revealed no significant main effects of word length, F(1, 51) = 0.03, p = 0.89, or cue word type, F(1, 51) = 2.83, p = 0.10, but a significant interaction between cue word type and word length, F(1, 51) = 10.94, p = 0.002, partial ^{2} = 0.18. Simple effects analysis showed a significant difference between monosyllabic and disyllabic accuracy rates in the syntactic cue condition, F(1, 51) = 4.87, p = 0.032, partial ^{2} = 0.09, 95% CI = [-0.26, -0.01], and in the semantic cue condition, F(1, 51) = 6.12, p < 0.017, partial ^{2} = 0.11, 95% CI = [0.03, 0.27].

Figure 3 [Figure 3: see original paper] Verb acquisition accuracy rates for 3-year-old children under different contextual cue conditions

The results of Experiment 2b indicated that 3-year-olds could not acquire verbs under dual-cue conditions. Interestingly, when semantic cue words were added, 3-year-olds more frequently selected the object-same event, suggesting they tended to categorize the heard target words as nouns, and were more likely to categorize disyllabic than monosyllabic words as nouns.

This study examined the ability of Mandarin-speaking children aged 3–5 to use grammatical and semantic cues to acquire verbs. The results showed that 5-

year-olds could use single syntactic cue words to acquire novel verbs, whereas 4-year-olds required additional cues (added syntactic or semantic cues) for verb acquisition. Word length affected lexical acquisition in both 3- and 4-year-olds: 4-year-olds more easily categorized monosyllabic words as verbs, while 3-year-olds under semantic cue conditions more readily categorized disyllabic words as nouns. The study reveals the role of grammatical and semantic cues in verb acquisition among novice Mandarin speakers and the specificity of lexical acquisition mechanisms in Mandarin, which we discuss in detail below.

4.1 Syntactic Bootstrapping Effects in Mandarin

This study first replicated and extended previous findings (Ma et al., 2020), demonstrating that Mandarin-speaking children can reliably use single syntactic cues to acquire verbs only from age 5. While previous research did not differentiate target word length, this study found that the 5-year-old group could use the cue *zài* to acquire verbs regardless of whether target words were monosyllabic or disyllabic, whereas the 4-year-old group could not. More importantly, after adding more reliable cue words, this study found that 4-year-olds could also use syntactic cues to acquire novel verbs. Given that the 3-year-old group could not pass the task, this suggests that age 4 may represent the emergence of syntactic bootstrapping for verb acquisition in Mandarin-speaking children. Previous literature also suggests that grammatical knowledge is built upon a certain vocabulary foundation (Bates & Goodman, 2001); perhaps children only master sufficient vocabulary around age 4 to become more sensitive to syntactic knowledge. Conversely, syntactic knowledge development begins to facilitate novel lexical acquisition from this period onward. This aligns with previous researchers' claims that grammar and semantics exhibit mutual facilitation effects (Moyle et al., 2007; Caglar-Ryeng et al., 2019).

4.2 Influence of Mandarin Morphology on Children' s Verb Acquisition

This study found that morphological cues (e.g., word length) influenced lexical acquisition in children aged 3–4. Specifically, 4-year-olds more easily categorized monosyllabic words as verbs, whereas 3-year-olds under semantic cue conditions more readily categorized disyllabic words as nouns. Word length is a rather special grammatical cue in Mandarin. Early-acquired Mandarin verbs are primarily monosyllabic, while nouns are mainly polysyllabic (predominantly disyllabic) (Tan, 2008), and early-acquired verbs have shorter word lengths than nouns (Hao et al., 2015). Our findings indicate that children aged 4 and younger are sensitive to target word form. When target word length matches that of the word category they typically encounter, it facilitates lexical acquisition; when mismatched, it hinders acquisition. Previous studies (Imai et al., 2008; Ma et al., 2020) did not carefully examine this issue. Future research should match target word length and other lexical forms to make experimental materials more consistent with children' s authentic linguistic input.

4.3 Semantic Bootstrapping Effects in Mandarin

This study found that semantic cues can facilitate verb acquisition in 4-year-olds. Previous research on children' s verb acquisition mechanisms has primarily examined syntactic cues (Brown, 1957; Imai et al., 2005; Imai et al., 2008; Ma et al., 2020), with less attention to semantic cues. Some scholars propose that syntactic and semantic bootstrapping are closely connected, and that when understanding unfamiliar words, children combine syntactic cues with semantic cues to make guesses (Pinker, 1984; Gleitman, 1990; Fisher et al., 2020). Experiment 2a found that 4-year-olds could acquire verbs using the syntactic cue *zài* and the semantic cue *with hand*. Neuroscientific research indicates that younger children rely more heavily on semantic cues (Wagley & Both, 2021; Skeide & Friederici, 2016). Therefore, future research could further explore the role of other semantic cues in verb acquisition among younger children.

4.4 Specificity of Mandarin Lexical Acquisition Mechanisms

This study found that the specificity of Mandarin lexical acquisition mechanisms primarily manifests in morphological and syntactic cues, with greater specificity effects at younger ages. First, Mandarin word formation differs from alphabetic languages in the Indo-European family: Mandarin verbs are primarily monosyllabic, while nouns are mainly polysyllabic (predominantly disyllabic) (Tan, 2008). This study found that 4-year-olds more easily categorized monosyllabic words as verbs, and 3-year-olds under semantic cue conditions more readily recognized disyllabic words as nouns, while word length had no effect on 5-year-olds. This suggests that target word length may serve as a special cue for Mandarin-speaking children to distinguish word categories, with younger children being particularly sensitive to this cue. This result reminds us that research on Mandarin lexical acquisition should not merely follow Western theoretical approaches examining "syntactic bootstrapping effects" but should also attend to the influence of Mandarin morphological cues on lexical acquisition.

Second, the syntactic bootstrapping hypothesis originates from English, where Indo-European languages typically encode grammar through inflectional morphology (e.g., number, tense), resulting in sentences rich with cue words that children can exploit (Brown, 1957; Fisher & Gleitman, 2002; Shi & Lepage, 2008; Waxman et al., 2009). Unlike Western languages, Mandarin lacks determiners and morphological inflections. For convenience in cross-linguistic comparisons, previous research has used present progressive markers as lexical cues for verb acquisition: *zài* in Mandarin, *-teiru* in Japanese, and *-ing* in English (Imai et al., 2008). However, *zài* is not a stable verb marker in Mandarin. Ma et al. (2019) found through Mandarin child corpus research that *yòu* and *le* have higher co-occurrence probabilities with verbs. This study found that 4-year-olds could not acquire verbs through the syntactic cue *zài* but could successfully do so when the syntactic cue *yòu···le* was added. This demonstrates that cross-linguistic comparisons should consider not only cue word consistency but also the reliability of the cue in the target language. In summary, reliable cue words in English

may not be reliable in corresponding Mandarin expressions. This suggests that research on Mandarin lexical acquisition mechanisms should strengthen indigenous research, particularly for younger children. Future studies should also explore more Mandarin-specific cue words and examine the ability of children under 4 to acquire verbs using single syntactic cues.

In conclusion, this study found that 5-year-old Mandarin-speaking children can reliably use single syntactic cues to acquire verbs without being affected by target word form (e.g., word length), whereas children aged 4 and younger require multiple cues combining grammar and semantics to acquire novel words and are sensitive to target word form. This study suggests that lexical acquisition should attend not only to universal grammatical cues but also to language-specific cues in the native language and the reliability of those cues.

Under the conditions of this experiment, we draw the following conclusions: (1) Syntactic bootstrapping effects exist in Mandarin-speaking children aged 4–5. Syntactic cues reliably facilitate novel verb acquisition in 5-year-olds without being affected by target word form; when more reliable syntactic cues are added, 4-year-olds can also use syntactic information to acquire novel verbs. (2) For 4-year-olds who are not yet proficient with syntactic cues, supplementary semantic cues can also effectively facilitate verb acquisition, thus demonstrating "semantic bootstrapping effects." (3) Morphological cues affect part-of-speech judgments in Mandarin-speaking children aged 3–4: 4-year-olds more easily categorize monosyllabic words as verbs, whereas 3-year-olds under semantic conditions more readily categorize disyllabic words as nouns. Morphological and semantic factors jointly influence lexical acquisition in children aged 3–4.

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Yongxiang Chen: Conceptualized the research, designed the study protocol.
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Yongxiang Chen: Revised and finalized the manuscript.

Note: Figure translations are in progress. See original paper for figures.