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Syntactic Cues for Inferences about Causality in Language Acquisition: Evidence from an Argument-Drop Language

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**ABSTRACT**

Syntactic bootstrapping facilitates children’s initial learning of verb meanings based on syntactic information. A challenging case is the argument-drop languages, where the number of argument NPs is not a reliable cue for distinguishing between transitive and intransitive verbs. Despite this fact, the availability of syntactic bootstrapping in Japanese (Matsuo et al., 2012) implies that case-marking particles play a role in the identification of a verb’s transitivity. This study investigates whether Japanese-speaking 2-year-olds infer the meaning of novel verbs using case-marking cues as well as typical transitive/intransitive frames. The results of the intermodal preferential looking paradigm showed that they made transitive-causative association, even when only a direct object marked with the accusative case was provided. This indicates that children can utilize case markers as cues to a verb’s transitivity. We suggest that all these discoveries provide support for the availability of syntactic bootstrapping in Japanese and its universality in language acquisition.

**Introduction**

At the onset of verb learning, children need help to focus on the particular aspects of the events that verbs describe, because verbs relate to ever-changing events and they often refer to only particular aspects of the events. Syntactic bootstrapping is considered to facilitate children’s initial learning of verb meanings based on syntactic information (Gleitman, 1990; Landau & Gleitman, 1985). Children make use of syntactic information, such as the number and position of argument noun phrases (NPs) in a sentence, which is usually captured as a syntactic frame, to guess the broad meaning of the verb used in the sentence. For example, causative meaning tends to be denoted by a transitive frame, whereas non-causative meaning tends to be denoted by an intransitive frame. Although there is no absolute correspondence between verb meanings and syntactic frames and it is impossible to determine the precise meaning of the verb, the syntactic frames act as a kind of “zoom lens” in directing the children’s attention to certain aspects of the event (Fisher, Gleitman, & Gleitman, 1991; Gleitman, 1990).

Empirical support for syntactic bootstrapping was first presented by Naigles (1990), who used an intermodal preferential looking (IPL) paradigm to demonstrate that English-speaking 25-month-olds can use syntactic frames to infer a causative/non-causative distinction. Her experiment consisted of two phases. In the training phase, children saw a combination of two different actions performed by two animal entities: one causative (e.g., a duck forced a rabbit into a bending position) and the other non-causative (e.g., a duck and a rabbit flexed their arms simultaneously). The children in the...
transitive condition heard a novel verb in the transitive frame as in (1), and those in the intransitive condition heard a novel verb in the intransitive frame as in (2).

(1) Look, the duck is gorping the bunny!
(2) Look, the duck and the bunny are gorping!

In the following test phase, the causative and non-causative action scenes were presented separately side by side, while the children were asked which action was denoted by the novel verb (“Where’s gorping?” or “Find gorping now!”). Naigles found that they looked preferentially at the causative scene for the transitive frame in (1) (NP-V-NP) and preferentially at the non-causative scene for the intransitive frame in (2) (NP-V), providing evidence that English-speaking 25-month-olds can use syntactic frames to infer verb meanings in terms of a causative/non-causative distinction.

Additional evidence has been supplied by a number of English studies that investigated the correspondence between transitive/intransitive frames and causative/non-causative meanings by using a variety of experimental methods (Arunachalam & Waxman, 2010; Hirsh-Pasek, Golinkoff, & Naigles, 1996; Kidd, Bavin, & Rhodes, 2001; Naigles & Kako, 1993; Noble, Rowland, & Pine, 2011; Yuan & Fisher, 2009). At the same time, a critical issue has emerged regarding the universality of syntactic bootstrapping. Previous studies on syntactic bootstrapping have been largely limited to English, in which syntactic frames are highly informative about a verb’s transitivity because argument NPs must be overtly expressed. On the other hand, in an argument-drop language such as Japanese, syntactic frames may not be a robust cue to transitivity because argument NPs can be dropped from a sentence. Despite this fact, Matsuo, Kita, Shinya, Wood, and Naigles (2012) reported that Japanese-speaking 28-month-olds were able to associate a transitive frame with causative events. This study is the first to reveal children’s syntactic bootstrapping in an argument-drop language by using novel verbs within the IPL paradigm. However, a crucial issue remains to be investigated. That is, what exactly is the cue to syntactic bootstrapping in Japanese? We will focus on the role of case-marking particles attached to argument NPs, and will examine whether young children can make use of this cue to capture syntactic frames and to infer verb meanings in Japanese. In doing so, we are also concerned with a methodological issue. Although traditional experiments on syntactic bootstrapping presented action events visually in the training phase when providing target sentences (e.g., Naigles, 1990), such a procedure was found to be unnecessary. Recently, Arunachalam and Waxman (2010), and Yuan and Fisher (2009) provided syntactic information alone in the absence of visual cues, and presented strong evidence that English-speaking 27- to 28-month-olds can infer verb meanings from syntactic information alone. Adapting this new methodology, which we call a “dialogue method”, we will investigate syntactic bootstrapping in Japanese.

**Syntactic bootstrapping in argument-drop languages**

Many experimental studies support the basic idea of syntactic bootstrapping (Arunachalam & Waxman, 2010; Hirsh-Pasek et al., 1996; Kidd et al., 2001; Naigles, 1990; Naigles & Kako, 1993; Noble et al., 2011; Yuan & Fisher, 2009). Virtually all of these studies observed that English-speaking 2-year-olds hearing a novel verb in a transitive frame looked longer at or pointed more often at the causative event than the equivalent group of children hearing a novel verb in an intransitive frame. These results indicate that children distinguish between transitive and intransitive verbs and associate transitive verbs with a causative event.

To better understand the nature of syntactic bootstrapping, recent investigations have addressed the issue of its universality. Of particular interest in this regard are argument-drop languages. In their studies of children’s verb learning in argument-drop languages, Göksun, Küntay and Naigles (2008) and Lee and Naigles (2008) examined Turkish-speaking 2- to 5-year-olds and Mandarin-speaking 2- and 3-year-olds, respectively. In an act-out comprehension task, the children were given intransitive verbs in a transitive frame and transitive verbs in an intransitive frame, and were then asked to act out the scenes using
puppets and props. The results showed that in both languages the children followed the syntactic frames for the interpretation of the sentences, and ignored the verb’s original transitivity. These findings indicate children’s sensitivity to syntactic frames even in the learning of argument-drop languages. However, it is impossible to make a direct comparison with the original IPL studies in English (Naigles, 1990) because the Turkish and Mandarin studies used familiar verbs in their act-out tasks, and their participants included older children.

More recently, Matsuo et al. (2012) investigated another argument-drop language, Japanese, in an IPL paradigm by using novel verbs. Using the same visual stimuli and procedure used by Naigles (1990), this study tested three sentence patterns: the transitive frame in (3), the intransitive frame in (4), and the transitive frame without case markers in (5).

(3) Ahiru-san-ga usagi-san-o neket-teru yo.
   duck-Mr.-Nom rabbit-Mr.-Acc Verb-Prog Pcl
   “The duck is x-ing the rabbit”

(4) Ahiru-san-to usagi-san-ga neket-teru yo.
   duck-Mr.-and rabbit-Mr.-Nom Verb-Prog Pcl
   “The duck and the rabbit are x-ing”

(5) Ahiru-san usagi-san neket-teru yo.
   duck-Mr. rabbit-Mr. Verb-Prog Pcl
   “The duck is x-ing the rabbit”

Their results showed that Japanese-speaking 28-month-olds associated the sentences provided in the transitive frame (3) with a causative event, but the other two types of sentences, shown in (4) and (5), were not associated with either a causative event or a non-causative event. On the basis of these results, Matsuo et al. proposed that Japanese-speaking 28-month-olds utilize the combination of the number of overt arguments and case markers to infer the meaning of novel verbs. It was found that children do not make use of the number of argument NPs alone as a cue to a verb’s transitivity because they do not associate the sentence in (5) with a causative event. On the other hand, it remains to be investigated whether case markers alone can be cues to a verb’s transitivity. Our study is concerned with this point.

Before presenting our experimental protocol, we describe some important properties of Japanese relevant to syntactic bootstrapping. In Japanese, all argument NPs appear pre-verbally, resulting in an SOV order as shown in (6). However, a subject and a direct object are not always visible due to argument drop. The sentences in (7) and (8) show examples of subject drop and direct object drop, respectively.

(6) Hideki-ga Yoko-o hometa yo.
    Hideki-Nom Yoko-Acc praised Pcl
    “Hideki praised Yoko.”

(7) Yoko-o hometa yo.
    Yoko-Acc praised Pcl

(8) Hideki-ga hometa yo.
    Hideki-Nom praised Pcl

A single argument NP comes before the verb in both sentences, resulting in an NP-V pattern. Thus, the positions of the argument NP cannot be a clue to identifying the grammatical relations. (7) is distinguished from (8) by the presence of case-marking particles attached to the argument NPs. Nominative -ga marks a subject, and accusative -o marks a direct object in the typical transitive structure, although they are sometimes omitted in colloquial speech. Thanks to these case-marking particles, it is possible to identify the subject and direct object of the sentences in (6)–(8), and to interpret these sentences correctly. Then, what happens if a sentence involves an unknown verb? This is certainly a situation that Japanese-speaking children are likely to encounter in their linguistic environment. In the current study, we use this situation as a testing ground for syntactic bootstrapping.
in Japanese. Our hypothesis based on syntactic bootstrapping predicts that the use of a case-marking pattern makes it possible to detect the transitivity of a novel verb and to infer its meaning.

**Aim of current study**

The current study used the IPL paradigm to investigate whether syntactic bootstrapping occurs in 2-year-old children learning an argument-drop language. Here, we use the term syntactic bootstrapping to refer to the utilization of grammatical properties, including the number and position of argument NPs and case-marking particles. The number and the position of argument NPs form basic frames or patterns such as NP-NP-V, and NP-V. Case-marking particles encode the grammatical relations of the argument NPs. To assess the extent to which Japanese-speaking children can use these syntactic cues to make inferences about the meanings of novel verbs, we use the following types of sentences in our experiment.

(9) Tomo-kun-ga Yuu-tyan-o nemat-teiru yo.
   Tomo-Mr.-Nom Yuu-Ms.-Acc verb-Prog Pcl
   “Tomo is x-ing Yuu.”

(10) Tomo-kun-to Yuu-tyan-ga nemat-teiru yo.
    Tomo-Mr.-and Yuu-Ms.-Nom verb-Prog Pcl
    “Tomo and Yuu are x-ing.”

(11) Yuu-tyan-o nemat-teiru yo.
    Yuu-Ms.-Acc verb-Prog Pcl
    “(Someone) is x-ing Yuu.”

The sentences in (9) and (10) are supposed to represent transitive and intransitive structures, respectively. These are the Japanese equivalents of the English sentences typically used in previous studies (e.g., Naigles, 1990), and similar to the test sentences used by Matsuo et al. (2012), as shown in (3) and (4). These sentences overtly express two human participants in a novel event described by *nemat-teiru*. The participants are a subject marked with nominative -*ga* and a direct object marked with -*o* in (9); therefore, the verb is transitive. In sentence (10), the first participant is marked with -*to* “and” and the second with nominative -*ga*. They make a conjoined subject of this sentence; therefore, the verb is likely to be intransitive. The sentence in (11), from which the subject is dropped, is the key sentence for examining whether children use case-marking cues to infer verb meanings. Although there is a single overt argument in this sentence, the verb used in this sentence is transitive because only a transitive verb subcategorizes a direct object marked with -*o*. In other words, if there is an -*o*-marked argument in a clause, the verb appearing in the clause is most likely to be transitive. In this sense, accusative -*o* can be an essential cue to a verb’s transitivity in Japanese. Note that nominative -*ga* tells us nothing about a verb’s transitivity, because both transitive and intransitive sentences can have a subject marked with -*ga*.

If syntactic bootstrapping occurs in Japanese-speaking children under the IPL paradigm, we should observe that the children associate the sentences in (9) and (11) with a causative event and associate the sentence in (10) with a non-causative event. We assume the following two-step procedures for successful syntactic bootstrapping. The first step is a language-particular process. Japanese-speaking children use case-marking particles to identify the transitivity of the verb used

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1. However, it is impossible to deny that the verb in sentence (10) can be transitive since Japanese allows object drop. In this case, the corresponding event scene should involve three participants (i.e., two conjoined-subject entities and one object entity).

2. Accusative -*o* is limited to marking a direct object in Japanese. However, -*o* is also used for adverbal phrases (Haig, 1981; Martin, 1975; Shibatani, 1977), in which case an intransitive verb can appear in a clause where -*o* is used. This indicates that there is no absolute correspondence between -*o* and a transitive verb as regards their appearance within a clause. However, this fact does not undermine our predictions in the current study because what is needed for children’s learning is not absolute correspondence but a strong tendency for -*o*-marked NP to appear with a transitive verb.
in the sentence. They must know that an accusative case marker is used to mark the direct object of a verb and that the verb is transitive. With English, this procedure is realized through the use of the number and position of overt arguments. Therefore, English-speaking children must be sensitive to the number of arguments and word order. The second step is to associate the verb’s transitivity with causality, namely to build the correspondences between transitive and causative, and intransitive and non-causative. Considering the strong tendency for causative events to be expressed by transitive verbs in many languages, we assume that this procedure is universal. Young children’s ability to associate a causative event with a transitive verb has already been evidenced in previous studies, including the Japanese study by Matsuo et al. (2012). So, the current study stresses the importance of the first-step procedure in the investigation of syntactic bootstrapping in Japanese.3

According to Rispoli (1995), the first-step procedure is unlikely in Japanese due to an input deficiency. In his observation data (Rispoli, 1991), he found only 7% of the caregivers’ utterances included accusative -o in the transitive sentences that involved only direct objects. Considering the high omission rate of argument NPs and case markers, Rispoli (1995) claims that Japanese-speaking 2-year-olds cannot use case-marking particles to guess the meaning of new verbs.4 In contrast, Suzuki (1999) argues against an input deficiency of case-marking particles in Japanese. He claims that there are two critical issues to be considered when calculating case-marker use/drop in parental input. One is that case-marker drop should be counted independently of argument drop. He suggests that only overt arguments should be regarded as the potential contexts for providing case-marking information, because there is no opportunity for children to receive case-marking information when argument NPs drop. Based on this idea, Suzuki demonstrates that a recalculaiton of Rispoli’s data (1991) for the overt use of accusative -o, for example, increases up to 15.2% of the time. The other issue is that case-marker drop should be distinguished from topic-marker drop or other types of particle drop because these types of non-case-marker drop are also frequently observed in Japanese. He suggests that researchers should set explicit criteria for this purpose. In this way, Morikawa (1989) demonstrated that the exclusion of topic-marker drop reveals a fair amount of case-marking particle use in parental input. Her data analysis shows that the accusative case marker was used for the direct object 35.1% of the time and it was dropped 64.9% of the time. As Suzuki (1999) suggests, we take these results as evidence that case-marking information in the input may not be deficient. This line of argument may lead us to predict that case-marking particles would influence syntactic processing on their own, independently of the number of argument NPs.

The current study also investigated the methodological issue of syntactic bootstrapping using the IPL paradigm. In the traditional procedure used for syntactic bootstrapping experiments, children are visually presented with action events while listening to target sentences during the learning phase (e.g., Naigles, 1990). However, the successful performance of syntactic bootstrapping has recently been reported even when syntactic information alone is provided in the absence of visual cues (Arunachalam & Waxman, 2010; Yuan & Fisher, 2009). In this dialogue method, English-speaking 2-year-olds saw only a two-woman dialogue scene. In this learning phase, they heard novel verbs embedded in a transitive or intransitive frame, and they associated a causative event with the transitive frame in the test phase. Given that the basic idea of syntactic bootstrapping is that syntactic information itself is informative about verb meanings (Gleitman, 1990; Landau & Gleitman, 1985), we believe that the dialogue method adequately discloses the effect of syntactic bootstrapping. Therefore, the current study used the dialogue method to investigate whether the effect of syntactic bootstrapping is observed just as in the case of the previous studies.

3The two-step procedure does not imply any developmental order. Our suggestion is totally based on a logical possibility. That is, without identifying a verb’s transitivity, there is no way to guess the verb’s (non-)causality.

4Matsuo et al. (2012) also analyzed parental input by using the Jun corpus of the CHILDES database (Ishii, 1999) and obtained results that were compatible with Rispoli’s observation. With regard to the accusative case marker, they found that the direct objects appeared with -o just over 6% of the time.
Method

Participants

Forty-eight Japanese-speaking children (24 girls and 24 boys) with a mean age of 27.6 months (range: 27.1–28.7 months) completed this study. Eight additional children were tested but excluded from the present analysis because they failed to accumulate a sufficient amount of time looking at the monitor in the baseline and test phases (see “Data Analysis” for details). All the children grew up in a monolingual environment where they learned Japanese as their native language. They were recruited from the Kyoto area. Parents completed the Japanese version of the MacArthur-Bates Communicative Development Inventory (CDI): Words and Grammar (Watamaki & Ogura, 2004). The mean productive vocabulary was 356.7 words (SD 137.6, range: 72–621).

Apparatus and stimuli

The children sat on their mothers’ laps in a dimly lit testing room (250 cm wide, 250 cm deep) facing a 40-in monitor about 150 cm away. Visual stimuli were presented on the monitor using Microsoft PowerPoint installed on a Macintosh G4 computer. Audio stimuli were presented through a speaker located under the monitor behind black curtains. A digital video camera was placed behind a small opening in the black curtains, and about 3 cm below the monitor. The camera was connected to a 20-in monitor and a digital video recorder to record the direction of the children’s eye fixation and to allow an experimenter in an adjacent room to observe the children’s behaviors.

Audio-visual stimuli were created for the dialogue scene in which two Japanese-speaking women engaged in conversation with natural gestures in a soundproof booth. Visual stimuli were recorded for causative and non-causative scenes in which a man and a woman engaged in novel actions. The audio stimuli were also recorded in the soundproof booth. Then, the visual and audio stimuli were combined using movie-editing software.

Design and procedure

The participants were randomly assigned to a Transitive SOV condition (N = 16), a Transitive OV condition (N = 16), and an Intransitive SV condition (N = 16). Within each condition, they were randomly assigned one of two novel verbs (nemaru or wageru). The two verbs were used to confirm that a particular verb form does not affect children’s looking performance. A session consisted of a dialogue phase, a baseline phase, and a test phase. The children took part in two consecutive sessions to investigate whether their looking performance was consistent and stable across the two sessions.

Dialogue phase

In the dialogue phase, the children saw a color video clip of two women engaged in conversation (Figure 1). The dialogue video appeared in the center of the monitor (26.1 cm high, 46.3 cm wide). Table 1 shows the dialogues in the three conditions. The children in the Transitive SVO condition heard the sentence in (15), where both a subject and an object are overtly expressed. The children in the Intransitive SV condition heard the novel verb embedded in conjoined-subject sentence frames in (16). In the Transitive OV condition, the children heard the sentence in (17), where only a direct object is used. However, since an agent of a novel action must be mentioned at least once to make the conversation natural, we used a subject in the form of S + verb at the beginning of the dialogue, as shown in Table 1. It should be noted here that this utterance does not tell children whether the verb used in this condition is intransitive or transitive. As mentioned before, an S + verb pattern is ambiguous in that the verb can be intransitive with an overt subject or the verb can be transitive with an overt subject and a null object. Thus, it is an accusative case marker that provides the information about verb’s transitivity, and the children must refer to the accusative case to make inferences about causality. Novel verbs were used with aspectual markers -te iru (progressive) and -ta
(perfective) to make the conversation natural and authentic. In addition, aspectual markers ensure that the novel words used with them are verbs because their use is limited to verbs, whereas tense markers are compatible with both verbs and adjectives in Japanese. Each trial consisted of a 17-s dialogue including the novel verb in four sentences. The children saw the same video clip three times in succession. At the end of each trial, the scene was blank for 3 s before the next trial began.

(15) Tomo-kun ga Yuu-tyan o nemat-teiru /waget-teiru yo.
Tomo-Mr.-Nom Yuu-Ms.-Acc verb-Prog Pcl
“Tomo is x-ing Yuu.”

(16) Tomo-kun to Yuu-tyan-ga nemat-teiru /waget-teiru yo.
Tomo-Mr.-and Yuu-Ms.-Nom verb-Prog Pcl
“Tomo and Yuu are x-ing.”

(17) Yuu-tyan-o nemat-teiru /waget-teiru yo.
Yuu-Ms.-Acc verb-Prog Pcl
“(Tomo) is x-ing Yuu.”
Following the dialogue phase, the children underwent two baseline trials. Each trial lasted 12 s. While the children in each condition were watching two side-by-side video clips, they also heard an arousal phrase such as *Mite-mite!* (“Look!”). As shown in Figure 2, one video clip showed a causative scene in which a man spun a woman around on a chair, and the other showed a synchronous non-causative scene in which the same man and woman each waved a hand in circles. Each clip was 39.2 cm wide by 22.1 cm high. The two clips were shown with a space of 10 cm. We chose this action pair because Arunachalam and Waxman (2010) used the same action pair to provide clear evidence that 2-year-olds can infer verb meanings from syntactic frames alone in English.

The children were given two test trials in which they watched two side-by-side clips, while hearing a sentence in (18).

(18) Nemat-teiru/Waget-teiru no dotti.
verb-Prog Noml which
“Which is X-ing?”

We predicted that if the children were able to infer the meaning of the novel verb that they heard during the dialogue phase, the children in the Transitive SOV and the Transitive OV conditions would look longer at the causative scene in the test trials than in the baseline, and those in the Intransitive SV condition would look shorter at the causative scene in the test trials than in the baseline. Each test trial lasted 12 s. At the end of each trial, the scene became blank for 1.5 s before the next trial began. The left-right position of each video clip was randomized in a predetermined order.

Data analysis

A coder who was not informed of the experimental design and conditions undertook offline frame-by-frame coding (30 frames/s) from a video recording to calculate the proportion of children’s looking times to either the left or the right scene over total time looking at both scenes during the baseline and test trials. The exclusion criterion was that the child spent less than 50% of the time looking at each scene in each trial during the baseline and the test phases. All children who met this criterion were excluded from the present analysis. To assess data reliability, a different coder undertook the offline coding of a random selection of about 20% of the primary sample. The inter-coder correlations were high (mean = .97). We calculated the mean proportion of time spent looking at the causative scene in each of the two baseline and two test trials.
Results

The results are shown in Figure 3. The mean proportion of looking times to the causative scene was analyzed with a mixed-design ANOVA with Condition (Transitive SOV, Transitive OV, Intransitive SV) and Word type (nemaru, wageru) as between-subjects factors, and Phase (baseline, test) and Trial block (first, second) as within-subjects factors. The analysis revealed a significant main effect of Condition, $F(2, 42) = 11.152, p < .001, \eta_p^2 = .347$, and a significant interaction between Condition and Phase, $F(2, 42) = 16.772, p < .001, \eta_p^2 = .444$. No other main effects or interactions were significant.

To further examine the significant interaction between Condition and Phase, a series of analyses with a Bonferroni correction was performed. The results indicated that the children in the Transitive SOV condition looked significantly longer at the causative scene in the test trials ($M = 66.1\%, SD = 11.2$) than in the baseline ($M = 56.4\%, SD = 10.6$), $F(1, 42) = 10.586, p = .002, \eta_p^2 = .201$. Those in the Transitive OV condition also looked significantly longer at the causative scene in the test trials ($M = 61.8\%, SD = 8.9$) than in the baseline ($M = 53.4\%, SD = 8.4$), $F(1, 42) = 8.045, p = .007, \eta_p^2 = .161$. These results suggest that the 27-month-olds were able to associate the transitive frames with the causative scenes regardless of whether the frames had full overt arguments (i.e., SOV) or not (i.e., OV). In contrast, the children in the Intransitive SV condition looked significantly shorter at the causative scene in the test trials ($M = 42.5\%, SD = 14.8$) than in the baseline trials ($M = 54.4\%, SD = 13.7$), $F(1, 42) = 16.314, p < .001, \eta_p^2 = .280$. That is, they looked significantly longer at the non-causative scene in the test trials than that in the baseline trials.

Furthermore, a direct comparison of the test phase between conditions with a Bonferroni correction showed that the children in the Transitive SOV and the Transitive OV conditions looked significantly longer at the causative scene than the children in the Intransitive SV conditions ($ps < .001$). On the other hand, there was no significant difference in their looking times of the causative scene between the Transitive SOV and the Transitive OV condition ($p > .05$). These results suggest that the 27-month-olds successfully discriminated between transitive and intransitive frames, and that they equally identified transitive verbs in the SOV and OV frames. Also, a direct comparison of the baseline phase with a Bonferroni correction revealed no significant differences between conditions ($ps > .05$). This is because the children...
in all conditions looked similarly at the causative scene without hearing target verbs in particular frames.

Additionally, we conducted one-sample t-tests to compare the children’s preference for looking at the causative scene with a 50% chance level. The results showed that they looked significantly longer at the causative scene than chance in the Transitive SOV condition \((t[15] = 7.868, p < .001)\) and in the Transitive OV conditions \((t[15] = 7.219, p < .001)\). In contrast, those in the Intransitive SV condition looked significantly shorter at the causative scene (or longer at the non-causative scene) than chance \((t[15] = -2.453, p = .027)\). These results suggest that in all conditions the children demonstrated a significant preference for the target scenes.

**Discussion**

The results clearly indicate the availability of syntactic bootstrapping in children learning Japanese as a first language. Japanese-speaking 27-month-olds were able to associate a novel verb heard in a transitive frame with a causative event and a novel verb heard in an intransitive frame with a non-causative event within the IPL paradigm that adopted the dialogue method. These findings are consistent with the results reported by Naigles (1990), which is the original study of syntactic bootstrapping in English, and its Japanese replication by Matsuo et al. (2012). The current findings provided additional support for the universality of syntactic bootstrapping.

The results show that Japanese-speaking 2-year-olds can make use of case-marking particles as cues to syntactic bootstrapping. We have suggested a two-step procedure for successful syntactic bootstrapping in Japanese: the first step is to use a case-marking cue to identify the verb’s transitivity (i.e., a language-particular process), and the second step is to associate the verb’s transitivity with causality (i.e., a universal process). Thanks to case-marking particles attached to argument NPs in a sentence, children can identify the grammatical relations of the argument NPs (i.e., a subject or a direct object) and the verb’s transitivity. At 27 months of age, this first-step procedure operates in Japanese language learning as the children are already sensitive to these grammatical aspects of Japanese.

Nevertheless, one may argue against the first-step procedure due to the fact that two participants in the causative event correspond with agent and patient roles in the order that they were mentioned in a sentence (e.g., Bever, 1970; Gertner & Fisher, 2012). If this is true, Japanese-speaking children would use word order as a cue in the Transitive SOV condition. However, a contradictory view has already been offered by Matsuo et al. (2012), who found that Japanese-speaking 2-year-olds showed no preference for the causative event when the transitive SOV sentences were provided without case markers. This implies that Japanese-speaking children are sensitive to the existence of case markers and that they use case-marking cues at least partially for syntactic bootstrapping. Moreover, children’s success in associating a causative event with the sentences in the Transitive OV condition in the current study suggests that they certainly refer to case-marking particles. It should be remembered that the number of argument NPs is not a reliable cue to a verb’s transitivity in an argument-drop language. So, a single-argument sentence, an O + verb pattern does not provide any information about the verb’s transitivity unless children process the accusative case. Therefore, the successful association of a novel verb in the Transitive OV condition with a causative event indicates the operation of the first-step procedure.

One may also wonder why 2-year-old children were able to use case-marking cues despite the scant use of case-marking particles in parental input. The results of Matsuo et al. (2012) suggest that case-marking cues are necessary for children to infer verb meanings, but neither Rispoli (1995) nor Matsuo et al. (2012) considered that case-marking particles alone could cause syntactic bootstrapping in Japanese. Their argument was based on the input deficiency of case markers. However, we have mentioned above that there is a possibility that the case-marking information in the input may not be deficient, if case-marker drop, argument drop, and topic-marker drop are appropriately taken into consideration (Suzuki, 1999). From this viewpoint, Japanese-speaking
children are given adequate opportunities to learn case, and their early production of case-marking particles indicates their sensitivity to Japanese case. It is well known that case-marking particles emerge in children’s spontaneous utterances at around age 2. In terms of accusative -o, for example, two longitudinal studies of Japanese-speaking children reported that it appeared in a child’s utterance at 2;3 (Nagano, 1959) and 1;8 (Okubo, 1967). These observations suggest that children at the age of 27 months are sufficiently sensitive to produce case-marking particles; therefore, it is not strange at all that they are ready to use case-marking information to identify a verb’s transitivity.

A remaining issue to be discussed here includes the correspondence between intransitive and non-causative. As in Naigles’ original experiment, the present study observed that children in the Intransitive SV condition looked significantly shorter at the causative scene in the test trials than in the baseline trials. This suggests that Japanese-speaking children associate a novel verb used in a conjoined-subject sentence with a non-causative event. However, this suggestion may be controversial when we consider that the majority of English studies failed to observe 2-year-olds’ making an association between an intransitive verb and a non-causative event (e.g., Arunachalam & Waxman, 2010; Hirsh-Pasek et al., 1996; Naigles & Kako, 1993; Yuan & Fisher, 2009). This difficulty is, at least in part, rooted in the use of the conjoined-subject sentences. A conjoined-subject sentence, which has an [NP and NP + V] pattern in English, is assumed to depict a non-causative event in typical experimental settings, but this may also be compatible with a causative event in the real world. For example, Pozzan, Gleitman, and Trueswell (2016) point out that smiling, playing, and having fun can be causative, but these joint activities can be denoted by intransitive verbs in a conjoined-subject sentence. They suggest that this depiction indeterminacy is a source of difficulty in the conjoined-subject sentence.

On the other hand, Gertner and Fisher (2012) claim that the sentence representations of younger children (21-month-olds) are only partial. They further suggest that younger children are likely to take two consecutive nouns in a subject position as agent and patient without referring to the sentence structure of the conjoined-subject sentence. This suggestion is compatible with the results provided by Noble et al. (2011), where children at the age of 3;4 successfully associated a conjoined-subject sentence with a non-causative event but younger children performed at chance level.

Both Pozzan et al. (2016) and Gertner and Fisher (2012) provided a partial evidence for their proposals in English, but it is unclear whether or not their suggestions are applicable to Japanese. Conversely, our Japanese participants had no problem in associating an intransitive verb used in a conjoined-subject sentence with a non-causative event. Then, a question arises as to whether or not their performance truly reflects the first-step procedure of syntactic bootstrapping in Japanese. Our claim is that Japanese-speaking 2-year-olds surely use case-marking cues in conjoined-subject sentences, but an alternative explanation is also plausible. One such view is that Japanese-speaking children may refer to conjunctive -to “and” to select the event scene. Since a non-causative event depicts a synchronic action by two participants, this event may easily be associated with the two NPs connected by the conjunction. If this is true, they do not have to refer to the structural properties of the conjoined-subject sentence. However, since this account also applies to English, English-speaking children should have performed as well as Japanese-speaking children. Is there any reason to think only Japanese-speaking children are greatly helped by the conjunction? Unlike the English conjunction and, Japanese -to is a bound morpheme just like other particles such as nominative -ga and accusative -o, and it cannot be dropped. Since Japanese-speaking children were found to be sensitive to these case-marking particles, they may also be sensitive to conjunctive particle -to and may use it as a clue to the interpretation of a conjoined-subject sentence. The early acquisition of -to is also suggestive in the Japanese database that includes a vocabulary-checklist survey of 1699 parents (Minami & Kobayashi, 2013). The database estimates that 50% of children produce conjunctive particle -to at 25 months. In contrast, a similar English CDI database from Wordbank estimates that 50% of children produced conjunction and at 27 months (e.g., Frank, Braginsky, Yurovsky, & Marchman, in press; Jørgensen, Dale, Bleses, & Fenson, 2010). This contrast may partially be reflected in the experimental studies that examined the conjoined-subject sentences. This stipulation
is not empirically supported by the current study, although it cannot at this point be denied. Future study may reveal the effect of conjunctive -to, independently of the children’s syntactic knowledge about the conjoined-subject sentence in Japanese.

We are also concerned with the results provided by Matsuo et al. (2012) in that children did not associate an intransitive verb and a non-causative event. This leads to the last issue, which has to do with methodology. As evidenced by the results of the present and previous studies, the dialogue method taps children's syntactic bootstrapping in ideal ways. The absence of visual cues in the learning phase makes it possible to directly examine children’s sensitivity to syntactic information that is provided through audio stimuli. Since there are no visual cues in the learning phase, children do not have to decode complex action events and then associate the verb with a certain aspect of the events, as required by traditional studies using the observation method (e.g., Naigles, 1990). In this sense, the dialogue method reduces the burden on the children’s cognitive processes when perceiving and classifying visual events in a complex scene. In addition, the use of the dialogue method would make it possible to avoid the possible effect of causative bias. In the learning phase of the traditional observation method, children try to extract certain aspects of events and then associate them with the given verb. In this process, a causative bias may affect children’s performance. This is because in general children may tend to refer to a causative event rather than to a non-causative event (e.g., Brooks & Tomasello, 1999; Fisher, 1996; Fisher, Hall, Rakowitz, & Gleitman, 1994; Naigles & Kako, 1993). If this happens, children find a causative event more easily accessible than a non-causative event, which may produce favorable results for the transitive-causative association in the observation method. On the other hand, this never happens in the dialogue method, simply because there is no visual information in the learning phase. Now, returning to the different results in Matsuo et al. (2012) and in the present study regarding the association between intransitive and non-causative, we consider the possibility that the methodological differences are responsible for the different results. Their study adopted the traditional observation method, whereas ours employed the dialogue method, and only the latter is free from causative bias. Thus, the present study may have revealed Japanese-speaking children’s ability to associate intransitive with non-causative.

In summary, the present study using the IPL paradigm with the dialogue method demonstrated that 2-year-old Japanese-speaking children can associate an intransitive frame with a non-causative event as well as a transitive frame with a causative event. The results provide additional support for the work of Matsuo et al. (2012). Furthermore, the present study also provides the first evidence that case-marking particles work for syntactic bootstrapping in Japanese. While the first-step procedure of using a case-marking cue is a language-particular process, the second-step procedure is common to both argument drop and non-argument drop languages. As reported in previous studies, and also supported by the results of the present study, all children have the propensity to associate transitive verbs with causative events. This part of verb learning is potentially a universal aspect of syntactic bootstrapping. Altogether, we suggest that children may take different paths to verb learning depending on the language they are exposed to, but there is a way of learning verb meanings from syntactic cues in all languages.

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\footnote{However, as one of the reviewers pointed out, we must acknowledge that the mixed findings and arguments on the interpretation of a conjoined-subject sentence in the previous studies suggest that our interpretation might not be supported in future studies.}
References


