# Children’s Comprehension of Two-Level Possessives in Japanese and English

**Diego Guerrero, Terue Nakato, Joonkoo Park, and Thomas Roeper**

## 1. Background

Previous studies showed that in languages in which possessives are morphologically marked, children understand one-level possessive sentences (1-POSS) at 4 years old, and two (2-POSS) and three-level possessive sentences (3-POSS) at 6 years old (Hollebrandse & Roeper 2014; Li et al. 2020; Pérez-Leroux et al. 2012; Roeper & Snyder 2005; Roeper 2011; Terunuma & Nakato 2018; Terunuma et al. 2017). In Japanese, four-year-old children tend to understand 2-POSS (Terunuma & Nakato 2018; Terunuma et al. 2017). In Mandarin, 4-year-old children understand 1-POSS (Li et al. 2020). Six-year-old Mandarin-speaking children understand sentences with 2 and 3-POSS (Li et al. 2020). These studies used possessive relationships such as kinship (e.g., *Midori's father* in Terunuma and Nakato's study) or ownership (e.g., *Robot's lion* in Li et al’s study), which are represented implicitly using visual cues. We argue that these cues could be partly responsible for an early children's comprehension of recursive possessives (A. Pérez-Leroux et al. 2020).

### 1.1. Potential sources of noise in previous studies

In Li et al. (2020), the characters' position has one-to-one correspondence with the serial position in the sentence used to evaluate the comprehension (see Fig. 1). The type of item used could facilitate the children's performance. Each item contained two sets of characters that are linked for leashes and collars (see Fig. 1). The figures presented in each set have the same identities (i.e., In Fig. 1, the nouns cookie, snake, lion, and robot), but its spatial position is different. In the correct answer, the character's spatial position has one-to-one correspondence with the serial position in the sentence used to evaluate the comprehension. For example, if the researcher asks the child, "*Could you give a leaf to the robot's lion's snake's cookie*" the series of nouns (i.e., robot lion snake cookie) only have one-to-one correspondence with the set on the top (Fig. 1 top). The other set does not have the same pattern (Fig. 1 bottom). We claim that this stimuli’s characteristic helps trigger children's correct answers because they could follow

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 *Proceedings of the 45th annual Boston University Conference on Language Development*, ed. Danielle Dionne and Lee-Ann Vidal Covas, 259-275. Somerville, MA: Cascadilla Press.

the series of nouns as well as comprehending the recursive structure of the sentences. In Terunuma and Nakato (2018), the possessor has spatial proximity with the possessed (e.g., *Midori's father's* is next to *Midori*, see Fig 2). Additionally, in this item there is one-to-one correspondence between the possessor and the possessed. The top row corresponds to the possessor and the bottom row corresponds to possessed. For example, *Midori's father's dog* is below to *Midori's father*, and *Midori's dog* is below to *Midori* (see Fig 2).

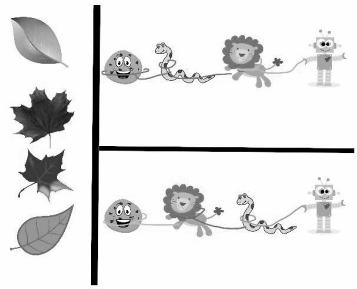

**Figure 1. Example of stimuli used in Li et al. (2020)**

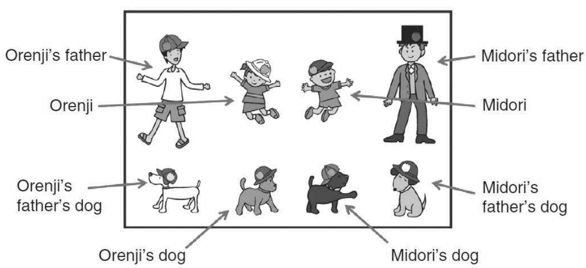


**Figure 2. Example of stimuli used in Terunuma and Nakato (2018)**

A second factor that could impact children's comprehension of the recursive possessives is the characters' identity. For example, in Terunuma and Nakato's question "*What color is Orenji's hat's flower?*" there is no ambiguity about the possessor's identity. In Figure 2, only one element in the stimuli have the property to be Orenji, and the capacity to identify it rests in short-term memory. This feature could bias the child's answer to one specific object (i.e., Orenji's hat's flower) but does not necessarily indicate that he/she has a full comprehension of the possessive relations between the elements in the question.

A third factor that could be a potential source of noise is the character's animacy. Storbeck and Kaiser (2020) found that the character's animacy influences the performance in possessive's production. They showed that adults tend to mention more frequently animate objects in a sentence-continuation task than inanimate objects when they completed the sentences. These results suggest that the objects' animacy category in the sentence could affect the recursive possessives' production.

From the perspective of general capacities, Working Memory (WM) could be a factor that facilitates the performance in recursive possessive task. Arslan, Hohenberger, and Verbrugge (2017) provided an essential piece of evidence about the relationship between WM and categorical recursion. They showed that 4- to 8-year-old children with a higher span in a Verbal WM task tend to obtain higher scores when they were evaluated in a second-order relative clauses task. These elements suggest that WM is a general capacity that must be controlled to understand the acquisition of categorical recursion.

This study aims to explore children's comprehension of possessives when spatial cues, semantic bias, and domain-general capacities are controlled. The items in the task include three choices with three identical animate characters in the same spatial position but representing conjunctive or recursive relationships (see Fig. 3). In addition, children's WM span was tested in the current study.

## 2. Experiment

### 2.1. Participants

#### 2.1.1. English-Speaking participants

Forty-five children participated in the experiment (mean age = 6 years; 6 months, range = 3 years 10 months – 9 years 2 months). All were fluent native monolingual English speakers recruited from the Massachusetts area. Most of the children belonged to middle-class families. Participants were recruited and tested at museums in the state of Massachusetts; at least, one caregiver accompanied all children. No participant had any history of speaking or hearing difficulties or cognitive impairment.

#### 2.1.2. Japanese-Speaking participants

Forty-one monolingual Japanese-speaking children were tested (mean age 7 years; 9 months, range = 6 years 8 months – 8 years 9 months). All were fluent native monolingual Japanese speakers recruited in Kanagawa. Most of the children belonged to middle-class families. Participants were tested at an after-school day care center in Kanagawa prefecture; at least, one caregiver accompanied all children. No participant had any history of speaking or hearing difficulties or cognitive impairment.

### 2.2. Procedure and tasks

All the participants in both languages were tested in a possessive task and a WM task. In the possessive task, 16 items were presented to each child. In the WM task, the digit backward protocol was used.

#### 2.2.1. Possessive task

In this task, leashes and collars were used to represent the possessor-possessee relationship (see Fig. 3). Half of the items evaluate 2-POSS, and the remaining half evaluate conjunctive possessives. In each item, three sets with identical characters in the same spatial position were presented. Each item included two incorrect sets. One set represented the same type of structure (e.g., if the item evaluated was a 2-POSS, this incorrect set represented an incorrect 2-POSS relationship). The second set represented a different structure (e.g., if the item evaluated was a 2-POSS, the incorrect set represented incorrect conjunction).

Fig 3A is an example of the 2-POSS items (*Please give the banana to the dog's cat's duck*). All sets have three characters (dog, cat, and duck) in the same spatial position. In the incorrect 2-POSS set (right one in Fig 3A), leashes connected the characters in the direction opposite to the correct one (e.g., *duck's cat's dog as opposed to dog's cat's duck*). In the incorrect conjunctive set (left one), the relationship among characters represented the same sequence as the target (e.g., *dog's and cat's duck*).

Fig 3B is an example of the conjunctive items (*Please give the banana to the dog's and cat's duck*). In the incorrect 2-POSS set (left one in 3B), the leashes connected the characters in the order matching with the input word order (e.g., *cat's dog's duck for 'cat's and dog's duck'*). In the incorrect conjunctive set (right one in 3B), the relationship among characters represented joint ownership, but did not match the input (e.g., *dog's and duck's cat for 'cat's and dog's duck'*). The correct answers in each condition quantified children's comprehension of recursion and conjunction.

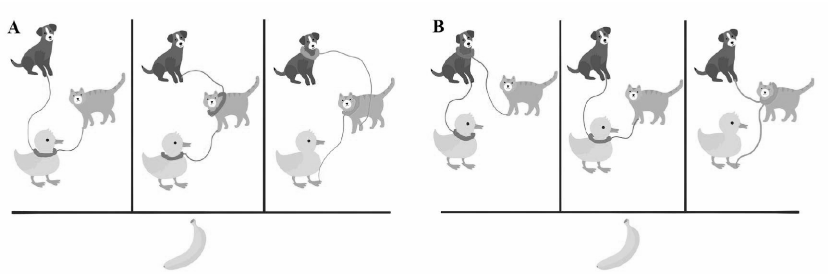


**Figure 3. Examples of the items used in this study to evaluate 2-POSS (A) and conjunction (B)**

### 2.2.2. Digit span backwards

In the digit backward task, children repeated a sequence of digits dictated by the researcher in a backward order. Children were tested on three lists, each with length 2 (e.g., 8 – 3, 5 – 4, and 2 – 7). If the children got at least two out of the three lists correct, the researcher proceeded to the next set's lists (e.g., 8 – 2 – 9, 6 – 8 – 7, and 8 – 7 – 1). The procedure continued until the children got two or more lists wrong from the set of three. The digits were read in an even tone, approximately at a rate of one digit per second.

## 2.3. Results

The results showed that the relationship between variables varies according to the children's language (see Fig 4). In Japanese-speaking children, 2-POSS score showed a positive correlation with age ($r(41) = .4$, $p < .05$), WM span ($r(41) =.4$, $p <.05$), and Conjunction score ($r(41) = .42$, $p < .05$). Conjunction score did not show a relationship either with age or WM span.

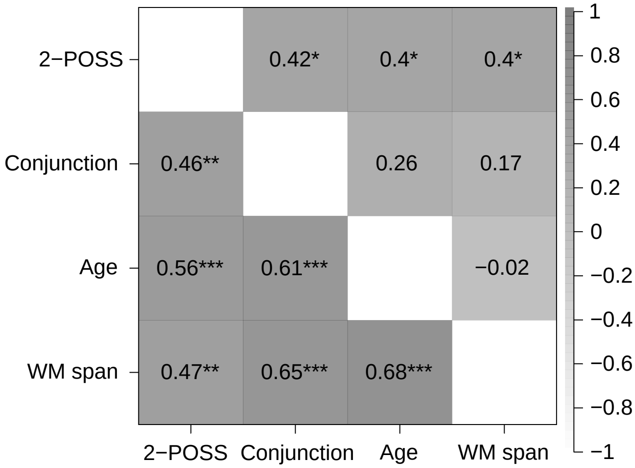


**Figure 4. Correlation between children's 2-POSS score (2-POSS), Conjunction score (Conjunction), age, and WM span. Numbers in the squares represent Pearson correlation coefficient. The entries above the main diagonal correspond to Japanese-speaking children, and the elements below the main diagonal to English-speaking children. P-values ***<.001, **<.01, *<.05.**

However, the Pearson correlation results indicated a significant and high positive association between all the variables in English-speaking children. These results suggest that the relationship between the scores in the possessive tasks and the control variables (i.e., age and WM span) behave differently in English and Japanese-speaking children. Therefore, the following inferential analysis were conducted independently for each language.

### 2.3.1. English Speaking children

A simple linear regression analysis was used to explore the relationship between children's age and WM span. Results indicated that there was a linear relationship between age and WM score ($F(1, 43) = 36.46$, $p < .01$, Adj. $R^2 = .45$).

Four regression models were conducted to analyze the relationship between children's age, WM span, and 2-POSS/Conjunction scores. Two simple linear regression analyses were used to explore the relationship between children's age and 2-POSS score and Conjunction score (see Fig 5). The results indicated that there was a significant effect between age and 2-POSS score ($F(1, 43) = 19.84$, $p < .01$, Adj. $R^2 = .30$), and between age and Conjunction score ($F(1, 43) = 25.02$, $p < .01$, Adj. $R^2 = .35$).

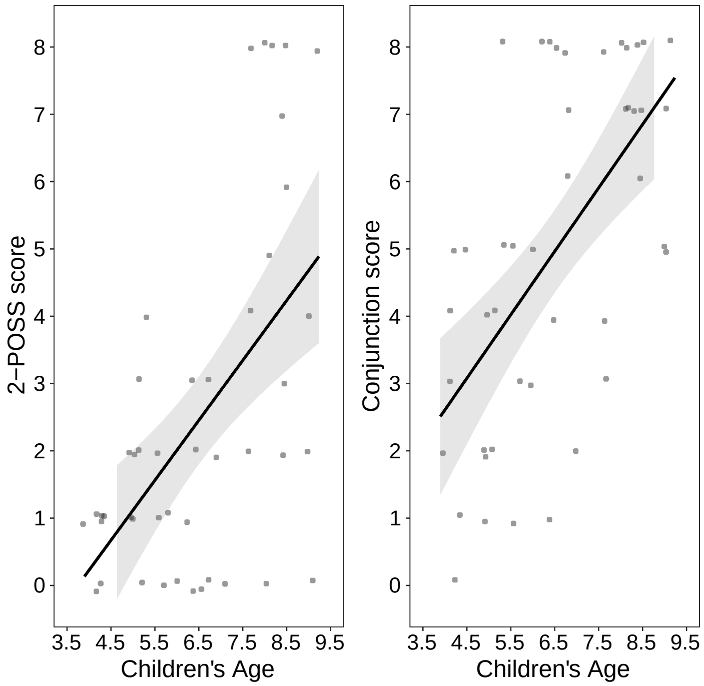


**Figure 5. Linear relationship between English-speaking children's age and possessive task**

Two additional models were tested to evaluate if the effect of age remained significant when WM span was included in the model (see Fig. 6). The results indicated that there was a significant collective effect between age, WM span and 2-POSS score ($F(2, 42) = 10.42$, $p < .01$, Adj. $R^2 = .30$). The only significant predictor of the model was age ($\beta = 0.71, t = 2.60, p = .01$). The comparison between the simple (i.e., children's age as a predictor) and the multiple models (i.e., children's age and WM span as predictors) showed that WM span's inclusion did not improve the model.

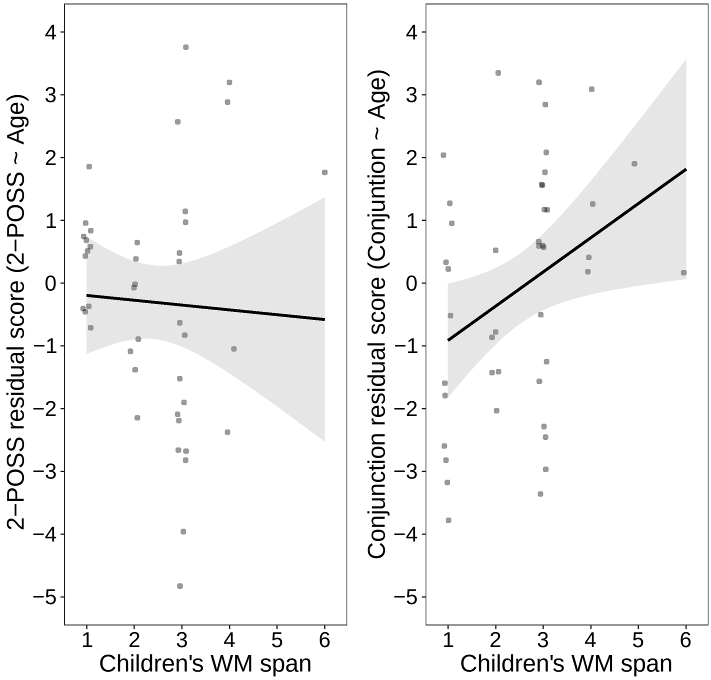


**Figure 6. Linear relationship between English-speaking children's residuals and WM span. The y-axis represents the residuals of the regression models 2-POSS score ~ Age (Left) and Conjunction score ~ Age (Right).**

Similarly, a significant collective effect between age, WM span and Conjunction score was found ($F(2, 42) = 18.82$, $p < .01$, Adj. $R^2 = .45$). In this model, age ($\beta = 0.48, t = 2.02, p = .05$) and WM span ($\beta = 0.94, t = 2.89, p = .01$) were significant predictors. The comparison between the simple (i.e., children's age as a predictor) and the multiple models (i.e., children's age and WM span as predictors) showed that the inclusion of WM span did improve the model ($p<.001$).

### 2.3.2. Japanese Speaking children

The same four analyses were conducted for the Japanese-speaking children. Two simple linear regression analyses were used to explore the relationship between children's age and 2-POSS score and Conjunction score (see Fig 7). The results indicated that there was a significant effect between age and 2-POSS score (F(1, 39) = 7.41, p = .01, Adj. $R^2$ = .14), but not between age and Conjunction score (p = .1).

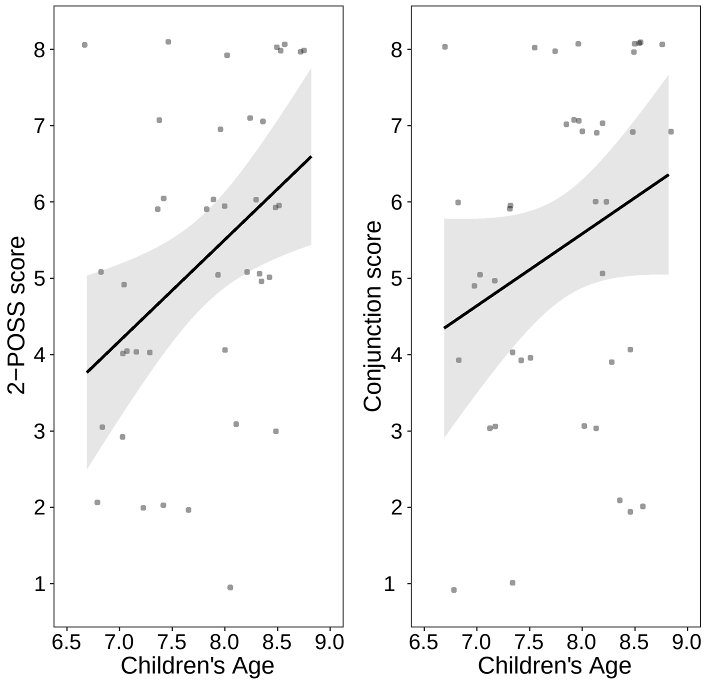


**Figure 7. Linear relationship between Japanese-speaking children's age and possessives task**

Two additional models were tested to evaluate if the effect of age remained significant when WM span was included in the model (see Fig.8). The results indicated that there was a significant collective effect between age, WM span and 2-POSS score (F(2, 38) = 9.19, p < .01, Adj. $R^2$ = .29). Age ($\beta = 1.35,\ t = 3.05, p < .01$) and WM span ($\beta = 1.21,\ t = 3.06, p < .01$) were significant predictors of the model. The comparison between the simple (i.e., Children's age as a predictor) and the multiple models (i.e., Children's age and WM span as predictors) showed that the inclusion of WM span did improve the model (p < .001).

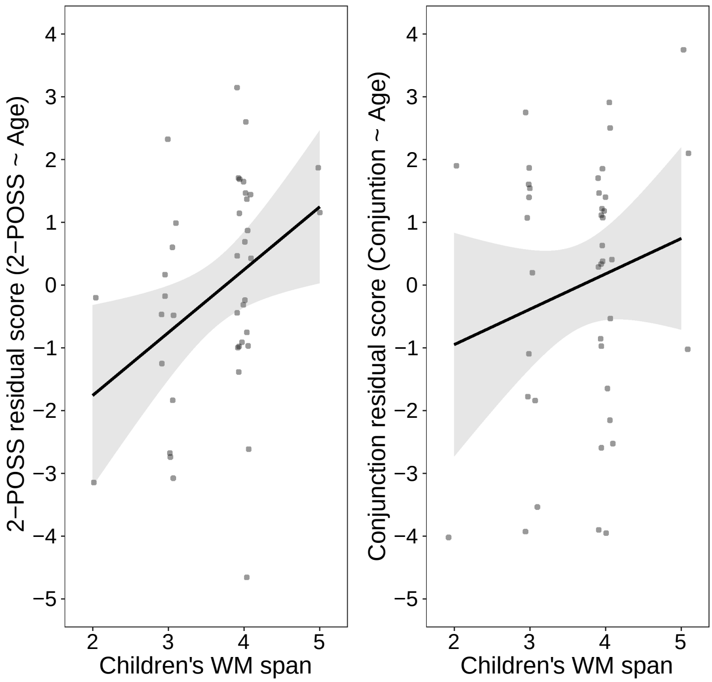


**Figure 8. Linear relationship between Japanese-speaking children's residuals and WM span. The y-axis represents the residuals of the regression models 2-POSS score ~ Age (Left) and Conjunction score ~ Age (Right).**

A significant collective effect between age, WM span and Conjunction score was not found ($F(2, 38) = 2.13$, $p = .13$, Adj. $R^2 = .05$). In this model, neither age nor WM span were significant predictors. The comparison between the simple (i.e., children's age as a predictor) and the multiple models (i.e., children's age and WM span as predictors) indicated that WM span did not improve the model.

## 2.4. Children's answers

### 2.4.1. Children's character selection

Correct answers in the possessive tasks are composed of two key elements. The first element corresponds to the character selection; children must point out the third character in the sentence. For example, in the item "*Please give the banana to the dog's cat's duck*", the child must give the banana to the "duck." The second element corresponds to the correct set. In each item, there is one correct set and two incorrect ones. Following this analysis of the items' structure, below we describe children choices in the possessive tasks.

The results showed (see Fig. 9) that children's behavior in character selection tends to be similar between possessive tasks for each language. Japanese-speaking children frequently selected the third character even when they failed in both possessive tasks.

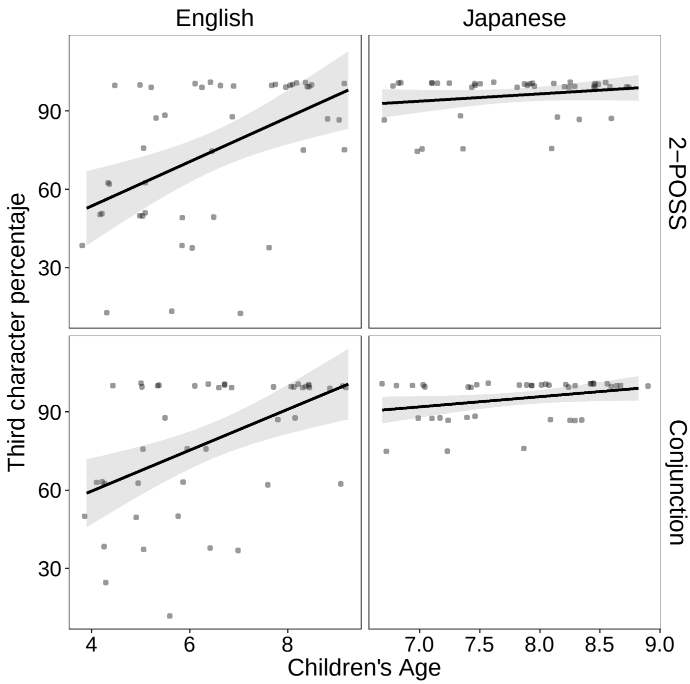


**Figure 9. Children's character selection. Each dot represents a child. The left panel show English-speaking children's performance, and the right one Japanese-speaking children's performance. The y-axis represents the percentage in which the child selects the third character in any of the sets (i.e., correct or incorrect).**

Multiple linear regression analysis was used to explore the relationship between the percentage of third character selection and age, WM span, and possessive task (2-POSS, Conjunction). In Japanese-speaking children there was not a significant collective effect between the age, WM span, and possessive task and percentage ($F(3, 78) = 2.33$, $p = .08$, Adj. $R^2 = .05$). The only significant predictor of the model was children's age ($\beta = 3.38, t = 2.38, p < .05$). These results suggest that neither WM span nor possessive task influenced children's selection of the third character.

The same analysis was conducted for English-speaking children. The results showed that the model was significant ($F(3, 86) = 13.27$, $p < .01$, Adj. $R^2 = .29$). The individual predictors were examined further and indicated that age $(\beta = 4.10, t = 2.02, p = .05)$ and WM span $(\beta = 8.24, t = 2.78, p < .01)$ were significant predictors in the model. These results suggest that WM span and age influence children's selection of the third character.

### 2.4.2. Children's set and character selection in Conjunction task

In the figures 10, 11, 12, and 13, the columns represent the child's character selection (i.e., First, Second, and Third correspond to the noun's position in the possessive expression). The rows represent the set selected by the child. In Figures 10 and 11, in the incorrect 2-POSS set (2-POSS), leashes connect the characters to match the input word order. In the incorrect conjunctive set (Conjunction I), the relationship among characters represents joint ownership but does not match the input (e.g., *dog's and duck's cat* for *'cat's and dog's duck'*). In the correct set, the relationship among characters represents joint ownership and matches the input.

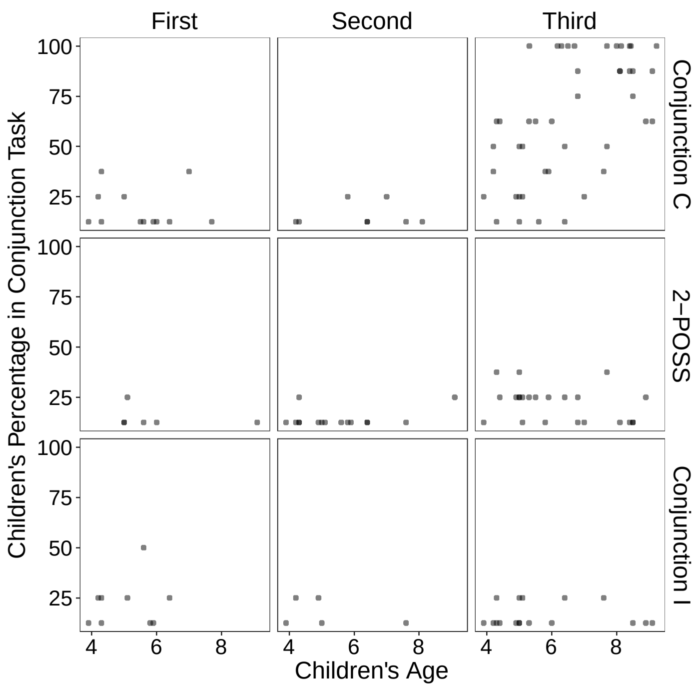


**Figure 10. English-speaking children's selection of the set and character in the conjunction task. The dots represent the child's percentage of his/her selection. A child could have 75% in Conjunction C and third character (Top-right), and 25% in 2-POSS and third character (Middle-right).**

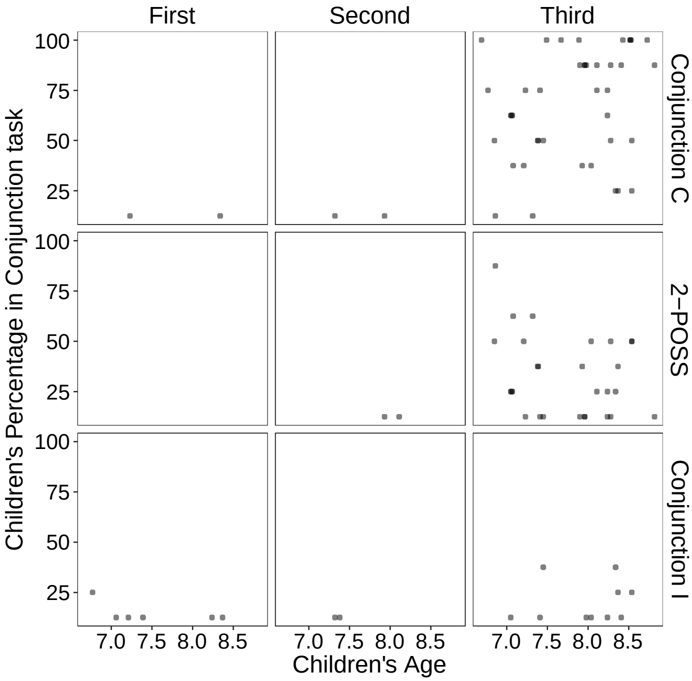


**Figure 11. Japanese-speaking children's selection of the set and character in the conjunction task**

In this task, English-speaking children tended to choose the third character (see Fig. 10). When they failed to choose the correct conjunctive set, they did not prefer the incorrect 2-POSS set (2-POSS) or the incorrect conjunction (Conjunction I). Similarly, Japanese-speaking children tended to choose the third character (see Fig. 11). However, when they failed, some children chose the third character in the incorrect 2-POSS set (2-POSS).

### 2.4.3. Children's set and character selection in 2-POSS task

In Figures 12 and 13, in the incorrect 2-POSS set (2-POSS I), leashes connect the characters in the direction opposite to the correct one (e.g., *duck's cat's dog* as opposed to *dog's cat's duck*). In the incorrect conjunctive set (Conjunction I), the relationship among characters represents the same sequence as the target (e.g., *dog's and cat's duck* for '*dog's cat's duck*').

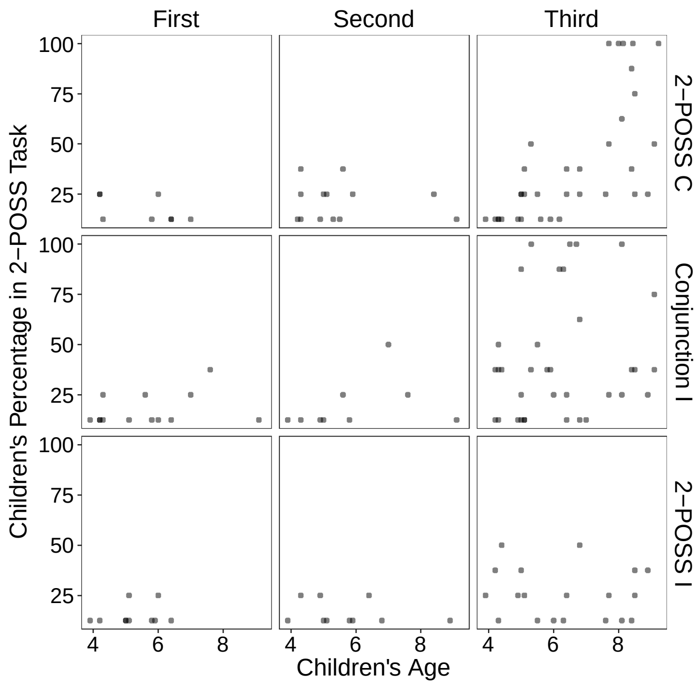


**Figure 12. English-speaking children's selection of the set and character in the 2-POSS task**

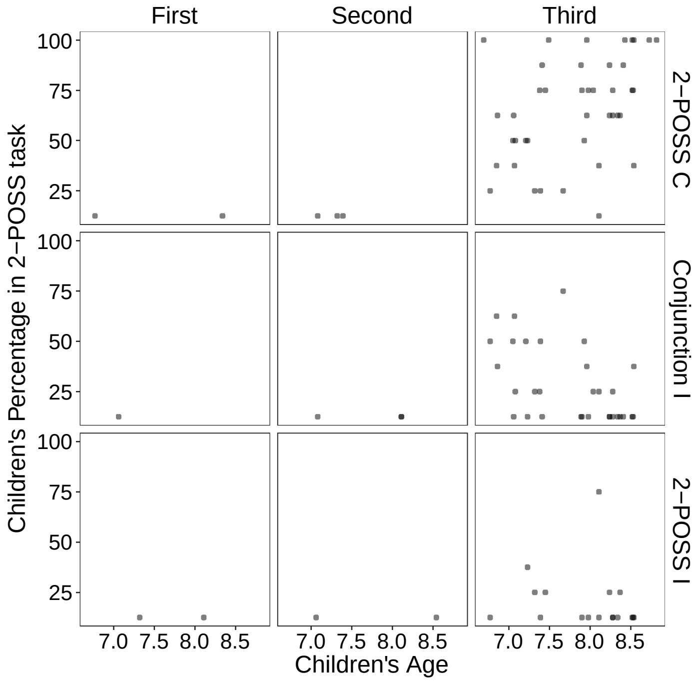


**Figure 13. Japanese-speaking children's selection of the set and character in the 2-POSS task**

In the 2-POSS task, English-speaking children younger than 7 years old tended to choose the third character in the incorrect conjunction set (Conjunction I in Fig. 12). Children older than 7-years old tend to choose the third character in the correct set (2-POSS C). Japanese-speaking children tend to choose the third character in the correct set (2-POSS C). However, when they fail, these children tend to choose the third character in the incorrect conjunctive set (Conjunction I in Fig. 13).

## 2.5. Language comparison

The results showed (see Fig. 14 left panel) that children tend to obtain more correct answers in the conjunction task (English: 4.96, Japanese: 5.41) than in the 2-POSS task (English: 2.94, Japanese: 5.26). However, the mean age is different between groups. English-speaking children older than 6 years and 8 months were selected to compare a group with a similar age to Japanese speaking-children (see Fig 14 right panel). Twenty children with a mean age of 8 years 0 months were selected. The results showed that these English-speaking children tend to have a mean Conjunction score (6.45) higher than the Japanese-speaking children (5.41). In 2-POSS, Japanese speaking children (5.26) tend to obtain a higher score than the English-speaking children selected (4.00).

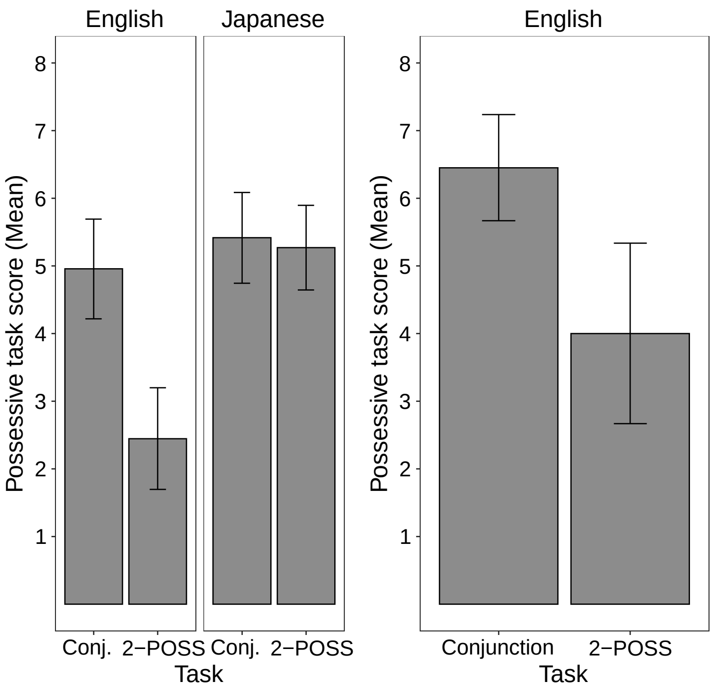


**Figure 14. Possessive task scores. The left panel represents the English and Japanese-speaking children's mean scores in the Conjunction and 2-POSS tasks. The right panel represents the English-speaking children's older than 6 years and 8 months. The whiskers showed a 1.96*standard error.**

## 3. Discussion

Previous studies about children's comprehension of recursive possessives showed that children at 6-years old understand at least 2-POSS. Li et al. (2020) found that 6 years old Mandarin-speaking children tend to understand 2- and 3-POSS, and Terunuma and Nakato (2018) showed that 4 years old Japanese-speaking children understand 2-POSS. However, in this study, most children in both languages (English and Japanese) did not consistently understand two-level recursive possessives (2-POSS) until 7 years of age. This delay could be explained by the current paradigm, which minimizes semantic and visual cues. For example, Li et al.'s experimental paradigm includes items in which the characters' spatial position has a one-to-one correspondence with the characters' serial position in the sentence used. Similarly, in Terunuma and Nakato's experimental paradigm, the human possessor has a one-to-one correspondence with the dog possessed.

The differences between this study and previous studies in 2-POSS comprehension indicate that young children use all cues available around them when they learn the recursive-possessive syntax. Children's comprehension of the recursive possessives is not stable or established enough like in adults. Maybe to solve a task without clues, children need an abstract syntactic structure, which is autonomous and not affected by any other factors.

In the Conjunction task, children tend to choose the correct answer earlier than in the 2-POSS task. Additionally, the results show that when the children fail in the 2-POSS task, they tend to choose the set representing a conjunctive relationship between characters. These results could suggest that children in an early stage avoid a recursive structure.

The analysis of the impact of WM in children's performance showed differences between languages. In English, WM span was not a significant predictor for the 2-POSS score, but it was for the Conjunction score. In Japanese, the inverse relationship was found: WM span was a significant predictor for the 2-POSS score but not for the Conjunction score.

The main factor that could explain the differences between languages in children's WM is the age differences between groups. Half of the English-speaking children are younger than the youngest Japanese-speaking child (6.6-year-old). Additionally, most of the English-speaking children have a WM span of 3 or less (only 4 children have a span of 4, and 1 child have 6), on the contrary, most of the Japanese-speaking children have a WM span of 3 or more (only 2 children have span of 2).

In conjunction, the increment in WM span from 1 to 3 results in an increment in the Conjunction score in English-speaking children. However, in Japanese-speaking children, the increment in WM span from 3 to 5 does not influence the Conjunction score. This behavior suggests that understanding the conjunctive structure requires a Working Memory capacity to manipulate two items (i.e., WM span of 3). In recursion, the capacity to manipulate two items (i.e., WM span of 3) could be necessary but sufficient to understand the recursive possessive structure.

The exploration of children's answers showed that Japanese-speaking children tend to select the third character even when choosing the incorrect set. For this group, neither WM span nor possessive task influence children's selection. In English-speaking children, the results showed that the third character selection increase as a function of age and the WM span but not as a function of the possessive task. These results suggest that children tend to search the sentences' head without distinguishing each structure's particularities.

Japanese-speaking children performed the recursion task more consistently at a younger age than English-speaking children. English-speaking children around at the same age performed the conjunction task more consistently than 2-POSS task. These results suggest that language-specific properties could influence children's comprehension of recursion and conjunction.

In conclusion this evidence suggests an intricate interaction of general memory properties and the process in which a speaker seeks visual pragmatic confirmation of linguistic structures.

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# Proceedings of the 45th annual Boston University Conference on Language Development

edited by Danielle Dionne
and Lee-Ann Vidal Covas

Cascadilla Press Somerville, MA 2021

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ISSN 1080-692X
ISBN 978-1-57473-067-8 (2 volume set, paperback)

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