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Interpretive constraints shape cue learning in early L2 sentence processing

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Abstract

This study examines how cue accessibility shapes both sentence comprehension and grammatical learning in children acquiring Japanese as a first (L1) or second language (L2). Adopting a good-enough processing framework, we propose that learners rely on the most accessible cue to construct a plausible interpretation, rather than integrating all available cues. We conducted two experiments on the interpretation of transitive sentences and the acquisition of case markers. Experiment 1 showed that Chinese-native children learning Japanese as an L2 relied on word order prior to acquiring case-marker knowledge, whereas Japanese monolingual children showed no reliable word-order bias. Experiment 2 showed that argument-omitted input facilitated case-marker learning, with a stronger effect for bilingual children. We argue that when word order yields a plausible interpretation, attention to case markers is reduced, whereas its failure promotes reliance on case markers and facilitates learning.

Keywords: early L2 learning; bilingual children; case markers; artificial language; cue weighting; good-enough processing

INTRODUCTION

In second language (L2) acquisition, learners must interpret sentences by integrating multiple linguistic cues such as word order and morphological case marking. A robust finding across typologically diverse languages is that learners initially rely on cues that are most accessible and most strongly entrenched in their first language (L1). For example, speakers of non-case-marking languages such as Mandarin Chinese tend to heavily rely on word order when interpreting transitive sentences in Japanese, whereas speakers of case-marking languages give greater weight to morphological cues (Bates & MacWhinney, 1989; Koda, 1993). Such differences are particularly pronounced in the early stages of L2 acquisition, when target-language cues are not yet reliably available for real-time interpretation.

Traditional cue-based accounts (i.e., Competition Model) explain these patterns in terms of cue validity, frequency, and learned cue weighting. On this view, learners gradually adjust cue strengths as they accumulate evidence from the input. However, this approach implicitly assumes that all available cues are equally considered during processing, and that learning primarily reflects long-term statistical optimization

over experience. By contrast, recent findings in sentence processing suggest that comprehension is often “good enough” rather than fully detailed: comprehenders may rely on a single highly accessible cue to construct a sufficiently plausible interpretation, without fully integrating all available information (Ferreira & Patson, 2007; Goldberg & Ferreira, 2022). Crucially, this finding raises a question that has not been fully addressed in acquisition research: what factors determine whether a cue is even engaged during learning in the first place?

We propose that cue learning is not solely determined by cue frequency or reliability in the input, but it critically depends on whether a cue is required for a successful real-time interpretation. Specifically, we argue that learners operate under a processing regime in which they first attempt to construct a “good-enough” interpretation using the most accessible cue. When this cue yields a sufficiently coherent interpretation, processing terminates early and alternative cues receive reduced attention. On the contrary, when the dominant cue fails to support a plausible interpretation, learners are forced to recruit additional linguistic information, thereby increasing the likelihood that lower-salience cues are processed and learned. This proposal directly links real-time sentence processing to long-term grammatical learning through a simple mechanism: learning is gated by interpretability under a default cue use. Under this view, cue reweighting arises not only from statistical exposure but also from differential engagement driven by processing success or failure during comprehension.

This study tests this hypothesis in Mandarin-speaking children learning Japanese as an L2, compared with Japanese monolingual children. This population provides a natural contrast between a word-order-dominant L1 (Mandarin) and a morphologically case-marking L2 (Japanese). Importantly, Japanese allows flexible word order while encoding grammatical roles primarily through case markers, whereas Mandarin chiefly relies on word order to encode thematic roles (Hakuta, 1982; Miao & Zhu, 1992). This typological contrast allows us to examine how learners shift between competing cues under different processing conditions.

We ask two key questions: Do L2 learners rely on word order as a default interpretive heuristic even in the absence of reliable case-marking knowledge? Does the success or failure of this heuristic determine whether learners subsequently acquire case markers?

To address these questions, we conducted two experiments using an artificial language paradigm. Experiment 1 examined baseline sentence interpretation in the absence of meaningful case markers, testing whether learners rely on word order as a default strategy under uncertainty. Experiment 2 investigated how children learn novel case markers under two different input conditions: a full-argument condition, in which word order is sufficient to assign thematic roles, and an argument-omitted condition, in which word order alone is insufficient, thereby forcing reliance on case marking.

Across both experiments, we tested a single core prediction: cue learning is facilitated not by exposure alone but also by situations in which default interpretive cues fail to yield a sufficiently informative interpretation, thereby triggering deeper processing of alternative cues. Together, these experiments aim to provide a processing-based account of cue reweighting in L2 acquisition, in which learning is shaped by the dynamics of real-time interpretation rather than input statistics alone.

EXPERIMENT 1

Word-order-based comprehension of transitive sentences

Experiment 1 investigated whether children rely on word-order information when comprehending transitive sentences prior to acquiring case-marker knowledge. Using an artificial language paradigm (Hudson Kam & Newport, 2005), the participants were presented with eight transitive sentences in an Object-*bi*-Subject-*po*-Verb (O-*bi*-S-*po*-V) order without any prior training or learning phase.

The syllables *bi* and *po* were novel and unfamiliar and carried no grammatical meaning for the children at the time of testing. Thus, the sentences consisted of familiar nouns followed by meaningless syllables, rather than interpretable case markers. Importantly, the participants were not trained on the O-*bi*-S-*po*-V structure; therefore, this experiment assesses baseline interpretation preferences rather than learning. Because all test sentences followed an O-*bi*-S-*po*-V order, reliance on word order would result in a first-noun-as-agent interpretation, whereas chance-level or inconsistent responses would indicate no systematic use of word-order cues. Any systematic interpretation bias observed in this task therefore reflects reliance on word-order information rather than case-marker knowledge.

Method

Participants

The participants included Japanese-speaking monolingual children and Chinese-native children learning Japanese as an L2. The Japanese monolingual group consisted of 20 four-year-olds ($M = 4;6$, range = 4;1–4;9); 19 five-year-olds ($M = 5;6$, range = 5;1–5;10); 18 six-year-olds ($M = 6;7$, range = 6;1–6;10); and 20 seven-year-olds ($M = 7;5$, range = 7;2–7;8). The L2 group consisted of 40 Chinese-native children (ages 6–10 years, $M = 8.4$) attending elementary schools in Japan, with a mean length of exposure to Japanese of 5.8 months. Children first exposed to Japanese at or after the age of three were classified as L2 learners, following previous work on early L2 exposure definitions (e.g., Hakuta, 1982).¹

Materials

The experiment employed artificial case markers to examine sentence comprehension in the absence of prior case-marker knowledge. Two non-lexical syllables, *po* and *bi*, served as artificial markers: *po* followed the subject noun and *bi* followed the object noun. Neither marker was explained to the children prior to testing.

The stimuli were constructed using four pairs of familiar animals (monkey–cow, lion–panda, tiger–elephant, rabbit–bear) and two transitive verbs (*osu* “push” and *tataku* “hit”) in the progressive form. Each animal alternated between agent and patient roles across events, and each sentence was paired with a corresponding video. Eight test events were created using the same animal pairs and two additional verbs (*hipparu* “pull” and *keru* “kick”), all presented in an O-*bi*-S-*po*-V word order. Each test sentence was paired with two videos depicting reversed agent–patient roles. Three filler sentences (S-*po*-O-*bi*-V, S-*po*-V, O-*bi*-V) were also included. All auditory stimuli were recorded by a female native speaker and audiovisually presented.

Procedures

The participants completed a sentence–picture matching task to assess their comprehension of O-*bi*-S-*po*-V sentences prior to any exposure to the meanings of the artificial case markers (see Figure 1). On each trial, the participants listened to a sentence while viewing two videos depicting the same action with reversed agent–patient roles, and they indicated the matching scene by pointing. This task assessed whether children relied on word-order information in the absence of case-marker knowledge.

¹ The age ranges differed between the monolingual and bilingual groups by design. For Japanese monolingual children, we focused on ages 4–7, a period widely recognized as critical for the development of case-marker knowledge in Japanese (e.g., Zhao et al., 2026). In contrast, for bilingual children, chronological age does not directly correspond to the developmental course of Japanese case-marker acquisition, which is more closely related to the onset

and amount of exposure to Japanese. Accordingly, the bilingual group consisted of children who began exposure to Japanese at or after age 3 and who had approximately 3 to 12 months of exposure at the time of testing. This period corresponds to the stage from initial comprehension of the nouns and verbs used in the experiment to the stage at which the basic meanings of case markers begin to emerge.

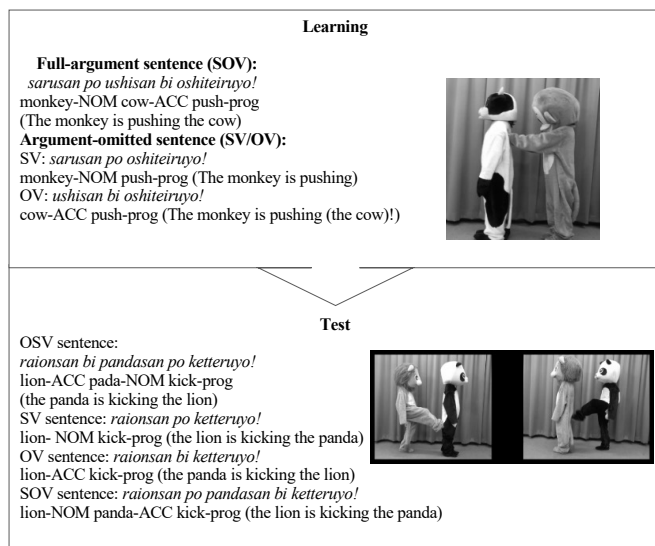


Figure 1: Flow of experiment using artificial case markers.

Analysis

A generalized linear mixed-effects model (GLMM) with a binomial link function was fitted to the data (Baayen et al., 2008). The dependent variable was response accuracy (correct = 1, incorrect = 0). Language Group (monolingual vs. bilingual) was included as a fixed effect, with random intercepts for participants and items. To control for potential age differences between groups, age (in years, treated as a continuous variable) was included as a covariate. The final model was specified as follows:

```
glmer(Accuracy ~ LanguageGroup + Age + (1 | subj)
+ (1 | item), family = binomial)
```

Results

Bilingual children showed performance well below chance (accuracy = 20%), indicating a strong tendency to interpret the first noun as the agent in O-bi-S-po-V sentences. By contrast, Japanese monolingual children performed at chance level (accuracy = 46%), suggesting no consistent reliance on word-order cues.

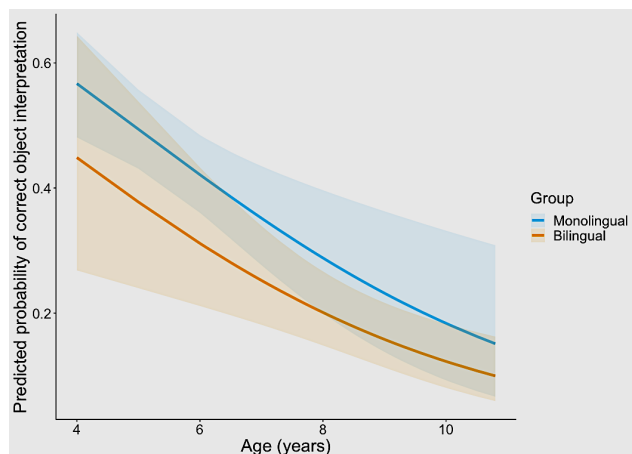


Figure 2: OSV sentence interpretation by language group.

To examine group differences while accounting for participant- and item-level variability, a GLMM was conducted. The analysis revealed a significant main effect of Language Group. As shown in Figure 2, the coefficient for the monolingual group was significantly negative ($\beta = -1.25$, $SE = 0.23$, $z = -5.32$, $p < .001$), indicating that Japanese monolingual children were significantly less likely than bilingual children to interpret the first noun as the agent. Importantly, this effect remained significant after controlling for age, indicating that the observed group difference cannot be explained by age differences between the groups.

Interim Discussion

The results of Experiment 1 revealed a clear divergence between groups: bilingual children showed a strong first-noun-as-agent bias, whereas monolingual children did not exhibit a reliable word-order preference in the absence of case-marker knowledge.

These findings suggest that L2 learners rely on a default word-order-based heuristic under uncertainty, consistent with a good-enough processing account. As no training was provided, this bias reflects an initial processing strategy rather than learned knowledge of the artificial grammar. By contrast, monolingual children did not systematically adopt this strategy, indicating that word-order cues alone are insufficient to guide interpretation in their case. Experiment 2 therefore examines how this initial reliance on word-order cues is modified through the acquisition of Japanese case markers.

EXPERIMENT 2

Acquisition of artificial case markers in Japanese transitive sentences

Experiment 2 investigated how children acquire the meanings of artificial case markers (*po* and *bi*) in Japanese transitive sentences, and whether learning is influenced by input type and language background. Building on Experiment 1, which revealed group differences in word-order use, Experiment 2 examined whether such differences shape subsequent case-marker learning.

The participants were exposed to sentences containing the artificial markers under two learning conditions: a full-argument condition (S-po-O-bi-V), in which both subject and object were overtly expressed, and an argument-omitted condition (S-po-V/ O-bi-V), in which either the subject or the object was omitted. Learning was assessed using the same O-bi-S-po-V test sentences as in Experiment 1.

Building on a good-enough processing account, we propose that learning depends on whether available cues are sufficient for role assignment during comprehension. In the full-argument condition, sentences contain two overt arguments, allowing learners to construct a sufficiently plausible interpretation based on word order, which reduces attention to case markers. On the contrary, in the argument-omitted condition, in which only one argument is overtly

expressed, word order alone is insufficient to assign thematic roles, forcing learners to rely on alternative cues such as case markers. This increased reliance is expected to facilitate learning.

Based on Experiment 1, we further predicted that this effect would be stronger for bilingual children, who showed a robust word-order-based heuristic, than for Japanese monolingual children, who did not exhibit a consistent reliance on word order.

Method

Participants

The participants included Japanese-speaking children and Chinese-native children learning Japanese as an L2. The Japanese monolingual group consisted of a sample distinct from that in Experiment 1 and included 28 four-year-olds ($M = 4;6$), 33 five-year-olds ($M = 5;6$), 28 six-year-olds ($M = 6;7$), and 22 seven-year-olds ($M = 7;5$), recruited from nurseries and elementary schools in Japan. The bilingual group comprised the same Chinese-native Japanese L2 children who participated in Experiment 1.

Materials

The experiment employed the same two non-lexical syllables, *po* and *bi*, as artificial case markers. In the artificial language, *po* followed the subject noun and *bi* followed the object noun. Neither marker was explained to the children prior to learning.

The learning stimuli consisted of two pairs of familiar animals (monkey–cow, rabbit–bear) and two transitive verbs (“*osu*” push and “*tataku*” punch) in the progressive tense. Eight learning events were constructed, with each animal appearing once as an agent and once as a patient.

During the learning phase, two sentence types were used: full-argument sentences with canonical SOV order (*S-po-O-bi-V*) and argument-omitted sentences in which either the subject (*O-bi-V*) or the object (*S-po-V*) was omitted. Each sentence was paired with a video depicting the corresponding action.

For the post-test phase, eight test events were created using two different animal pairs (lion–tiger, panda–elephant) and two additional transitive verbs (“*hipparu*” pull and “*keru*” kick). All test sentences followed an *O-bi-S-po-V* word order and were paired with two videos depicting reversed agent–patient assignments. Three filler sentences (*S-po-O-bi-V*, *S-po-V*, *O-bi-V*) were also included. All auditory stimuli were recorded by a female native speaker of Japanese and audiovisually presented.

Procedures

The participants first completed a learning phase, followed by a test phase. In the learning phase, they were randomly assigned to either a full-argument condition, in which only *S-po-O-bi-V* sentences were presented, or an argument-omitted condition, in which *O-bi-V* and *S-po-V* sentences were presented. Sentence–video pairs were presented twice, and exposure to the artificial case markers (*po* and *bi*) was matched across conditions. In the test phase, the participants completed the same sentence–picture matching task as in

Experiment 1, listening to *O-bi-S-po-V* test sentences and selecting the matching video (Figure 1).

Results

Experiment 2 examined whether children acquired the meanings of the artificial case markers *po* and *bi*, and whether learning differed as a function of learning condition (full-argument vs. argument-omitted) and language group (monolingual vs. bilingual). Test performance was analyzed using a GLMM with a binomial link function. Learning Condition, Language Group, and Age were entered as fixed effects, with random intercepts for participants and items.

```
glmer(Accuracy ~ Condition * Group + Age + (1 | subj) + (1 | item), family = binomial)
```

Crucially, the interaction between Learning Condition and Language Group was significant ($\beta = -1.12$, $SE = 0.51$, $z = -2.18$, $p = .029$), indicating that the effect of learning condition differed across groups. Specifically, the disadvantage of the full-argument condition was greater for bilingual children than for monolingual children.

Simple effects analyses showed that accuracy was higher in the argument-omitted condition than in the full-argument condition for both groups; importantly, this effect significantly differed across groups, as indicated by the interaction, with a larger effect for bilingual children (monolingual: $\beta = 1.22$, $p < .001$; bilingual: $\beta = 2.38$, $p < .001$). A main effect of Learning Condition was also observed ($\beta = -1.53$, $SE = 0.23$, $z = -6.77$, $p < .001$), reflecting higher overall accuracy in the argument-omitted condition. A significant effect of Age was found ($\beta = 0.31$, $SE = 0.10$, $z = 2.92$, $p = .004$), indicating improved performance with increasing age; importantly, the interaction between Learning Condition and Language Group remained significant after controlling for age. The main effect of Language Group was not significant ($p = .38$), indicating no overall group difference when collapsing across conditions.

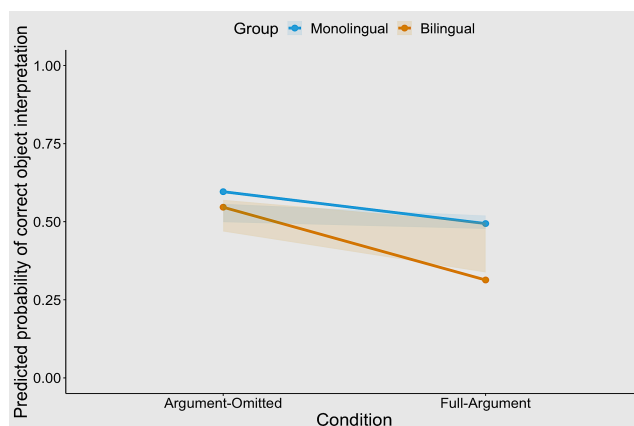


Figure 3: Accuracy in case markers learning across learning condition and language group.

Interpretation and Transition

The results of Experiment 2 showed that argument-omitted input facilitated case-marker learning, with a stronger effect for bilingual children. Together with Experiment 1, these findings suggest that bilingual children rely on a word-order-based heuristic that supports plausible interpretations in full-argument sentences, reducing attention to case markers. When this heuristic fails in argument-omitted sentences, learners rely on case markers, facilitating learning. This pattern is consistent with a good-enough processing account, in which learning is shaped by whether available cues succeed or fail during real-time processing.

GENERAL DISCUSSION

This study examined how children learning Japanese use linguistic cues in comprehending and acquiring transitive sentences. Experiment 1 showed that L2 learners relied on word order in the absence of case-marker knowledge, whereas monolingual children demonstrated no reliable bias. Experiment 2 showed that case-marker learning was facilitated by argument-omitted input, with a stronger effect for bilingual children. Together, these findings highlight the role of real-time interpretive constraints under a default cue use in shaping sentence interpretation and grammatical learning.

Differential use of word order in monolingual and bilingual children

The results of Experiment 1 revealed a clear difference between groups. Bilingual children showed a strong first-noun-as-agent bias, whereas monolingual children did not exhibit a consistent preference. This pattern is consistent with previous findings on L1 transfer, whereby learners rely on cues that are highly accessible in their first language (Bates & MacWhinney, 1989; Koda, 1993).

From a good-enough processing perspective, this suggests that bilingual children adopt a word-order-based heuristic because it provides a readily available basis for constructing a sufficiently plausible interpretation under a default interpretive processing. When case-marker information is unavailable or not yet accessible, learners rely on the most accessible cue to derive a good-enough interpretation. By contrast, monolingual children do not systematically rely on word order (e.g., Zhao et al., 2026). Rather than indicating weaker performance, this pattern suggests that these children do not treat word order alone as sufficient for constructing a good-enough interpretation under uncertainty. Thus, the groups differ not only in cue availability but also in what counts as a sufficiently informative interpretation under a default cue use.

Learning of case markers under different input conditions

Experiment 2 showed that argument-omitted input facilitated case-marker learning, with a stronger effect for bilingual children. This pattern follows from a good-enough processing account, in which learners rely on cues that are sufficient for a plausible interpretation under real-time processing constraints (Ferreira, 2003; Ferreira & Patson, 2007; Christianson et al., 2001).

In full-argument sentences, two overt arguments allow learners—particularly bilingual children—to construct a plausible interpretation based on word order alone. Because this satisfies a default interpretive processing, a deeper processing of alternative cues, such as case markers, is not engaged, reducing opportunities for learning, consistent with good-enough approaches to sentence processing (e.g., Goldberg & Ferreira, 2022). By contrast, in argument-omitted sentences, word-order-based heuristics cannot support role assignment. When initial interpretations fail to yield a sufficiently informative interpretation, learners must attend to additional cues, thus increasing reliance on case markers and facilitating learning. Crucially, these findings suggest that learning depends not simply on exposure but also on whether cues are required for a successful real-time interpretation under a default cue use.

Within cue-based accounts such as the Competition Model, cue competition arises not only from the relative reliability of cues but also from whether a cue is sufficient to support interpretation during processing. Integrating this with a good-enough processing account, the present results suggest that cue competition is mediated by real-time interpretive success: whether a cue is learned depends on whether it is required to construct a sufficiently informative interpretation during processing, consistent with cue competition accounts of learning (e.g., Rescorla & Wagner, 1972; Mackintosh, 1975).

Processing constraints and learning in L2 acquisition

The stronger effect observed in bilingual children naturally follows from this account. Because bilingual learners rely more heavily on word order as an accessible heuristic, they are more likely to construct good-enough interpretations under default processing conditions in full-argument sentences. This is consistent with evidence that L2 learners rely on shallow or heuristic-based processing strategies under limited processing resources (e.g., Clahsen & Felser, 2006). This reduces the need to engage with less accessible cues, such as case markers, thereby limiting opportunities for learning.

When this heuristic fails in argument-omitted sentences, bilingual learners must shift their attention to alternative cues. Such shifts in attention can trigger more detailed processing and facilitate learning. This shift is not driven by explicit learning strategies or increased exposure, but by the failure of an initially sufficient default interpretive strategy. As a

result, bilingual children show a larger learning effect when the dominant cue becomes insufficient. More broadly, these findings suggest that language learning is shaped by when real-time interpretive processing fails to yield a sufficiently informative interpretation, rather than by input frequency alone. Learners do not necessarily encode all available cues; instead, they selectively attend to those that are required to achieve a good-enough interpretation under processing constraints.

Implications for cue-based accounts

These findings have important implications for cue-based approaches to language acquisition, such as the Competition Model. Such frameworks emphasize input frequency and cue reliability (e.g., MacWhinney, 2005), but the present results suggest that these factors alone are insufficient to explain how cues are learned.

Cue reweighting may depend not only on frequency or reliability but on whether a cue is engaged during real-time interpretive processing under a default cue use. This idea is compatible with proposals that learning is mediated by attention and processing dynamics (e.g., Ellis, 2006). Cues not required for successful interpretation may receive limited attention, whereas those that become necessary may be learned more rapidly. Thus, cue competition is mediated by real-time processing: whether learners succeed or fail in constructing good-enough interpretations determines which cues are learned.

CONCLUSION

This study demonstrates that real-time processing constraints mediate the relationship between input and learning. Learners rely on the most accessible cues to construct good-enough interpretations, and they only engage alternative cues when necessary. As a result, learning is driven not simply by the presence of information in the input but also by whether that information is required to achieve successful comprehension.

More broadly, these findings highlight the importance of integrating processing-based accounts, such as good-enough processing, into language acquisition theories, suggesting that when learners process deeply is as important as what they are exposed to.

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