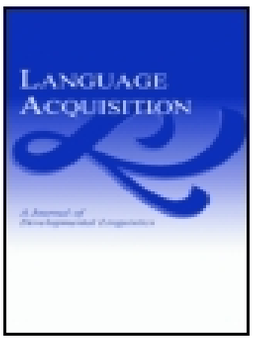

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Japanese children's knowledge of the locality of *zibun* and *kare*

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ABSTRACT

Although the Japanese reflexive *zibun* can be bound both locally and across clause boundaries, the third-person pronoun *kare* cannot take a local antecedent. These are properties that children need to learn about their language, but we show that the direct evidence of the binding possibilities of *zibun* is sparse and the evidence of *kare* is absent in speech to children, leading us to ask about children's knowledge. We show that children, unlike adults, incorrectly reject the long-distance antecedent for *zibun*, and while being able to access this antecedent for a non-local pronoun *kare*, they consistently reject the local antecedent for this pronoun. These results suggest that children's lack of matrix readings for *zibun* is not due to their understanding of discourse context but the properties of their language understanding.

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1. Introduction

Reflexive pronouns show a restricted distribution across languages (Koster & Reuland 1991; inter alia). They must have antecedents in the same sentence, and those antecedents are typically restricted in where they can occur. In English, for example, the antecedent of a reflexive must occur in the smallest clause containing the reflexive (1) (Chomsky 1973).

(1) a. *Mary$_i$ left. Herself$_i$ looked unhappy.

b. Mary$_i$ saw herself$_i$.

c. *Mary$_i$ said John saw herself$_i$.

In Japanese, the antecedent of a reflexive *zibun* must be a subject, but it can be any subject in the same sentence, no matter how many clause boundaries intervene (2) (Inoue 1976; Kuno 1987; inter alia).

(2) a. Akira$_i$-ga zibun$_i$-ni penki-wo nut-ta.

Akira-NOM zibun-DAT paint(noun)-ACC paint(verb)-PAST
'Akira painted self.'

b. Taro$_i$-wa Akira$_j$-ga zibun$_{i/j}$-ni penki-wo nut-ta to omot-ta.

Taro-TOP Akira-NOM zibun-DAT paint-ACC paint-PAST COMP think-PAST
'Taro thought that Akira painted self.'

In addition to its anaphoric use, the reflexive *zibun* can also be used indexically as a first- and second-person pronoun as in (3).

(3) a. Zibun-ga shi-masu.
zibun-NOM do-FORMAL

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'I'll do it.'

b. Zibun-ga suru-no?
zibun-NOM do-Q
'Do you do it?'

Non-reflexive pronouns also display restrictions on where their antecedents can be found. Whereas English reflexive pronouns are in roughly complementary distribution with non-reflexive pronouns, the Japanese *kare* displays locality effects that are independent of the behavior of *zibun*. Although the Japanese reflexive *zibun* can be bound both locally and across clause boundaries, the third-person pronoun *kare* 'he' generally cannot take a local antecedent as in (4) (a local reading is possible given appropriate contexts (e.g., Hoji 1995)).[1]

(4) a.*Taro$_i$-ga kare$_i$-ni penki-wo nut-ta.
Taro-NOM kare-DAT paint-ACC paint-PAST
'Taro painted him.'

b. Taro$_i$-wa Akira$_j$-ga kare$_{i/*j}$-ni penki-wo nut-ta to omot-ta.
Taro-TOP Akira-NOM he-DAT paint-ACC paint-PAST COMP think-PAST
'Taro thought that Akira painted him.'

Given this variation in locality domains both across and within languages, it follows that learners must identify the locality domain for each pronoun on the basis of their experience with their language. Orita et al. (2013) propose that learners can identify the domain of anaphora for some element X if they have access to three pieces of information: (i) whether X is anaphoric, (ii) the structure of the sentences X occurs in, and (iii) an estimate of the sentence meaning based on the context. With these three pieces of information, a learner will be able to hone in on the likely locality domain for X. The computational modeling in Orita et al. (2013) showed that this learning proposal is feasible if learners can access partial information about the interpretations of the sentences and the syntactic environment of that target anaphoric expression. However, this article shows that information (ii), the structure of sentences that X occurs in, would be difficult for children to obtain in Japanese because their input does not reflect the full distribution of binding possibilities. In other words, there is a mismatch between what the learning model needs and what children actually receive from the input.

To determine whether this lack of evidence in children's input poses a challenge for the learning model, it would be important to first identify when children know the domain of anaphora. To determine the age at which this learning procedure is complete or what intermediate stages of knowledge the learner passes through, this study examines Japanese children's knowledge of the locality of *zibun* and *kare*. In particular, we ask whether Japanese children know that *zibun* can take both a local and long-distance antecedent and that *kare* cannot take a local antecedent.

We first show that in speech to children, the direct evidence of the binding possibilities of *zibun* is sparse, where the most frequent use of *zibun* is as a second-person pronoun, and the evidence of *kare* is absent. The distribution of *zibun* may cause difficulties for the learner because there is no use of *zibun* that takes a long-distance antecedent in any person. This data sparsity problem leads us to ask when learners can learn the locality of different anaphoric expressions that do not appear to occur in the input.

Prior work using the Truth-Value Judgment task (Crain & Thornton 1998) has argued that children have knowledge of long-distance *zibun* (Okabe 2008; Otsu 1997). However, as we will discuss, those

[1]The pronoun *kare* is also stylistically conditioned: It cannot be used to refer to social superiors or young children (Noguchi 1997). Historically, it had been used as a non-first-person pronoun back in the medieval period (Li 2002), and later it has been used as a translated counterpart of the third-person pronouns in European languages (Hirota 1969).

studies had methodological biases that could lead children to accept the long-distance antecedent even if it were not grammatically licensed. In the case of *kare*, as far as we are aware, it has not yet been examined whether children know the locality of this pronoun. Thus, it is important to examine whether children know the locality of *zibun* and *kare* to pave the way for a fuller account of how children learn the locality of different anaphoric expressions in a language from sparse input. In this study, we control for the methodological biases and show that children, unlike adults, incorrectly reject the long-distance antecedent for *zibun*, while being able to access this antecedent for a non-local pronoun *kare*. These results suggest that children have an immature understanding of the locality properties of *zibun* that cannot be attributed to their misunderstanding of discourse context but instead must stem from properties of their language understanding.

2. The distribution of *zibun* and *kare* in child-directed speech

To get an estimate of what kind of evidence children may access to learn the locality of anaphoric expressions in Japanese, we examined child-directed speech data of Arika (2;11–5;00) and her mother in the MiiPro Corpus (Nisisawa & Miyata 2010). In this corpus, there are 40,412 utterances in total from Arika's mother. Of 40,412 utterances, there are 49 instances of *zibun*, which is only 0.12% of the mother's utterances, and there is no instance of third-person pronouns *kare*. Table 1 breaks up 49 instances of *zibun*. Each row indicates the attached case marker, and each column indicates the person and locality of the antecedent. A number in each cell indicates frequency.

The most frequent use of *zibun* is as a second-person pronoun that takes a local null subject antecedent as in (5). Of the third-person uses, all display local binding as in (6). In other words, there are no long-distance antecedents in any person. This should pose a serious problem for a strictly data-driven learner as in Orita et al. (2013) who has to end up with a grammar where *zibun* can be bound across clause boundaries with no restrictions on the person features of its antecedent. Thus, if this corpus is representative of speech to children generally, these results suggest that there is no direct evidence about the full set of binding possibilities of *zibun*. Learning that *zibun* can be bound across clauses would seem to require projecting beyond the input.

(5) Zibun-de taberu-no?
self-by eat-Q
'Do you eat by yourself?'

(6) Fuuchan, zibun-no suki-na mono mitsuke-ta-ndakara, . . .
NAME self's favorite thing find-PAST-because
'Because Fuuchan found her favorite thing, . . .'

Table 1. Instances of *zibun* in MiiPro, Arika corpora; "intra" indicates *zibun* that takes an intra-sentential antecedent, and "extra" indicates *zibun* that takes an extra-sentential antecedent; "2nd-person ambiguous" indicates *zibun* whose status is structurally ambiguous between the indexical use and the one that takes a local null subject antecedent.

	2nd-person intra (null subject)	2nd-person extra (indexical)	2nd-person ambiguous	3rd-person intra local	3rd-person intra non-local	3rd-person extra	Total
zibun-de 'by self'	30	0	0	1	0	0	31
zibun-no 'self's'	2	0	0	7	0	3	12
zibun-wa/ga 'self-TOP/NOM'	0	1	3	0	0	2	6
zibun-wo/ni 'self-ACC/DAT'	0	0	0	0	0	0	0
Total	32	1	3	8	0	5	49

Given this sparse distribution of *zibun* and *kare*, a learning model such as Orita et al. (2013) that requires input sentences that reflect the full set of binding possibilities would be insufficient to explain when and how children learn anaphoric expressions in a language and that an alternative source of evidence would be required from which learners can deduce the long-distance properties of *zibun* and the local domain of *kare*.

Prior to exploring such questions, it would be important to identify whether and when children know the locality of *zibun* and *kare*. Previous experimental studies argued that children have knowledge of long-distance *zibun* (Okabe 2008; Otsu 1997). However, as we describe in the following section, those studies had methodological biases that could have led children to accept the long-distance antecedent even if it were not grammatically licensed.

3. Previous studies

Otsu (1997) and Okabe (2008) reported that children have knowledge of the fact that *zibun* can take its antecedent across a clause boundary. However, we argue that the potential long-distance antecedent was disproportionately salient and that the Condition of Plausible Dissent (Crain & Thornton 1998) was not sufficiently satisfied in these studies. These factors could have led children to accept the long-distance antecedent even if it were not licensed by their grammar. We review and discuss these studies in the remainder of this section.

3.1. *Otsu (1997)*

Otsu (1997) tested children's interpretation of *zibun* in the sentence (7) with a modified version of Truth Value Judgment task. The sentence in (7) is potentially ambiguous between two interpretations: (i) "Taro thought that Akira showed Hanako Taro's picture" (*zibun* is bound by the long-distance antecedent) and (ii) "Taro thought that Akira showed Hanako Akira's picture" (*zibun* is bound by the local antecedent). The object in the embedded clause, *Hanako*, cannot be an antecedent for *zibun*.

(7) Taro-wa Akira-ga Hanako-ni zibun-no e-o mise-ta to omot-ta.
Taro-TOP Akira-NOM Hanako-ACC self-GEN picture-ACC show-PAST COMP think-PAST
'Taro thought that Akira showed Hanako self's picture.'

Three- to 5-year-old children participated in this experiment. In the experiment, an experimenter manipulates dolls behind an occluder so that a child participant and a puppet seated in front of the occluder cannot see what happens. After manipulating dolls behind the occluder, the experimenter whispers the test sentence in (7) to the child. Then the experimenter asks the puppet to guess what the dolls did behind the occluder. The question sentence to the puppet is in (8). The child's task is to reward the puppet upon hearing the sentence whispered by the experimenter: If the child thinks that the puppet's guess is correct, the child gives the puppet a sweet. If the child thinks that the puppet's guess is wrong, the child gives the puppet a rag.

(8) Taro-wa Akira-ga Hanako-ni dare-no e-o mise-ta to omot-ta no.
Taro-TOP Akira-NOM Hanako-ACC who-GEN picture-ACC show-PAST COMP think-PAST Q
'Whose picture did Taro think that Akira showed to Hanako?'

Otsu considers children's responses as adult-like when they give a sweet to the puppet's answer either "Taro's picture" (long-distance interpretation) or "Akira's picture" (local interpretation) and non-adult-like when they give a rag to the puppet's answer "Hanako's picture." Based on the results in Table 2, he concluded that children have adult-like knowledge of *zibun*—that is, *zibun* can have both a local and long-distance antecedent.

However, it is not clear what exactly adult-like responses are in this experiment because adult controls are not provided. In addition, it is unclear to what extent children in this study demonstrated the long-distance interpretation because the proportion of each interpretation was not provided.

In addition, there seems to be a confounding factor in the test sentence (7). The genitive-marked reflexive *zibun* like *zibun-no e* (self's picture) has at least three interpretations as in (9).

(9) a. *zibun* (self) as an owner of the picture
b. *zibun* (self) as a painter of the picture
c. the picture of *zibun* (self)

If children's interpretation of self's picture is either (9a) or (9b), this could be problematic. If they interpret self's picture as either (9a) or (9b), pragmatic knowledge put a greater pressure toward the interpretation of *zibun* as the one who showed the picture, the local antecedent *Akira*, because the most natural interpretation is that the owner/painter of the picture shows that picture to the other. Children might have used this kind of pragmatic knowledge instead of accessing their grammar. This confound would primarily be expected to increase the acceptability of the local antecedent. However, it also calls into question more generally the extent to which children's responses reflect their hypothesized grammatical constraints.

In sum, it is not clear what the results in Otsu (1997) indicate about child's grammar because (i) adults' judgments were not provided, (ii) the proportion of children's local versus long-distance responses was not reported, and (iii) it is difficult to identify which interpretation of the genitive *zibun* the children access; the different interpretation of the genitive *zibun* might give rise to different discourse pressures on choosing an antecedent. For these reasons, we argue that a more controlled study is needed.

3.2. *Okabe (2008)*

Okabe (2008) tested Japanese children's knowledge of the locality of *zibun* in a sentence (10) with Truth Value Judgment task:

(10) Buta$_i$-wa kuma$_j$-ga zibun$_{i,j}$-no keeki-o tabe-ta no-o mi-ta.
pig-TOP bear-NOM self-GEN cake-ACC eat-PAST COMP-ACC see-PAST
'The pig saw that the bear ate self's cake.'

The sentence in (10) is potentially ambiguous between two interpretations: (i) "The pig saw that the bear ate the pig's cake" (*zibun* is bound by the long-distance antecedent), and (ii) "The pig saw that the bear ate the bear's cake" (*zibun* is bound by the local antecedent). Her study has two scenarios as in (11) and (12) that correspond to each of the above two interpretations.

Table 2. Results in Otsu (1997).

Age	# of children	# of children who had adult-like responses
3	5	4
4	11	10
5	15	15

(11) Scenario where the interpretation (i) is true (long-distance *zibun*)

> A pig and a bear bought cakes, one for each. This big one is for the pig, and this small one is for the bear. The bear came there. He was so hungry that he wanted to eat the pig's big cake rather than his small cake. "Well . . . I know this big one is for Pig. But he is not here now. What do I do?" He thought about this a while, but he can't help and eat the pig's big cake. But while the bear was eating the pig's big cake, the pig was standing right behind the door and watching what the bear was doing. (Okabe 2008)

(12) Scenario where the interpretation (ii) is true (local *zibun*)

> A pig and a bear bought cakes, one for each. They decided to eat them together later. The pig said, "Don't eat the cakes, okay? Let's eat them together later!" and left the room. But, when the bear was left in the room alone, he became so hungry and could not wait for the pig. "Umm . . . we promised to eat them together . . . I can't eat this now. But I want to . . . " The bear tried not to eat the cake. But as the cakes look so yummy, he said, "Umm . . . this one is mine. So I can eat this." and ate his cake. But while the bear was eating his cake, the pig was standing outside of the room and looked what the bear did through the window. (Okabe 2008)

Okabe reported that children in all ages (nine 4-year-olds, ten 5-year-olds, and nine 6-year-olds) allowed both the local and long-distance antecedents and showed preference to the local antecedent. The average percentage of the long-distance antecedent responses in a condition where the matrix subject interpretation is true (11) was 71%. The average percentage of the local antecedent responses in a condition where the embedded subject interpretation is true (12) was 93%.

However, this study seems to have a problem in satisfying the Condition of Plausible Dissent (Conroy et al. 2009; Crain & Thornton 1998). In a Truth Value Judgment task, the test sentence is potentially ambiguous between two interpretations. We infer which interpretation of the sentence children would access by observing their responses. If children systematically fail to access one interpretation, despite the context making that interpretation salient, then we can infer that they do not allow that interpretation of the test sentence. In the typical Truth Value Judgment task, the test sentence is presented at the end of the scenario where only one reading of the sentence is true and the other is false. Crucially, two interpretations should be sufficiently available at some point in the scenario. In other words, the false reading should be considered and made "disputable" in the context. If the false reading was never considered in the scenario, children may have difficulty with rejecting that interpretation, even though their grammar disallows that interpretation.

In Okabe's study, children whose grammar disallows the long-distance binding of *zibun* might have accepted the long-distance interpretation in scenario (11) because the local interpretation "the pig saw that the bear ate the bear's cake" was never considered in the story. To satisfy the Condition of Plausible Dissent in (11), an event such that the bear ate his cake and the pig saw that situation needs to be almost made true but clearly made false in the story. Without having this kind of event in the story, children might have a difficulty with rejecting the long-distance binding interpretation even if their grammar disallows it because this was the only interpretation made available in the context. In other words, children may have been forced to choose the long-distance antecedent because that is the only discourse-accessible antecedent, even if it were not grammatically licensed.

In summary, though previous studies report that children have knowledge of long-distance *zibun*, methodological issues put these conclusions into question. To provide a more stringent test of children's knowledge, we conduct a new experiment.

4. Experiment

We have shown that children face a sparse-data problem for long-distance *zibun* and pronominal *kare*. In the corpus we analyzed, these elements do not occur. At first glance, this seems to pose

a learning problem: How can learners learn the locality of different anaphoric expressions that do not occur in the input? However, this depends on assumptions about children's learning outcomes that may not be accurate. Previous studies examined children's knowledge of the locality of *zibun*, but we have shown that these studies had methodological biases that could have led children to accept the long-distance antecedent for *zibun*. In the case of a non-local pronoun *kare*, we do not know whether children know the locality of this pronoun. Thus, it is necessary to examine the locality of *zibun* and *kare* in a better controlled experimental setting to pave the way for a fuller developmental account. The following experiment investigates children's knowledge of the locality of *zibun* and *kare* to make this first step.

It should be noted here that testing children's knowledge of non-local *kare* not only assesses what they know about the locality of this pronoun but also provides an independent test of the discourse availability of the long-distance interpretation for *zibun* in the experimental context (i.e., as a control condition for *zibun*).

4.1. *Participants*

Japanese-speaking children (age range: 4;05–6;02, N = 48) and adult controls (undergraduate and graduate students, N = 82) participated in this study. Child participants were recruited in several preschools in Japan. Adult participants were recruited in several universities in Japan.

4.2. *Design and materials*

The experiment used a Truth Value Judgment task (Crain & Thornton 1998), in which a child and a puppet companion, Shaun the Sheep, watched the experimenter acting out a story on a computer screen. When the story was over, Shaun made a statement about it, and the child's task was to reward or correct Shaun based on the accuracy of his statement with respect to the scenario. Instead of responding to the puppet, adult controls were asked to fill in a response sheet. They circled *yes* or *no* in response to each of the puppet's statements.

Experiment 1 examined how Japanese children and adult controls interpret a sentence with *zibun* such as (13a), where both local and long-distance interpretations are possible for adult speakers. The outcome of Experiment 1 still leaves a question open as to whether the observed bias (either local or long-distance) is derived from their grammar or their understanding of discourse context. To distinguish these two possibilities, Experiment 2 examined how Japanese children and adult controls interpret the sentence with *kare* such as (13b). If children can access the non-local antecedent for *kare*, their inability to access the same antecedent for *zibun* cannot be attributed to their understanding of discourse context. All sentences used in the two experiments are listed in the appendix.

(13) a. Taro-wa Akira-ga zibun-ni penki-wo nut-ta to omot-ta.
Taro-TOP Akira-NOM *zibun*-DAT paint-ACC paint-PAST COMP think-PAST
'Taro thought that Akira painted self.'
b. Taro-wa Akira-ga kare-ni penki-wo nut-ta to omot-ta.
'Taro-TOP Akira-NOM *kare*-DAT paint-ACC paint-PAST COMP think-PAST
'"Taro thought that Akira painted him.'

We created two scenarios, the MATRIX-TRUE scenario and the EMBEDDED-TRUE scenario. Participants in each experiment were randomly assigned to one of these two conditions.

Two scenarios differ regarding which interpretation they make true or false. We probe the following two possible interpretations in (14). In the MATRIX-TRUE scenario, the interpretation (14a) is true but the interpretation (14b) is false. In the EMBEDDED-TRUE scenario, the interpretation (14a) is false but the interpretation (14b) is true.

(14) a. **Taro** thought that Akira painted **Taro**.
b. Taro thought that **Akira** painted **Akira**.

For adults, *zibun* is compatible with both interpretations in (14), so we expect adult participants to accept the test sentence (13a) in both conditions. On the other hand, *kare* is compatible with only the interpretation (14a) for adults, so we expect adult participants to accept (13b) in the MATRIX-TRUE condition and to reject it in the EMBEDDED-TRUE condition. Table 3 summarizes truth values for each scenario.

Each participant was presented with four test items, four control items, and two practice items. After the two practice items, four test items and four control items were presented in one of two randomized orders. The assignment of the trial order was counterbalanced across participants.

Control items were included to provide an independent measure of the children's understanding of the scenarios. They test how children understand these scenarios in contexts when there is no question of what the grammar allows or disallows. In the control sentences, the embedded object NP, which is either *zibun* or *kare* in the test sentences, is replaced with a name as in (15).

(15) Taro-wa Akira-ga Jiro-ni penki-wo nut-ta to omot-ta.
Taro-TOP Akira-NOM Jiro-DAT paint-ACC paint-PAST COMP think-PAST
'Taro thought that Akira painted Jiro.'

This replacement does not result in a Principle C violation because the replaced proper name refers to someone else, neither *Taro* nor *Akira*. Control sentences were always false, to ensure that children could say "no" to sentences that were unambiguously false and to ensure that they could answer questions of the same grammatical complexity in similarly complex scenarios.

In test and control sentences, the matrix verb was always *omo-u* 'think,' and four different embedded verbs were used: *nu-ru* 'paint,' *nose-ru* 'place on,' *tsuke-ru* 'attach,' and *kabuse-ru* 'put on/wear.' Note that the pronoun *kare* can only have a referential antecedent (i.e., no bound variable reading) when it is anteceded by a logophoric center as in (13b) (Yashima 2015).

In a representative story, there are three boys and two different color paints, as in Tables 4 and 5. The boys are playing a painting game. One boy wears a blindfold while the other two boys paint somebody. After the painting is finished, the boy with the blindfold takes it off and guesses which boy used which color. He first considers the wrong possibilities but then discovers evidence that leads him to the correct guess. Table 4 shows an example of a story for the MATRIX-TRUE scenario, and Table 5 shows an example of a story for the EMBEDDED-TRUE scenario. Note that these example stories are abridged versions of the pictures that were used in the experiments. The actual stories use more pictures in a step-by-step manner.

This design satisfies the Condition of Plausible Dissent by ensuring that all possible readings are both disputable and available. For example, in the MATRIX-TRUE scenario, the matrix antecedent reading ("Taro thought that Akira painted Taro") was made true at the end of the story (Scene 5).[2] The embedded

Table 3. Truth values of the test sentences for each scenario.

	Experiment 1		Experiment 2	
	zibun		*kare*	
Scenario type	(14a)	(14b)	(14a)	(14b)
MATRIX-TRUE scenario	True	False	True	False
EMBEDDED-TRUE scenario	False	True	False	False

[2]There is a possibility that the test sentence in (13a) could be judged as false based on Taro's wrong guess that Jiro painted the yellow one (Scene 5). Though this guess was clearly made false by finding the evidence on the yellow paint (Akira's fan), it is true that Taro once thought that Jiro painted the yellow one. We think this kind of reasoning would not have occurred. Many children in our experiments talk frequently during each story, such as "No, (Taro is) wrong!" and "(Taro is) Correct!" These reactions, though qualitative, would suggest that children understood the characters' belief and that the belief has changed based on the evidence (a piece of fan and a piece of hair).

Table 4. Example of a story for the MATRIX-TRUE scenario (the abridged version).

Scene #	Picture	Script
1		**Taro** (a boy in the middle) puts the blindfold on. This blindfold also blocks his hearing. While he cannot see and hear anything, **Akira** (a boy with a hat on the left side) and **Jiro** (a boy with spiky hair on the right side) are going to paint on somebody. Taro's task is to find who used which color paint.
2		It's Akira's painting turn. Akira is wondering "Well, I can paint yellow one on my kimono, but this wouldn't match my kimono. I'll paint Taro yellow." (After Akira's painting event, the experimenter points out that Akira inadvertently left a piece of his pink fan on the yellow paint.)
3		Now it's Jiro's turn. Jiro painted the red one on Akira's head. (After Jiro's painting event, the experimenter points out that Jiro inadvertently left a piece of his hair on the red paint.)
4		Taro took the blindfold off. He was guessing which boy used which color paint. He first guessed that Akira painted the red one because the red paint seemed to match with Akira's kimono. Subsequently, he discovered Jiro's hair on the red paint. He noticed that his guess (Akira painted the red one) was wrong and that Jiro painted the red one.
5		Then Taro guessed that Jiro painted the yellow one. Subsequently, he discovered Akira's fan on the yellow paint. He noticed that his guess (Jiro painted the yellow one) was wrong and that Akira painted the yellow one.

Table 5. Example of a story for the EMBEDDED-TRUE scenario (the abridged version).

Scene #	Picture	Script
1		**Taro** (a boy in the middle) puts the blindfold on. This blindfold also blocks his hearing. While he cannot see and hear anything, **Akira** (a boy with a hat on the left side) and **Jiro** (a boy with spiky hair on the right side) are going to paint on somebody. Taro's task is to find who used which color paint.
2		It's Akira's painting turn. Akira is wondering "Well, yellow one would match my kimono. I'll paint yellow one on my kimono." (After Akira's painting event, the experimenter points out that Akira inadvertently left a piece of his pink fan on the yellow paint.)
3		Now it's Jiro's turn. Jiro painted the red one on Taro's shirt. (After Jiro's painting event, the experimenter points out that Jiro inadvertently left a piece of his hair on the red paint.)
4		Taro took the blindfold off. He was guessing which boy used which color paint. He first guessed that Akira painted the red one because the red paint is Akira's favorite color. Subsequently, he discovered Jiro's hair on the red paint. He noticed that his guess (Akira painted the red one) was wrong and that Jiro painted the red one.
5		Then Taro guessed that Jiro painted the yellow one. Subsequently, he discovered Akira's fan on the yellow paint. He noticed that his guess (Jiro painted the yellow one) was wrong and that Akira painted the yellow one.

antecedent reading ("Taro thought that Akira painted Akira") was almost made true: In the middle of his inferences, Taro guessed that Akira painted himself, but this was clearly made false in the story (Scene 4). Since we were concerned about children's ability to recognize that the sentence has an embedded clause that represents Taro's belief, and so interpret the puppet's assertion not with respect to Taro's belief but based on only the embedded clause, we also ensured that the interpretation "Akira painted Akira" (independent of Taro's belief) was almost made true but clearly made false in the story (Scene 2).

4.3. *Predictions*

We consider three possibilities. First, children's knowledge could be adult-like, in which case they would accept all of the test sentences in Experiment 1 and *kare* in the MATRIX-TRUE scenario in Experiment 2. On the other hand, they would reject *kare* in the EMBEDDED-TRUE scenario. The latter two possibilities differ from the first in their prediction for *zibun*. The second possibility is that children's grammar disallows the long-distance interpretation for *zibun*. The third possibility is that children could have acquired the right grammar for *zibun* (i.e., their grammar allows both the local and long-distance antecedents for *zibun*) but for independent processing factors made that interpretation difficult to access. These latter two possibilities both predict that children would accept the sentences with *zibun* in the EMBEDDED-TRUE scenario but reject the same sentences in the MATRIX-TRUE scenario. Experiment 2 will help determine whether children see the matrix antecedent as available in the discourse context when it is the only interpretation available. In other words, the *kare* conditions in Experiment 2 will help distinguish whether children's responses for the long-distance *zibun* are derived from their understanding of discourse context or their language understanding.

However, if Experiment 2 rules out discourse as an explanation of children's locality bias for *zibun*, it nonetheless cannot distinguish between a grammatical or processing-based explanation of this bias. If children's grammar is adult-like, they might show a dispreference for the matrix antecedent due to an interference effect from the local subject (Dillon et al. 2014). This interference effect would not arise for *kare*; however, the local subject's unavailability as a grammatical antecedent would also impact its role as a potential interferer for retrieval processes. Nonetheless, Experiment 2 will allow us to rule out the possibility that discourse factors are solely responsible for children's locality bias in Experiment 1.

5. Experiments

5.1. *Control condition*

For all experiments, participants' responses were analyzed based on the number of "yes" responses to the puppet's statements. Control sentences (e.g., "Taro thought that Akira painted Jiro.") were always false, to ensure that children could say "no" to sentences that were unambiguously false and to ensure that they could answer questions of the same grammatical complexity in similarly complex scenarios. Children and adult controls correctly rejected nearly all control sentences as false. Figure 1 shows the percentage of the control sentences correctly rejected in each experiment.

5.2. Experiment 1*: zibun*

Participants in Experiment 1 were 24 Japanese-speaking children aged 4;05–6;02 years (12 children in each condition) and 41 adult controls (21 in the MATRIX-TRUE and 20 in the EMBEDDED-TRUE). Six additional children were replaced in Experiment 1: One child made errors on practice trials, one child made errors on more than two control trials, and four children could not finish all trials.

Figure 2 summarizes the results of the experimental conditions. In the MATRIX-TRUE condition, adults accepted 83.3% of the test items, whereas in the EMBEDDED-TRUE condition, they accepted only 57.5%. However, children showed a different pattern. They accepted 66.67% of the items in the EMBEDDED-TRUE condition but only 20.83% in the MATRIX-TRUE condition. Children showed a local bias.

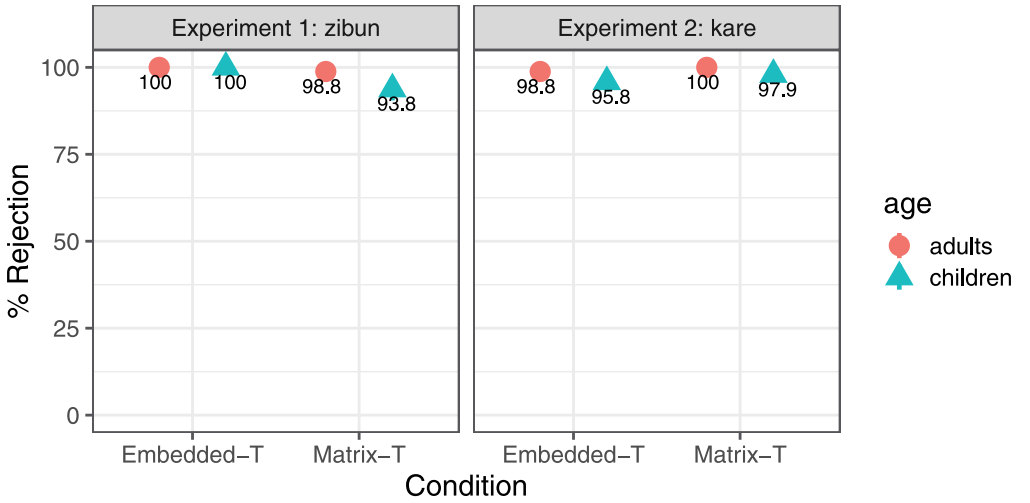

Figure 1. Rates of correct rejection for control sentences: Points show mean and error bars show standard error of those means.

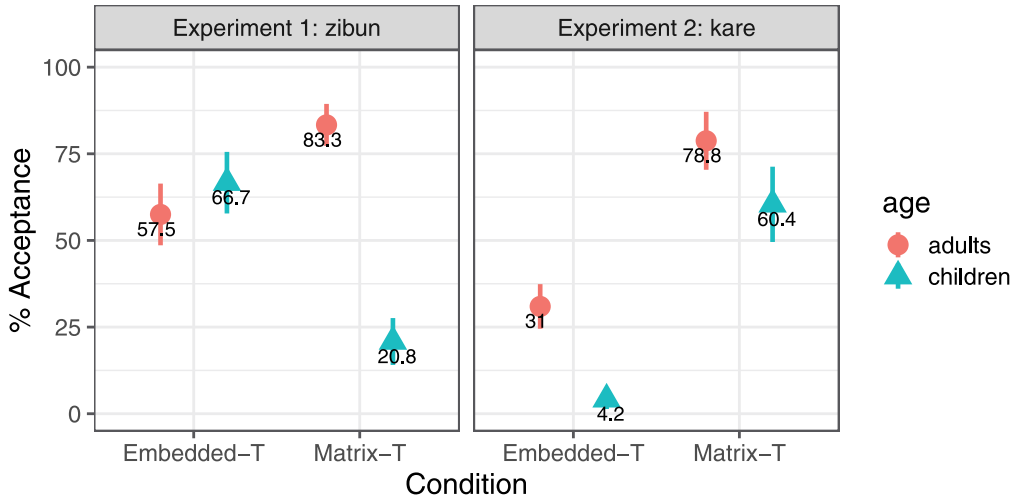

Figure 2. Acceptance rates for test sentences: Points show mean and error bars show standard error of those means.

To evaluate the reliability of this pattern, we use a mixed-effects model with age (adult controls and children) and scenario type (MATRIX-TRUE and EMBEDDED-TRUE) as fixed effects and participant IDs and item IDs as random effects. The model revealed no influence of the random effects, $\beta = 0.48$, $SE(\beta) = 0.49$, $p = 0.32$). We fitted a model with fixed effects for age, scenario type, and their interaction and then tested each effect in turn.

To test the interaction, we use a log-likelihood ratio test to compare the model with a model that lacks the fixed interaction. This test shows that the model with interaction provides a better fit than the model without interaction (BIC[3] 302.47 vs. 314.09), and this interaction is significant, $\chi^2(1) = 17.18$, $p < 0.001$. To test the fixed main effects, we compare a model containing the same random effects but only the fixed effects (without interaction) against two other models: one containing the random effects but only the fixed main effect of age (BIC: 292.84) and another containing the random effects

[3]Bayesian information criterion: BIC penalizes models with additional parameters (the model log-likelihood is one component of the BIC). A lower BIC score signals a better model.

but only the fixed effect of scenario type (BIC: 268.09). These tests suggest that the main effect of age, $\chi^2(1) = 8.64$, $p = 0.003$, was significant, but the main effect of scenario type, $\chi^2(1) = 0.0009$, $p = 0.97$, was not. Overall, the model containing two main effects and their interaction provides a better fit than the less complex models.

Adult controls show a slight bias for the matrix antecedent, which is revealed by the depressed acceptance rate in the EMBEDDED-TRUE condition, despite the fact that the embedded reading was both true and available. These results might reflect an antilocality bias in on-line processing (Omaki et al. 2014).

We encouraged children to tell the puppet why he was right or wrong to get more information on children's interpretations of the sentences. Though most of them were able to clearly explain what happened in a story, they were shy and looked nervous when they were asked to tell the puppet why his statement was right or wrong. When they said something to this kind of justification question, many of them tended to just repeat (a part of) the puppet's statement.

Among a few justifications elicited from children, two children in the EMBEDDED-TRUE condition and one child in the MATRIX-TRUE condition who rejected the test sentence told the puppet why he was wrong using *zibun-de* (by self) such as in (16).

(16) Akira-wa zibun-de penki nutta-yo.

Akira-TOP zibun-by paint(noun) paint-PAST-FP
'Akira painted by himself.'

This kind of justification suggests that these children might have represented *zibun-ni* (zibun-DAT) in the test sentence as *zibun-de* (by self), even though that was not what the experimenter said. Crucially, when *zibun-de* is used, the sentence has only a local reading. We return to this possibility in the Discussion section.

5.3. Experiment 2*: kare*

The results in Experiment 1 raise two possibilities: (i) that children have a locality bias for *zibun* versus (ii) that children (unlike adults) do not see the matrix antecedent as available in the discourse context. The *kare* conditions could help distinguish these two possibilities. If children can access the matrix antecedent for *kare*, their inability to access the same antecedent for *zibun* cannot be attributed to their understanding of discourse context.

Participants in Experiment 2 were 24 Japanese-speaking children aged 4;01–5;08 years (12 children in each condition) and 41 adult controls (20 in the MATRIX-TRUE and 21 in the EMBEDDED-TRUE). Two additional children were replaced because they made errors on practice trials.

Figure 2 summarizes the results of Experiment 2. In the MATRIX-TRUE condition, adults accepted 78.8% of the test items, whereas in the EMBEDDED-TRUE condition, they accepted only 31%. Children showed a similar pattern. They accepted 60.4% of the items in the MATRIX-TRUE condition but only 4.2% in the EMBEDDED-TRUE condition.

In the same way as Experiment 1, We fitted a mixed-effects model with fixed effects for age, scenario type, and their interaction and then tested each effect in turn. A log-likelihood ratio test comparing the full model with a model that lacks the fixed interaction shows that unlike Experiment 1, there is no significant influence of the interaction, $\chi^2(1) = 0.92$, $p = 0.34$; BIC 267.92 vs. 263.27. To test the fixed main effects, we compare a model containing the same random effects but only the fixed effects against two other models: one containing the random effects but only the fixed main effect of age (BIC: 292.84) and another containing the random effects but only the fixed effect of scenario type (BIC: 268.09). These tests suggest that both the main effect of scenario type, $\chi^2(1) = 35.13$, $p < 0.001$, and the main effect of age, $\chi^2(1) = 10.37$, $p = 0.001$, are significant. Overall, the model containing two main effects without their interaction provides a better account of the data than the other models (BIC: 263.27).

Table 6. Acceptance rates for each test item in Experiment 2.

Age-scenario	Test #1	Test #2	Test #3	Test #4
Children EMBEDDED-TRUE	0 (0)	8.3% (1)	8.3% (1)	0 (0)
Children MATRIX-TRUE	66.6% (8)	58.3% (7)	50% (6)	66.6% (8)
Adults EMBEDDED-TRUE	42.9% (9)	23.8% (5)	42.9% (9)	14.3% (3)
Adults MATRIX-TRUE	80% (16)	75% (15)	75% (15)	85% (17)

In addition to the influence of fixed effects, we observed a significant influence of random effects, $\beta = -1.55$, $SE(\beta) = 0.57$, $p = 0.007$, in the model containing two main effects). The analysis revealed that adult controls' acceptance rate of one test item in the EMBEDDED-TRUE condition was noticeably lower than other test items (item #4 in Table 6).

The embedded verb used in this test sentence #4 was *kabuse-ru* 'put on/wear.' This transitive verb has a lexically reflexive predicate counterpart *kabu-ru*, whose object is not referentially distinct from its subject such as in (17).

(17) Taro-ga booshi-wo kabut-ta.
Taro-NOM hat-ACC put on-PAST
'Taro put on the hat (to himself).'

Adult participants in the EMBEDDED-TRUE condition might had been less likely to accept this test sentence because *kabuse-ru* in the test sentence is less reflexive than its counterpart *kabu-ru*.

In sum, Experiment 2 shows that the possibility that children do not see the matrix antecedent as available in the discourse context can be rejected. The difference in children's acceptance rates between the *kare* EMBEDDED-TRUE and the *kare* MATRIX-TRUE indicates that children were not answering to the sentences with *kare* by chance. When the grammar allows only one interpretation and that interpretation is the matrix interpretation, then children access that interpretation at the same rate as adults (*kare* in the MATRIX-TRUE condition). This indicates that the matrix interpretation is made available in our scenarios. Thus, properties of children's language understanding (and not their understanding of discourse context) are responsible for their lack of matrix readings in Experiment 1. It remains to be investigated what accounts for children's low acceptance rate for *zibun* in the MATRIX-TRUE condition. Future work will determine whether children's grammar only allows a local antecedent or whether their grammar allows for both local and long-distance readings but they have a processing bias for a local antecedent.

6. Discussion

Although the Japanese reflexive *zibun* can be bound both locally and across clause boundaries, the third-person pronoun *kare* cannot take a local antecedent. However, we showed that the direct evidence of the binding possibilities of *zibun* is sparse and that the evidence of *kare* is absent in speech to children. This data-sparsity problem led us to ask when learners can learn the locality of different anaphoric expressions that do not seem to occur in the input. Prior work has argued that children have knowledge of long-distance *zibun*. However, those studies had methodological biases that could lead children to accept the long-distance antecedent even if it were not grammatically licensed. In the case of *kare*, it has not yet been examined whether children know the locality of this pronoun.

We controlled for the methodological biases and showed that children, unlike adults, incorrectly reject the long-distance antecedent for *zibun* while being able to access this antecedent for a non-local pronoun *kare*. These results suggest that the matrix interpretation is made available for *zibun* in our experimental materials, and thus children's lack of matrix readings for *zibun* is not due to their understanding of discourse context but the properties of their language understanding.

Although children do not show ceiling performance in either condition, the overall pattern clearly shows the impact of a child's grammar. In Experiment 2 (*kare* condition), children show very different patterns of responses for the two conditions. They correctly reject the EMBEDDED-TRUE interpretation and correctly accept the MATRIX-TRUE interpretation much more than the EMBEDDED-TRUE interpretation. The analysis of Experiment 2 reveals that there is no main effect or interaction. This suggests that children and adults are alike with respect to the experimental manipulation. By the same token, in Experiment 1 (*zibun* condition), children accept the EMBEDDED-TRUE interpretation at rates that are hugely different from the *kare* EMBEDDED-TRUE condition. The analysis of Experiment 1 reveals that there is a significant interaction between age and condition, indicating that there is a reliable difference between children and adults. These contrasts show that even if the task was difficult and performance was not ceiling, children can access each interpretation in the context and that the impact of the child's grammar can be assessed.

The matrix clause in the test and control sentences is always "*Taro thought that . . .* " and the truth value of the entire sentence is always same as the truth value of its embedded clause. Thus, there is a possibility that children in our experiment ignored the matrix clause of the test sentence and answered based only on the interpretation of the embedded clause. We acknowledge that there is no control condition that eliminates this possibility. However, previous studies suggest that this may not be a concern. First, children at this age range (4;05–6;02) are well past the age of making the kind of false belief errors that would result from ignoring the matrix clause. A meta-analysis of 178 studies reports that children start responding based on beliefs at about average 4;00 (Wellman, Cross & Watson 2001). In addition, Lewis, Hacquard & Lidz (2017) show that even children who are at a stage of making errors with belief reports do not make these kinds of errors when the whole sentence is false.

Another possible explanation for our effects is that children in our experiment might have had difficulty with parsing center embedding and might therefore have been unable to fully interpret the test sentence, leading to responses based solely on the embedded clause. However, previous studies show that Japanese children start using center-embedding at least by age 2 (Ozeki & Shirai 2007) and demonstrate an adult-like interpretation of the center-embedded relative clauses in the age range of 4;11 to 6;11 (Sugisaki & Murasugi 2017), which mostly overlaps with the age range in our study. For these reasons, we believe that children's ignoring of the matrix clause is unlikely to have been an issue in our study.

In Experiment 1, we observed a few justifications using *zibun-de* (by self) from children. This suggests that these children might have misheard or misparsed the test sentence with *zibun-de* instead of *zibun-ni* and made a judgment based on this representation. Alternatively, these children might have replaced *zibun-ni* with *zibun-de*, which was the most frequent use of *zibun* in the input according to our corpus study, and made a judgment based on this representation. If either of these is the case, it is hard to infer which antecedent of *zibun* the children rejected. However, such justifications occurred only three times; thus it is likely that the rate of such occurrences (misheard, misparse, or replacement) was low.

In addition to *zibun*, we also provide new evidence about children's knowledge of the locality domain for *kare*. In our experiment, children correctly rejected the local antecedent for *kare* while they accepted the matrix antecedent for this pronoun. These results may indicate that children's knowledge of *kare* is adult-like (despite the lack of evidence in the input), but there is also another possibility, Gricean inference (Grice 1975). Children could have inferred that if the puppet had meant to refer to the local antecedent, he would have used *zibun*. Since he did not use that form, they could infer that he meant to refer to the matrix antecedent. However, even if this strategy were right, it remains unclear how learners ever learn that *zibun* allows both local and long-distance antecedents.

In our experiments, children incorrectly rejected the matrix antecedent for *zibun*, despite being able to access this antecedent for *kare*. These results suggest that children are able to access the matrix antecedent, but for other reasons they prefer the local antecedent for *zibun*. The corpus study and experiments are consistent with two explanations. First, children might have wrongly learned that *zibun* only allows local antecedents. In this scenario, they start with a grammar with a smaller extension and would need additional evidence to change their grammar to one that allows both local and long-distance readings. This account is consistent with the classic subset principle account

(Berwick 1985; Gold 1967; Manzini & Wexler 1987) and its Bayesian near-equivalents (Tenenbaum & Griffiths 2001). Alternatively, their grammars might be adult-like, but they choose the local antecedent for *zibun* because it is more active in working memory and hence is easier to retrieve. The results in the *kare* conditions do not argue against this view because the local antecedent is not compatible with *kare*. That is, the processing difficulty is derived from ambiguity resolution. In the *kare* case, there is no ambiguity and so the grammar blocks interference from the local antecedent. This account would be in line with adult sentence processing with Principle B (Badecker & Straub 2002).

How can children eventually acquire or demonstrate the adult-like knowledge of *zibun*? The previous two accounts have different predictions with respect to the input and the development of general cognitive mechanisms. The classic subset principle account (Berwick 1985; Gold 1967; Manzini & Wexler 1987) (or the probabilistic variant, Tenenbaum & Griffiths 2001) regards children's current performance as a reflection of the distribution of the input and predicts that children will learn the long-distance *zibun* when they encounter such uses in the input. This account requires that children are able to parse multiclause utterances, that they are able to recognize when the interpretation produced by their immature grammars is not the one intended by the speaker, and to use that mismatch to change the locality conditions on *zibun*. The processing-based account assumes that children have already determined that *zibun* can have a long-distance antecedent and predicts that children will demonstrate their long-distance interpretation when they become able to revise their initial local interpretation, which requires the use of domain general cognitive mechanisms such as working memory or cognitive control mechanisms (e.g., Mazuka, Jincho & Oishi 2009). To identify which account would better predict the developmental trajectory, we need to (i) further examine the distribution of input from different genres and input for different (older) ages, and (ii) test whether variability in cognitive control mechanisms predicts variability in the interpretation of *zibun*. Such variability might come from individual variation or from tasks that allow children to allocate more resources to cognitive control (see Hsu & Novick 2016).

7. Conclusion

The Japanese reflexive *zibun* can be bound both locally and across clause boundaries, while the third-person pronoun *kare* cannot take a local antecedent. By controlling methodological biases observed in previous experiments, this study has shown that children, unlike adults, incorrectly reject the long-distance antecedent for *zibun*, despite being able to access this antecedent for a pronoun *kare*. These results suggest that children's lack of matrix readings for *zibun* is not due to their understanding of discourse context but the properties of their language understanding.

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Appendix: List of stimuli

Experiment 1: Test sentences

1. *Taro-wa Akira-ga zibun-ni penki-wo nut-ta to omot-ta.*
   Taro-TOP Akira-NOM zibun-DAT paint-ACC paint-PAST COMP think-PAST
   'Taro thought that Akira painted (the paint on) self.'
2. *Taro-wa Akira-ga zibun-ni siiru-wo tsuke-ta to omot-ta.*
   Taro-TOP Akira-NOM zibun-DAT sticker-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the sticker on self.'
3. *Taro-wa Akira-ga zibun-ni neko-wo nose-ta to omot-ta.*
   Taro-TOP Akira-NOM zibun-DAT cat-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the cat on self.'
4. *Taro-wa Akira-ga zibun-ni boushi-wo kabuse-ta to omot-ta.*
   Taro-TOP Akira-NOM zibun-DAT hat-ACC put on-PAST COMP think-PAST
   'Taro thought that Akira put the hat on self.'

Experiment 2: Test sentences

1. *Taro-wa Akira-ga kare-ni penki-wo nut-ta to omot-ta.*
   Taro-TOP Akira-NOM kare-DAT paint-ACC paint-PAST COMP think-PAST
   'Taro thought that Akira painted (the paint on) him.'
2. *Taro-wa Akira-ga kare-ni siiru-wo tsuke-ta to omot-ta.*
   Taro-TOP Akira-NOM kare-DAT sticker-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the sticker on him.'
3. *Taro-wa Akira-ga kare-ni neko-wo nose-ta to omot-ta.*
   Taro-TOP Akira-NOM kare-DAT cat-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the cat on him.'
4. *Taro-wa Akira-ga kare-ni boushi-wo kabuse-ta to omot-ta.*
   Taro-TOP Akira-NOM kare-DAT hat-ACC put on-PAST COMP think-PAST
   'Taro thought that Akira put the hat on him.'

Experiment 1 and 2: Control sentences

1. *Taro-wa Akira-ga Jiro-ni kurimu-wo nut-ta to omot-ta.*
   Taro-TOP Akira-NOM Jiro-DAT cream-ACC paint(verb)-PAST COMP think-PAST
   'Taro thought that Akira painted cream on Jiro.'
2. *Taro-wa Akira-ga Jiro-ni bazzi-wo tsuke-ta to omot-ta.*
   Taro-TOP Akira-NOM Jiro-DAT badge-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the badge on Jiro.'
3. *Taro-wa Akira-ga Jiro-ni tori-wo nose-ta to omot-ta.*
   Taro-TOP Akira-NOM Jiro-DAT bird-ACC put-PAST COMP think-PAST
   'Taro thought that Akira put the bird on Jiro.'
4. *Taro-wa Akira-ga Jiro-ni manto-wo kabuse-ta to omot-ta.*
   Taro-TOP Akira-NOM Jiro-DAT cape-ACC put on-PAST COMP think-PAST
   'Taro thought that Akira put the cape on Jiro.'