Crosslinguistic Differences in the Encoding of Causality: Transitivity Preferences in English and Japanese Children and Adults

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ABSTRACT

Languages differ in how they encode causal events, placing greater or lesser emphasis on the agent or patient of the action. Little is known about how these preferences emerge and the relative influence of cognitive biases and language-specific input at different stages in development. In these studies, we investigated the emergence of sentence preferences to describe causal events in English- and Japanese-speaking children (aged three and five years) and compared this to preferences displayed by adults. We studied two factors suggested to influence this choice: Language (Corpus study & Experiment 1) and Intentionality (Experiment 2). Participants watched videos depicting familiar and novel causal actions, and made a best-match choice between a transitive and intransitive description. We found a stronger preference for intransitive sentences with causal verbs and more frequent argument omissions in Japanese child-directed speech than in English child-directed speech. The trajectory of acquisition in the selection of transitive sentences for causal events differed between languages. For intentionality, with familiar verbs both Japanese and English speakers selected fewer transitives for accidental than intentional scenes, but this pattern was more pronounced in Japanese speakers. However, with novel verbs, only five-year-olds and adults showed this preference. These data provide important new information to constrain theories about the process of learning to map event structure to language, and its interdependence with intentionality and the distributional properties of linguistic input to children.

Introduction

Causal events occur throughout our daily lives, for example when we open the door to leave our house, or observe a busy waiter bump into a table and break a vase. We describe these events using language to communicate effectively with others. However, depending on the perspective we adopt, the same event can be described in different ways, for example by using a simple non-causal intransitive (“The vase broke”), a simple transitive causative (“He broke the vase”), a periphrastic causative (“He made the vase break”), or even causal conjunctions (“He knocked the table and the vase broke”). The focus of the current paper is on how and when children learn the form-meaning mappings between events and the conventional choice of linguistic structure for their language.

There is a long history of research, within functionalist approaches to language, examining the factors that determine a speaker’s choice of sentence structure to describe events (e.g. Langacker, 1991; Talmy, 1985). For example, the attentional salience of a referent (either physically or in terms of its importance to the speaker, e.g. Prentice, 1967), its accessibility or ease of retrieval from
memory (as determined by factors such as its animacy, Altman & Kemper, 2007 or givenness, Bock, 1977) and the prior use of similar words and phrases in the discourse context (Bock, 1986) all play a role (see Myachykov, Thompson, Scheepers, & Garrod, 2011 for a review). However, languages often encode particular aspects of events differently, and thus children are required to learn language-specific form-meaning mappings. For example, languages differ according to whether the path (trajectory of the motion) or manner (the way in which the motion takes place) of motion events is typically encoded in their verbal forms (Talmy, 1985, 2000; c.f. Allen et al., 2007; Choi, 2009; Engemann, Hendriks, Hickmann, Soroli, & Vincent, 2015), and children show some sensitivity to their language’s mappings by age three (Allen et al., 2007). Languages like Korean distinguish between spatial categories denoting tight vs. loose fit containment relations, whereas English does not. Infants seem ready to make these distinctions irrespective of their ambient language (Choi, 2006) but only Korean children maintain these distinctions into the third year of life, presumably reflecting a growing sensitivity to the form-meaning mappings in their language (Bowerman & Choi, 2003; Choi & Bowerman, 1991; McDonough, Choi, & Mandler, 2003).

In the current paper, we focus on the acquisition of another important cross-linguistic difference in the mapping of events to language, namely the differential use of simple transitive (causal) vs. intransitive (non-causal) sentences to describe causal events in English and Japanese. Sensitivity to causal relations emerges early in infancy (Saxe & Carey, 2006), but different languages have been hypothesized to map causal events to sentence structures in different ways. In our Corpus study and Experiment 1 we explore the form-meaning mappings for causal relations in English and Japanese and whether their trajectory of acquisition differs between the two languages. In Experiment 2 we investigate the influence of the intentionality of the event agent on preferred mappings. First, we summarize some broad observations about the patterns of language usage in English and Japanese, before reviewing evidence relating specifically to the influence of intentionality on sentence selection when describing causal events.

**Language-specific differences in the use of transitive constructions in English and Japanese**

Transitive and intransitive constructions are amongst the first sentence structures children need to acquire. In their influential work, Hopper and Thompson (1980) described ten parameters along which events vary in their degree of transitivity (e.g. the affectedness or individuation of the object, the volitionality of the agent, the number of event participants). Broadly speaking, events higher in transitivity are more likely to be encoded, across languages, using transitive rather than intransitive constructions. However, the precise mappings of form to meaning differ between languages, and the extent to which this system can be used to quantify transitivity cross-linguistically has been extensively discussed (e.g. Kittila, 2002; Næss, 2007; Tsunoda, 1991).

Variation in form-meaning mappings across languages means that children must learn to map transitive and intransitive sentence structures to the particular properties which define them in their language based on their exposure to the input. In the case of causative alternation verbs which permit the same event to be described from two perspectives (in English and Japanese using a transitive “He closed the box/Kanojo-yo wa hako-o shimeta” or intransitive sentence “The box closed/Hako-wa shimatta”), children must learn the specific semantic and pragmatic factors which govern sentence selection, for example, whether the speaker wants to highlight the agent. Although there is evidence that children are beginning to develop sensitivity to language-specific form-meaning mappings by around three years of age, currently little is known about the developmental trajectory for this process, how it might interact with children’s broader cognitive development, or how it might vary as a function of the specificities of the language input. These issues are central to understanding children’s acquisition of language because on the one hand, pre-linguistic infants are already sensitive to some of the kinds of information that can be encoded differently in languages, such as causality (Muentener & Carey, 2010), agent animacy (Poulin-Dubois, Lepage, & Ferland, 1996) and intentionality (Carpenter, Akhtar, & Tomasello, 1998). On the other, theories of language
learning such as the usage-based approach (e.g. Tomasello, 2003) propose that children learn grammatical constructions by registering the patterns of usage associated with individual words or phrases. They only gradually acquire abstract constructions and their associated form-meaning mappings on a trajectory that reflects the distributional properties of the language they hear (Ambridge, Kidd, Rowland, & Theakston, 2015). The pattern of acquisition of form-meaning mappings is therefore likely to differ across languages as a function of the interaction between children’s underlying cognitive capabilities and the patterns of language they are exposed to.

There is typological evidence that Japanese and English speakers map form to meaning differently for transitive and intransitive constructions. Nishimitsu and Pardeshi (2010), in their investigation of the factors governing sentence choice for translational equivalents in Japanese and English, argue that there are several contexts in which English speakers tend to use transitives where Japanese speakers prefer intransitives. For example, they argue that Japanese speakers prefer to avoid inanimate subjects of transitive verbs (with the exception of certain psychological verbs), such that a more natural translation of the English “Rain prevented us from going on a picnic” would be something like “We were unable to go on a picnic because of rain”, and where both agent and patient are inanimate, Japanese speakers would typically use intransitives to avoid any implication of intentionality (e.g. “Tsuki-wa Kumo-ni Kakure-ta”/“The moon hid the clouds”). English speakers, in contrast, are argued to favor transitives for both kinds of events (see also Jacobsen, 1992 for similar arguments and examples that Japanese is more limited in the kinds of meanings encoded by transitives than is English, e.g. with reference to nonprototypical transitive events and passivization).

Further evidence relevant to acquisition comes from corpus data, with several studies suggesting that Japanese and English children hear transitive and intransitive constructions used differently in their input. English children during the first three years of life are reported to hear a greater preponderance of transitive utterances. For example, Cameron-Faulkner, Lieven, and Tomasello (2003) found that only around 23% of all subject-predicates in English child-directed speech were intransitive (defined as utterances with both a subject and single lexical predicate with sub-categories transitive, intransitive & other). Similarly, Theakston, Maslen, Lieven, and Tomasello (2012) found that only around 14% of tokens of transitivity alternating verbs were intransitive. In contrast, Japanese children of a similar age are reported to hear between 52% and 66% intransitive verb uses, depending on exactly which verbs are included (e.g. all verbs that do not take an accusatively marked argument vs. morphologically marked transitive-intransitive verb pairs, Fukuda & Choi, 2009; Nomura & Shirai, 1997; Tsujimura, 2006). This might suggest that English-speaking children hear more transitive utterances than their Japanese counterparts to describe causal events. However, these studies of Japanese and English child-directed speech are not directly comparable due to differences in the nature of the verbs examined, the number of caregivers studied, the age of the children addressed and the contexts. Without controlling these variables, it is possible, in principle at least, that the apparent differences reflect greater use of unergative verbs (e.g. He dances) in Japanese than in English, or different patterns of input to children at different ages rather than differences in the mapping of form to meaning for causal contexts.

In addition, languages differ in the extent to which they permit argument omissions (e.g. Rispoli, 1987; Shibatani, 1990), and in their dominant word order (for example English has subject-verb-object word order whereas Japanese generally takes subject-object-verb word order). In English, word order is generally a reliable cue to indicate the agent and patient of a transitive action because the arguments are obligatorily mentioned, and ordering is consistent with subjects and objects appearing before and after the verb respectively. Moreover, the number of arguments may provide a reliable cue to transitivity (e.g. Fisher, 1996) because in a transitive sentence, both subject and object arguments are obligatory. In contrast, in Japanese, argument omissions mean that it is often impossible to identify participant roles using word order (available less than 10% of the time in child-directed speech) or case markers (available less than 20% of the time), whereas an animacy contrast between agent and patient is much more often available (over 90%, Tanaka & Shirai, 2014). Thus, English-speaking children are likely to have greater familiarity with the transitive construction
at an earlier age than their Japanese counterparts due to differences in how often they encounter transitive utterances with two overt arguments in their input (see Chan, Lieven, & Tomasello, 2009 for similar arguments and evidence with respect to Cantonese).

Children show some sensitivity to these language-specific differences from early in development, with Japanese and English children’s production of transitive and intransitive verbs differing in line with their input. Japanese children under three years of age have been reported to use more intransitive than transitive predicates (between 66% and 80% intransitives depending on the child and the types of verbs included) at rates which either mirror or exceed uses in their input (Fukuda & Choi, 2009; Nomura & Shirai, 1997; Tsujimura, 2006). Unfortunately, the relative sparsity of these data samples means it is not possible to accurately determine whether there is any reliable developmental change in the observed preference for intransitive frames. In contrast, English-speaking children of a similar age appear to begin by producing a relatively higher proportion of transitive verbs (38% and 55% intransitives, Theakston, Lieven, Pine, & Rowland, 2001; Valian, 1991), a preference that seems to increase developmentally (shown by a decrease in intransitive uses to 21% and 38% respectively in these studies). Theakston et al. (2001) also showed that English children’s relative use of alternating verbs in the transitive frame correlated with their use in the input, demonstrating that children are not just sensitive to the overall patterns in their input, but also to variation at the lexical level.

To summarize, the evidence suggests that (i) Japanese children hear more intransitive utterances than English children (in general and for causal scenes) and (ii) English children are likely to have greater familiarity with the full transitive construction than Japanese children due to frequent argument omissions in Japanese. However, previous studies do not control the verbs examined in the two languages making direct comparisons difficult. In our Corpus study and Experiment 1 we sought to test the following predictions by examining a matched set of transitivity alternating verbs:

(i) Japanese child-directed speech will show a stronger preference for intransitive sentences to describe causal scenes than English child-directed speech.
(ii) Japanese child-directed speech will show a higher proportion of argument omissions with causal verbs than English child-directed speech.
(iii) English children will converge on the patterns of sentence preference seen in adult speakers earlier than Japanese children, reflecting the greater availability of the full transitive construction to encode causal events in their input.

In addition, we explored whether the animacy of the patient influenced choice of sentence construction to describe causal scenes in the two languages. This was motivated, on the one hand, by the observation that prototypical transitives involve animate agents acting on inanimate patients and thus English children in particular may show a stronger transitivity preference for these more familiar form-meaning mappings as compared to events involving two animate entities (Noble, Iqbal, Lieven, & Theakston, 2016). On the other, Nishimitsu and Pardeshi (2010) suggested that Japanese (but not English) speakers favor transitive descriptions of causal events involving animate patients. However, as we found no clear effects of patient animacy on transitivity preference in either language or at any age, we do not discuss the role of patient animacy further.

Effects of intentionality

According to Hopper & Thompson (1980), “volitionality” or the extent to which an action is intentionally carried out by an agent, is associated with high transitivity, and thus constitutes one factor that could differentially influence the mapping of form to meaning across languages. For example, Ikegami (1981, 1991) described languages as “DO” or “BECOME” languages, suggesting that speakers of DO-languages like English tend to highlight the human agent of an event, whereas speakers of BECOME-languages like Japanese describe the event as if it happened spontaneously,
omitting to mention the agent altogether and/or selecting constructions which background the agent (e.g. passives, Alfonso, 1966). Speakers of Japanese are more likely to use non-agentive language than speakers of English, to differentiate intentional from accidental actions (Choi, 2009). For example, when describing videos of intentional or accidental versions of the same events, adult speakers of English and Japanese were equally likely to use agentive (transitive) expressions for intentional events (around 97%). In contrast, for accidental scenes, although both language groups used fewer agentive expressions, this difference was more pronounced for Japanese speakers (52%) than English speakers (69%, Fausey, Long, Inamori, & Boroditsky, 2010, see also Wolff, 2003). Moreover, these differences manifested in language may have a cultural component to them: speakers’ usage of transitive sentences has been shown to correlate with their ratings of the agent’s responsibility for the event with Japanese speakers utilizing intransitive constructions to avoid any culturally unacceptable implication of culpability (Yoshinari, Pardeshi, & Chung, 2010).

Tsujimura (2006) argued that these differences in language input to children are likely to lead to differences in the perspective children adopt on events, with Japanese children focusing on the result of a causal action rather than the process by which it occurs. Any such difference might be expected to arise gradually through exposure to particular sentence types in particular contexts, as children learn the form-meaning mappings typical for their language. In other areas of language development, children’s ability to use language in pragmatically appropriate ways gradually becomes more adult-like as they learn to coordinate their sensitivity to the knowledge states of others with the appropriate choice of referring expression (e.g. Hickmann & Hendriks, 1999; Matthews, Lieven, Theakston, & Tomasello, 2006). Similarly, developments in the use of mental state language and children’s performance on false belief or theory of mind tasks appear to go hand-in-hand (e.g. Astington & Baird, 2005; Gopnik, 1990). Thus, sensitivity to the role of intentionality in the selection of sentence structure is likely to require both an ability to adopt the perspectives of others, and to integrate this knowledge with developing sentence structure representations.

The question of how children come to encode language-specific differences in form and meaning when starting out with similar non-linguistic cognitive abilities has led some researchers to posit universal cognitive biases that initially guide the process (e.g. Rissman & Goldin-Meadow, 2017). For example, in two studies Muentener and Lakusta (2011) asked English-speaking three-year-olds to describe or select the best description for intentional vs. accidental events from a choice of causal and non-causal language (e.g. “She made the tower break” vs. “She dropped the block”). They found that the children produced and preferred causal over non-causal descriptions only when the action was performed intentionally (e.g. 67% causal descriptions for intentional actions, 50% for unintentional actions). They concluded that children are biased to adopt different perspectives on events according to whether the agent acts intentionally (the so-called “intention-to-cause bias”) and that these differences in perspective lead children to map the conceptual representation of “intentional causer” onto causal language. The origin for such a bias in mapping language to concepts is assumed to lie in earlier cognitive development, where young infants demonstrate sensitivity to animate agents (e.g. Poulin-Dubois et al., 1996) and differentiate accidental from intentional actions (e.g. Carpenter et al., 1998).

However, others have questioned the universality of the “intention-to-cause bias”. The original study focused on English-speaking children, but the mapping of form to meaning when describing causal scenes differs across languages. To address this issue, Kanero, Hirsh-Pasek, and Golinkoff (2015) carried out a similar study asking children to select the best description for causal scenes from a choice of declarative (causal, “The boy broke the tower”) or passive (non-causal, “The tower was broken”) sentences, but extended the study to include both English and Japanese-speaking children in two age groups (three and four years). They found no difference between the English and Japanese children in their preference for causal descriptions for intentional actions (3 yrs, English = 66%, Japanese = 63%; 4 yrs English = 82% Japanese = 86%); or accidental actions (3 yrs English = 51%, Japanese = 55%; 4 yrs English = 73%, Japanese 66%), although both language groups preferred causal descriptions for intentional over accidental actions, and both groups of four-year-olds showed...
a stronger overall preference for causal descriptions than the three-year-olds. They concluded that children in both language groups exhibit an “intention-to-cause bias”, a conclusion that was based in part on inferences from previous adult data. Specifically, they observed that the English and Japanese adults in Fausey et al.’s (2010) study who were asked to describe intentional and accidental events showed language-specific differences in their use of agentive descriptions (see above) and, coupled with their own data, they conclude these differences must be learned at some point in development after four years of age. However, task differences between the studies mean that it is impossible to draw strong conclusions, and highlight the importance of testing adult controls on the same task as children in order to draw clearer developmental comparisons.

From the above, we can derive the following predictions:

(i) If children operate with an “intention-to-cause bias”, we would expect to see a similar preference for causal language to describe intentional over accidental scenes in both English and Japanese children at three years of age (approximately 63–67% for intentional scenes, 50–55% for accidental scenes).

(ii) Based on the findings of Fausey et al. (2010), both English and Japanese adults will prefer causal descriptions for intentional scenes over accidental scenes, but this difference might be more pronounced in Japanese speakers.

(iii) The integration of perspective taking skills, sensitivity to cues such as cultural acceptability of blame assignment, and an understanding of how these cues influence choice of sentence structure is likely to take developmental time. Thus, we would expect any more pronounced preference in Japanese for causal descriptions for intentional over accidental scenes to increase over development.

Summary

The data which suggest a greater use of intransitive descriptions for causal events in Japanese in comparison to English, and the comparative influence of intentionality on choice of sentence structure in the two languages, are largely observational, based on spontaneous adult speech or translational equivalents (with very few experimental studies). Further, while corpus studies of child-directed and child speech have reported a difference in transitive vs. intransitive use between Japanese and English caregivers and children, they have not been directed at explaining why this occurs, or the particular conditions under which different sentence structures are preferred. Thus, very little is known about the comparative development of any transitive/intransitive preference in English- and Japanese-speaking children. Studies suggesting the presence of an “intention-to-cause bias” in young children’s descriptions of intentionally-caused events lack comparative data from older children and/or adults to cast light on the development of language-specific form-meaning mappings. In the studies reported in this paper we address two important limitations of previous work.

First, previous studies have not considered verb-specific differences in sentence structure associations when comparing overall language patterns. For example, a verb-general preference for intransitive forms in Japanese could be obscured by a choice of test verbs which includes a preponderance of verbs mainly used in transitive form, especially if the same verbs in the comparison language show different verb-specific patterns of usage. We introduce the term “transitivity bias” (Theakston et al., 2001) to refer to the distributional characteristics of individual verbs and take account of this in our analyses. Our corpus study thus aimed not only to select causative alternation verbs of comparable meaning in Japanese and English, but to enable comparison of their usage while taking account of differing transitivity bias across the two languages. We also coded our corpus data for argument omissions and agent and patient animacy to establish the extent to which input to children in our two languages differed. As a further test for the effects of language and intentionality on sentence selection independent of verb-specific distributional information gleaned from the input, in our
experimental studies we included both familiar verbs and novel verbs that were modeled equally in the two constructions in each language. In general, the same predictions hold for novel verbs as for familiar verbs, but given the participants’ very limited experience with these verbs, their selection of sentence type may be influenced to a greater extent by the broad patterns of usage in their language.

Second, to understand the development of language-specific vs. universal form-meaning mappings, it is necessary to collect data both from children at different ages and from adults to assess the end-state toward which the children are developing. In the present studies, we collect data on the same tasks from English and Japanese children aged three and five years of age and from an adult control group for each language. We test the predictions outlined above.

**Corpus study**

A Corpus study was first undertaken, to determine the relative use of transitive vs. intransitive frames with causal verbs in English and Japanese child-directed speech, and to identify verb-specific differences in use. Causative alternation verbs can be used in both transitive sentences including the information of the agent and patient (e.g. “He opened the door” / “Kare-wa doa-o aketa”) and intransitive sentences including only the patient (e.g. “The door opened” / “Doa-ga aita”).

Japanese data were obtained from the Miipro corpus of four Japanese children, part of the Child Language Data Exchange System (CHILDES) database of spontaneous speech (Miipro corpus, Miyata, 2012). The data consist of a series of conversations between Japanese caregivers and their monolingual children engaged in natural play. From this corpus, we examined all verb usage in child-directed speech between ages 3:0 and 3:11 (comprising a total of about 77 hours of conversation). All causal verbs with transitive and intransitive counterparts were then extracted. Their occurrence in simple and compound sentence structures to describe causal scenes was coded according to whether the frame was intransitive or transitive to determine the transitivity bias (percentage use in the transitive sentence structure) for each verb. Although, as is common in Japanese, subjects and/or objects can be omitted in conversation, causative alternation verbs have transitive/intransitive pairs that follow basic phonological rules, often sharing the same stem. Usually, transitive verbs, which have intransitive counterparts, end with either an “eru” or a “su” sound (e.g. okosu: wake up somebody), whereas the intransitive counterparts tend to end with an “aru”, “u” or “eru” sound (e.g. okiru: wake up on your own), permitting straightforward differentiation between intransitive and transitive verb uses. Transitive usage of “ugokasu/move” was not observed in Miipro corpus, so the frequency by caregivers was also checked from the Hamasaki corpus (Hamasaki, 2002; Oshima-Takane, MacWhinney, Sirai, Miyata, & Naka, 1998) and Okamoto corpus (Okayama, 1970, 1973; Shirai, Miyata, Naka, & Sakazaki, 2001).

English data were extracted from natural play-based interactions between 12 children and their caregivers (Theakston & Rowland, 2009), recorded from age 2;10 to 3;6. This corpus was used solely to extract instances of comparable verbs identified from the Japanese data to determine their relative use in transitive vs. intransitive sentence frames in English. The target verbs appeared in the English data between 17 and more than 600 times. Approximately 180 utterances per verb were extracted equally across the dyads as far as possible, and starting from the beginning of the data set. Where the total number of occurrences was below this target of 180, all were used. Verb uses were coded as transitive or intransitive, and their transitivity bias calculated.

Fourteen Japanese causative alternation verbs were selected. These were verbs which could occur in a transitive sentence with both animate and inanimate patients, and had closely equivalent meanings to the corresponding English verbs. In both languages these verbs encompassed wide variation in the degree of transitivity bias, and the bias of any given verb was not always the same in English and Japanese (see Table 1).

A Wilcoxon signed ranks test was conducted to determine whether there was a difference in the proportional transitivity bias in the use of our target verbs between English and Japanese caregivers, to establish whether the observed cross-linguistic differences in the preference for transitive sentence frames
outlined in the Introduction held for our test verbs (prediction 1). For the purposes of this comparison, we excluded the data for the verb “float” since there were only two exemplars in the Japanese data, so estimates of transitivity bias for this verb may not be accurate. The results showed that there was a significant difference in use ($Z = -2.13$, $N = 13$, $p = .03$) with English caregivers using more transitive frames (Mean = 63.8%) than Japanese caregivers (Mean = 43.3%) with many of our target verbs, in line with the broader patterns of use observed in previous examinations of child-directed speech in the two languages. The transitivity bias for all 14 verbs was used as a predictor in the experimental study analyses to take account of differences in the bias of individual verbs between the two languages.

We further examined the corpus data for the 12 verbs used in Experiment 1 to establish the relative use of animate, inanimate and omitted subject and object arguments in the two languages in transitive and intransitive constructions (see Figure 1 for the mean percentage use across verbs for each argument). Agent and patient animacy was coded based on the coding scheme reported in Theakston et al.

| Japanese (Intransitive/Transitive) | Transitive | Intransitive | Transitivity Bias (%) | Transitive | Intransitive | Transitivity Bias (%) |
|-----------------------------------|------------|--------------|-----------------------|------------|--------------|-----------------------|
| Drop (Ochiru/Otosu)              | 129        | 53           | 71                    | 114        | 12           | 90                    |
| Melt (Tokeru/Tokasu)             | 0          | 8            | 0                     | 3          | 18           | 14                    |
| Stop (Tommaru/Tomatta)           | 42         | 37           | 53                    | 100        | 101          | 40                    |
| Close (Shimaru/Shimeru)          | 37         | 10           | 79                    | 169        | 17           | 91                    |
| Roll (Korogaru/Korogasu)         | 4          | 5            | 44                    | 202        | 41           | 83                    |
| Float (Uku/UKaberu)              | 1          | 1            | 50                    | 1          | 8            | 11                    |
| Ring (Naru/Narasu)               | 10         | 12           | 45                    | 50         | 23           | 68                    |
| Freeze (Katamaru/Katameru)       | 2          | 4            | 33                    | 1          | 15           | 6                     |
| Spin (Mawaru/Mawasu)             | 8          | 19           | 30                    | 32         | 21           | 60                    |
| Bend (Magaru/Mageru)             | 1          | 19           | 5                     | 25         | 23           | 52                    |
| Break (Kowareru/Kowasu)          | 46         | 82           | 36                    | 274        | 47           | 85                    |
| Open (Aku/Akeru)                 | 4          | 92           | 4                     | 197        | 26           | 88                    |
| Move* (Ugoku/Ugokasu)            | 22         | 7            | 75                    | 123        | 57           | 68                    |
| Tear* (Yabukeru/Yabuku)          | 10         | 6            | 88                    | 11         | 2            | 85                    |
| Mean (excluding “float”)         |             |              | 43.8%                 | 123        | 57           | 68                    |
|                                  |             |              | (43.3%)               | 11         | 2            | (85)                  |

NB: Transitivity Bias was calculated by this formula [the raw frequency of transitive verbs/(the raw frequencies of intransitive + transitive verbs)]

*Move and Tear were substituted for Freeze and Float in study 2.

Figure 1. Mean percentage of transitive and intransitive subject and object arguments that are animate, inanimate, omitted or ambiguous.
(2012). Humans, human-like creatures (for example, characters from children’s television programs), animals, parts of the body, animal toys and animation characters (such as Thomas the tank engine) were coded as “animate”, as were the pronouns “I”, “you”, “he” and “she”. Inanimate entities were coded as “inanimate”, including objects referred to by the pronoun “it”. Use of the English “them”, “all” or “one” was coded as ambiguous. Missing arguments were coded as omissions.

It is clear from these data that both Japanese and English caregivers produce more animate than inanimate agents (subjects) in their transitives, but this is much more marked in English due to a very high proportion of argument omissions in Japanese. In addition, both English and Japanese caregivers produce more inanimate than animate patients in their intransitives (as subjects), and in their transitives (as objects), but Japanese caregivers are much more likely to omit the patient argument altogether in both constructions than English speakers. Thus, Japanese children have less exposure to the full transitive construction than English children, due to argument omissions (prediction 2).

Experiment 1

In Experiment 1 we examined whether language (and patient animacy) affects Japanese and English speakers’ preference for transitive or intransitive sentence constructions as a description of causal events, and when in development any observed differences emerge.

Participants

English and Japanese monolingual adults and children aged 3 to 5 years participated in the study. English speakers were recruited in Greater Manchester (UK) and Japanese speakers in Toyama (Japan). The English and Japanese adults were all students at a Sixth-Form college and vocational training college respectively. The children were all attending nursery or pre-school and data collection for all participants was carried out in their institutions.

There were 94 English speakers in total: 29 three-year-olds (10 male, aged 3;3 to 4;6, M = 47 months), 27 five-year-olds (13 male, aged 5;0 to 5;11, M = 66 months), and 38 adults (8 male, M = 16.55 years). There were 116 Japanese speakers in total: 23 three-year-olds (11 male, aged 3;7 to 4;6, M = 48 months), 32 five-year-olds (18 male, aged 5;0 to 5;11, M = 65 months) and 61 adults (35 male, M = 20.61 years). An additional 29 participants began the study but were excluded due to failing an initial screening test (12 English 3-yr-olds, one English 5-yr-old, two Japanese 3-yr-olds), failing to complete both test sessions (seven Japanese 3-yr-olds, five Japanese 5-yr-olds) or whose responses indicated they had failed to understand the task (one English 5-yr-old, one Japanese 3-yr-old), see Procedure, below for details. In addition, one computer animation failed during the novel verb testing of the Japanese adult participants, resulting in no data for the verb “ruku/rukero” in the animate condition.

Stimuli

Test items

For the 12 causative alternation verbs identified in the Corpus study, a total of 24 short computer animations were produced using Anime Studio Pro 11 (Smith Micro Software, Inc.), two per verb, in which a person performed an action that led to a state change in a patient (e.g. breaking a bell). Eight animate agents (four boys, four girls) featured in the animations, but for each verb one animation depicted an animate patient, the other an inanimate patient. Each animation could be described using a transitive or intransitive sentence (e.g., “She stopped the man/The man stopped”, see Appendix 1). Since some of the test verbs (open, close, ring and break) are not used commonly with animate patients, two pseudo-animate characters, Mr. Box and Mrs. Bell (a box or a bell with faces), were created to make more animate-like patients for these verbs.

To test whether we could observe language-general transitivity preferences in the absence of verb-specific differences in input, four novel causal verbs were created and eight corresponding test
animations created with both transitive and intransitive descriptions (e.g., “She meeked the chicken / The chicken meeked”, see Appendix 2 for a description of the novel actions & Appendix 3 for the novel verb training and test sentences). For each novel verb two training animations were shown to teach the meaning of the verb, after the familiar verb test items but before the novel verb test items. English novel verb forms (meek, lorp, blick and dax) were chosen from those used by Naigles, Bavin, and Smith (2005), but using different actions. Japanese novel verbs were selected from those used by Imai, Haryu, Okada, Hirsh-Pasek, Golinkoff, & Shigematsu (2008) for which easily recognizable intransitive/transitive counterparts could be created according to normal phonological rules (e.g. chimerau and chimaru). The actions represented by the novel verbs could not easily be described by a single familiar verb.

For each of the 32 test animations, an audio stimulus was created consisting of two sentences describing the scene, one transitive and the other the intransitive.

**Practice and filler sentences**

Three practice and 5 filler animations were made (see Appendix 6). They were used to teach the children the task and to disrupt any preference for a single structure throughout. The practice and filler animations were presented with one correct and one incorrect audio sentence.

**Procedure – children**

Each child was tested over two sessions (Session 1: familiar verbs, Session 2: novel verbs) each lasting approximately 20 minutes. For English children, testing was conducted by a fluent English speaker and the first author, and for Japanese children, by the first author alone. The audio stimuli were delivered through two hand puppets (teddy bear and elephant), one of which described the scene using the transitive sentence and the other the intransitive. The child was asked to choose which puppet gave the best description of what they had seen.

**Warm-up**

The two hand puppets were introduced and used to maintain the child’s interest and engagement in the study. The child was then told, e.g. “Now you are going to watch some animations. Then Teddybear and Elephant are going to tell the story about the animation. Can you choose which puppet tells the story better?” On screen, two animation characters (Mr. Box and Mrs. Bell) were introduced as Teddy Bear and Elephant’s friends. They were shown moving and with changing facial expression. Both characters were then shown on the same screen and the child was asked to point out each character (e.g. Can you show me Mr. Box?).

Three example animations were presented to the child to teach them the task. Only example and filler animations had obvious wrong answers. If the child chose the wrong one the researcher said, “Really? Are you sure? Shall we try to watch the animation and listen to the puppets more carefully?” If the child again failed to respond, the researcher corrected the child’s answer then moved on to the next animation.

**Familiar verb session**

In Session one, 12 familiar verbs were presented with animate and inanimate patients (total 24 scenes) with three initial examples and five fillers. After every fourth familiar verb animation, one filler animation was presented. The child, together with the puppets, watched each animation on a PC screen. One puppet then produced a transitive description (e.g. “She stopped the car/Kanojyo-ga kuruma-o tometa”) and the other an intransitive (e.g. “The car stopped/Kuruma-ga tomatta”). The transitive/intransitive sentences were delivered in real time by the experimenter as if voiced by the hand puppets. Next the child was asked to choose, “Which animal/puppet said it best?/Doocchino doubutuga jouzuuni ohanashidekitakana?” by the other experimenter, who was also controlling the videos. If the child failed to respond, they were told, “Let’s watch it again. So please watch the animation and listen to the puppet carefully/Mouikkai mitemiyo. Kondoha doubutuno ohanashio shikkarikiken”. If the child again failed to respond, the researcher moved on to the next animation. After each response, the child received encouragement.
**Novel verb session**

The procedure for introducing novel verbs followed that recommended by Matsuo, Kita, Shinya, Wood, and Naigles (2012). The novel verb session consisted of two parts: the training phase and the test, for each verb in turn. In the training phase, animations presenting the novel actions were shown on the computer screen, accompanied by a recorded audio explanation. Firstly, the gerund forms of the verbs were introduced, and transitive/intransitive present continuation forms were produced as the animations took place. After the animations finished, the past tense form of the verb was used in both the transitive/intransitive frame to ensure participants were aware that the verbs can be used both transitively and intransitively. After the animation, the puppeteer repeated the transitive and intransitive past tense sentences and asked each child to repeat the sentences aloud, to enhance verb learning. The test phase used the same procedure as for familiar verbs. The patients used in test trials with the novel verbs were different from those in the training sessions.

**Counterbalancing**

To control for order effects and puppet-specific preferences in both familiar and novel verb sessions, a number of measures were taken. The position of the puppets (right or left) was changed half way through the session. Each experiment was run according to one of four counterbalanced sequences (scripts). The test verb order, which puppet spoke first and whether the first test sentence was transitive or intransitive were all randomized. The number of participants tested using each sequence was balanced.

**Procedure – adults**

The same animations were presented to the adults, but the audio stimuli were prerecorded and presented immediately following the viewing of the animation rather than by puppets. Participants indicated their preferred sentence in each pair by ticking a corresponding number on a pre-printed form (the sentences were presented only orally). Adults were tested in groups (whereas children were tested individually), and sequentially watched the familiar verbs and the novel verb test animations without a break and a training session, as they can infer meaning from sentence structure quickly and reliably (Gillette, Gleitman, Gleitman, & Lederer, 1999).

**Screening and exclusions**

As described above (3.2.2), three practice and five filler animations were presented to check whether participants understood the task. This resulted in eight screening trials in total, where only one of the sentences accurately described the event. If participants understood that their task was to select the best sentence to describe the animation, they should score highly on these trials. We also examined the data to determine if participants showed a consistent pattern of response which indicated a failure to engage with the task as intended (for children: always choosing the same puppet, the first/second speaker, or the right/left puppet; for adults: always choosing the first/second speaker).

The filler animations using stroke and pull were found to lack discrimination and were therefore excluded from the screening analysis (by chance, the random pairing of events for the fillers – stroke/bump & pull/rock – resulted in both target and distractor verbs being a reasonable match to the animation). If participants failed to score four out of the remaining six correct answers on the screening trials, their data was excluded from the analysis, as were participants who showed a consistent (but irrelevant) pattern of responses across trials. These response patterns suggested that the participants were not engaging with the task as intended.

**Results**

This study examined whether language (or the animacy of the patient) affects Japanese and English three- and five-year-olds’ and adults’ choice of sentence construction (transitive or intransitive) to
describe causal scenes. Each participant’s responses were coded according to whether they chose the transitive or intransitive sentences as the best description of the animations, and the mean transitive preference calculated across participants for each condition.

As the task involved a forced choice paradigm, we first wanted to establish that the participants understood the task and were not choosing sentences purely at random. Although it is of course possible that participants could genuinely display an equal preference for the two sentence types, response patterns that deviate significantly from chance performance (50/50) would provide stronger evidence of having fully engaged with the task. To determine whether the proportions of transitive preference were above/below a chance level (50%), one-sample tests were conducted (Flowers, Bolton, & Brindle, 2008). For all groups except English three-year-olds, participants chose the transitive descriptions more than would be expected by chance (ps < .032). Taken together, these results suggest that the observed responses were not purely guessing behavior, with the possible exception of the English three-year-olds, although differential responding from three-year-olds in Experiment 2 suggests this explanation is unlikely.

Mixed effects logistic regression models were fitted to the data in R (Bates, Maechler, Bolker, & Walker, 2015, lme4 version 1.1–20), beginning by adding each main effect to a base model including only random effects and the control variable transitivity bias (novel verbs were assigned a value of 50%), followed by the addition of interaction terms to a model including only main effects. At each stage, ANOVA comparisons were used to establish the contribution of each new predictor to overall model fit. All main effects which contributed to a significant interaction term were retained in the final model. Random effects were Participant and Item and fixed effects were verb transitivity bias (centered) plus the four manipulations of age group (three-years vs. five-years vs. adults), language (English vs. Japanese), animacy (animate vs. inanimate patients), verb type (familiar, novel) and their interactions.

Figure 2 shows the mean preference for transitive sentences across verbs with animate and inanimate patients, for familiar verbs, and Figure 3 shows the results for novel verbs. The final model included all of the main effects plus the two-way interactions between age group and language, and verb type and language (see Table 2 for the model coefficients). Transitivity bias in the input was a significant predictor of sentence selection for all participants.

Post hoc comparisons were conducted using the Emmeans package in R to explore the interactions. For the language by age group interaction, these revealed that for English speakers, the five-year-olds (M = 81.25) and adults (M = 80.21) chose more transitive sentences than the three-year-olds

![Figure 2](image-url)  
*Figure 2.* Mean proportion transitive preference across verbs with animate and inanimate patients: familiar verbs.
In Japanese, by contrast, adults (M = 79.06) chose more transitive sentences than both three-year-olds (M = 58.70, p < .001) and five-year-olds (M = 66.60, p = .001). Comparing the age groups across languages revealed that English five-year-olds (M = 81.25) preferred transitive sentences more than Japanese five-year-olds (M = 66.60, p = .001), but there were no differences in transitive preference for either the three-year-olds or the adults (p = .080 and .171 respectively). For the language by verb type interaction, there was no difference between English and Japanese speakers in their transitivity preference for familiar (p = .195) or novel (p = .100) verbs, but whereas English speakers responded to both familiar and novel verbs in the same way (Ms = 70.26%, 69.75%, p = .786), Japanese speakers showed a weaker transitivity preference for novel (M = 65.88%) than familiar verbs (M = 70.36%, p = .007).

**Discussion: corpus study & experiment 1**

Languages encode causal events differently, so children are required to learn their own language-specific form-meaning mappings. In these studies, we investigated whether there are language-specific differences in transitivity preferences to describe causal events in Japanese and English, and when in development any differences emerge, taking account of the input children hear with causative (transitive/intransitive) alternation verbs.

Our first two hypotheses were tested through examination of corpus data. Previous corpus studies (e.g. Fukuda & Choi, 2009; Nomura & Shirai, 1997; Tsujimura, 2006) have reported that Japanese speakers use more intransitive than transitive sentences in general in spoken language, and display...
more argument omissions, but have not typically controlled for different types of events (verbs) across the two languages. Our corpus data corroborated these findings when controlling for verb, demonstrating that Japanese child-directed speech contains more intransitive descriptions of causal events, and more argument omissions, than English child-directed speech.

Our final hypothesis was that, in line with usage-based approaches to language learning and reflecting differences in input, English children will converge on the patterns of sentence preference seen in adult speakers earlier than Japanese children (reflecting the greater availability and reliability of word order cues to sentence meaning in the input to English children, due to a lack of argument omissions). Our experimental results provide support for this suggestion; English-speaking five-year-olds resembled their adult language counterparts but showed a stronger transitivity bias than three-year-olds whereas Japanese five-year-olds differed from adults and resembled the three-year-old group, showing a weaker transitivity preference (significant differences were found between the two five-year-old language groups). Broadly speaking, these findings are consistent with the suggestion that Japanese children will take longer to establish the form-meaning mappings associated with the full transitive construction than English children because (i) Japanese allows argument ellipsis, thus providing fewer opportunities for children to learn this construction from their input, and (ii) Japanese caregiver input favors the intransitive construction, thus transitive uses are less frequent and likely to be learned later. Furthermore, even in our English children, we see a developmental shift toward a stronger transitivity preference at five years than at three years. This is consistent with previous observations of English-speaking children’s early verb use (e.g. Theakston et al., 2001; Valian, 1991) and may reflect their sensitivity to the high token frequency of early learned intransitive verbs (e.g. go, come) in their input, and the relatively later learning of larger numbers of less frequent transitive verbs. The lack of a language difference between our adult speakers, despite the widely reported differences in overall use of transitive vs. intransitive constructions, mirrors the findings of Fausey et al. (2010) for adult descriptions of intentional causal events. For adults, these experimental contexts may lead to an overreliance on maximally informative linguistic expressions, encoding all of the information present in the scene, that is not typical of conversational discourse (see also Theakston, 2012). However, we also observed that Japanese speakers, unlike English speakers, showed a weaker preference for transitive descriptions of events encoded using novel verbs. This suggests that, in the absence of verb-specific knowledge, there is some influence of the broader language tendencies observed in previous studies, namely a stronger preference for intransitive descriptions (of causal events) in Japanese speakers.

In conclusion, Experiment 1 showed that in an experimental situation the differential preference for transitive vs. intransitive descriptions, between Japanese and English speakers observed in corpus data could not be demonstrated consistently. However, we did observe language differences in terms of the trajectory of acquisition, and in the differentiation between familiar and novel verbs. Taken together, these results suggest that there are different trajectories in the acquisition of the transitive construction in the two languages, and that these trajectories can be explained by children’s sensitivity to the distributional properties of the input they hear, and the gradual reweighting of the available cues to sentence meaning as children accumulate greater experience with the less frequent structures in their language. Another factor purported to influence choice of sentence construction is intentionality, which we investigate in Experiment 2.

**Experiment 2**

Experiment 2 examined whether intentionality affects English and Japanese speakers’ preference for transitive or intransitive constructions to describe causal events. The design and methodology was very similar to that of Experiment 1.

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As our corpus analysis was based on existing transcripts, we cannot be sure that all intransitive uses of the selected causal alternation verbs occurred in contexts including a causal agent. However, as we matched the verbs in the two languages as closely as possible for meaning, it seems unlikely that the observed differences in use of the transitive and intransitive constructions reflects differences in the kinds of events the verbs were used to describe. However, only a detailed coding of video data could fully rule out this possibility.
Participants

English and Japanese adults and children aged three- to five-years participated in the study. They were new participants, drawn from the same pool as in Experiment 1. The 78 English speakers comprised 21 three-year-olds (8 male, aged 3;3 to 4;6, \( M = 46.48 \) months), 26 five-year-olds (11 male, aged 5;1 to 5;11, \( M = 66.58 \) months), and 31 adults (5 male, \( M = 16.65 \) years). The 88 Japanese speakers comprised 25 three-year-olds (16 male, aged 3;5 to 4;6, \( M = 46.56 \) months), 27 five-year-olds (13 male, aged 5;0 to 5;11, \( M = 64.96 \) months), and 36 adults (24 male, \( M = 19.58 \) years).

Stimuli

Verbs

The same familiar verbs were used as in Experiment 1, except that move and tear replaced float and freeze, because these two verbs were difficult to depict in both accidental and intentional scenes (see Appendix 4). The novel verbs were the same as those used in Experiment 1, but the actions were changed to better allow depiction of intentional and accidental actions (e.g. “He meeked the flower/The flower meeked”) (See Appendices 2 & 5).

Test stimuli

Instead of using animations, the verbs were depicted by actors (one English male and one Japanese female) in short recorded scenes. Each video clip had sound effects to clarify what the performer demonstrated in each scene. Thus, the agents of the actions were animate and the same for each familiar and novel verb. All the patients were inanimate. The 12 familiar verbs and four novel verbs were each recorded depicting the agent accidentally or intentionally performing an action that led to a state change in an inanimate patient, resulting in thirty-two video clips in total. Each clip was presented with an intransitive and transitive descriptive sentence.

To confirm that the videos were perceived as depicting intentional/accidental actions, all test videos without accompanying sentences were rated on a seven-point scale (7 = completely intentional, 1 = completely accidental) by Japanese (n = 27) and English adults (n = 15). T-tests showed that both Japanese and English adults differentiated between the accidental and intentional scenes (Mean rating for accidental vs. intentional scenes = 3.26 vs. 5.45 in Japanese; 3.08 vs. 6.19 in English, \( t(15) = 7.96 \) & \( t(15) = 10.17, ps < .001 \)).

Practice and filler items

New practice and filler videos were made (see Appendix 6), since some actions used in the corresponding animations in Experiment 1 were not so easily performed and recognizable in videos, and to address the issue with certain matched stimuli encountered in Experiment 1.

Procedure, counterbalancing

Procedure and counterbalancing were the same as in Experiment 1.

Screening and exclusions

Three example animations and five filler animations (for screening) were presented together with one correct sentence and one distractor sentence describing the scenes. If participants failed to get 6 out of 8 of these correct, they were excluded. In addition, participants were excluded if they demonstrated consistent but irrelevant biases in their responding as in Experiment 1. The data from all adult participants was considered valid. An additional seventeen English children were tested but excluded (fourteen three-year-olds for always choosing the first/second puppet (8), failing the screening trials (5), and not completing the novel verb session (1), and three five-year-olds who
always chose the same puppet). An additional five Japanese children were excluded (four three-year-olds for not completing the novel verb session (3) and always choosing the same puppet (1), and one five-year-old for not completing the novel verb session).\(^2\)

**Results**

This study examined whether the intentionality of an action influences Japanese and English three- and five-year-olds’ and adults’ sentence construction preferences (transitive or intransitive) to describe causal scenes. Each participant’s responses were coded according to whether they chose the transitive or intransitive sentences as the best description of the animations, and the mean transitive preference calculated across verbs for each condition.

As the task again involved a forced choice paradigm, but this time using videos rather than animations, we first wanted to establish that the participants understood the task and were not choosing sentences purely at random. To determine whether the proportions of transitive preference were above/below a chance level (50%), one-sample T-tests were conducted. For both languages and in all age groups, respondents chose the transitive sentences significantly more than would be expected by chance (\(p\) values < .003). Taken together, these results suggest that the observed responses were not purely guessing behavior.

Figure 4 shows the transitive preference for accidental and intentional scenes with familiar verbs, and Figure 5 shows the data for novel verbs. The data suggest that speakers in both languages showed a similar transitive preference with intentional scenes which increased from three-years to five-years to adulthood, whereas for accidental scenes, Japanese speakers showed a weaker preference for transitives which was most marked in adulthood.

Mixed effects logistic regression models were fitted to the data, following the same procedure as in Experiment 1. Random effects were Participant and Item and fixed effects were verb transitivity bias (centered) plus the four manipulations of age group (three-years vs. five-years vs. adults), language (English vs. Japanese), intentionality (accidental vs. intentional), verb type (familiar, novel) and their interactions. Initial model fitting revealed that transitivity bias in the input was a significant predictor of sentence selection for all participants. There were significant two-way

\[\text{Figure 4. Mean proportion transitive preference across verbs with intentional and accidental scenes: familiar verbs.}\]

\(^2\)The difference in exclusion rates in both studies appeared to be due to less distracting test environment conditions in Japanese nurseries.
interactions between verb type and intentionality ($\chi^2 = 11.612, df = 1, p = .001$), language and intentionality ($\chi^2 = 11.403, df = 1, p = .001$), and age group and intentionality ($\chi^2 = 246.28, df = 2, p < .001$), and a three-way interaction between verb type, intentionality and language ($\chi^2 = 6.186, df = 2, p = .045$). Consequently, the data were split by verb type (familiar, novel) and separate models run to allow interpretation of the three-way interaction. The main effects of intentionality and language which contributed to this three-way interaction were retained in the models separated by verb type for comparability.

For familiar verbs, the final model (see Table 3) included the main effects plus the two-way interactions between language and intentionality, and age group and intentionality.

Posthoc comparisons were run using the Emmeans package in R to explore the interactions. For the language by intentionality interaction, speakers of both languages preferred transitive descriptions for intentional scenes (English $M = 83\%$, Japanese $M = 83\%$) over accidental scenes (English $M = 67\%$, Japanese $M = 53\%$, $ps < .001$), but whereas there was no difference between English and Japanese speakers for intentional scenes ($p = .764$), Japanese speakers chose transitive descriptions for accidental actions less often than English speakers ($p = .001$). For the age group by intentionality interaction, all age groups preferred transitive descriptions for intentional scenes (three-years $M = 66\%$, five-years $M = 88\%$, adults $M = 95\%$) over accidental scenes (three-years $M = 59\%$, five-years $M = 69\%$, adults $M = 52\%$, $ps < .017$) but this difference was much more marked in the adults than the three-year olds. For intentional scenes, the difference between each consecutive age group was significant ($ps < .001$) whereas for accidental

![Figure 5. Mean proportion transitive preference across verbs with intentional and accidental scenes: novel verbs.](image)

**Table 3.** Model coefficients for Experiment 2 – familiar verbs.

|                                | Estimate | Std. Err | z value | p value |
|--------------------------------|----------|----------|---------|---------|
| (Intercept)                    | 0.354    | 0.194    | 1.825   | 0.068   |
| Transitivity bias              | 0.007    | 0.003    | 2.667   | 0.008   |
| Language(Japanese)             | −0.579   | 0.180    | −3.220  | 0.001   |
| Intentionality(intent)         | 2.888    | 0.212    | 13.616  | < 0.001 |
| Agegroup(five)                 | 0.904    | 0.199    | 4.551   | <0.001  |
| Agegroup(three)                | 0.391    | 0.203    | 1.920   | 0.055   |
| Language(Japanese):Intentionality(intent) | 0.642   | 0.178    | 3.611   | <0.001  |
| Intentionality(intent):Agegroup(five) | −1.923  | 0.242    | −7.931  | <0.001  |
| Intentionality(intent):Agegroup(three) | −2.885  | 0.229    | −12.583 | <0.001  |
scenes, the five-year olds showed a stronger transitive preference than both three-year olds ($p = .047$) and adults ($p < .001$).

For novel verbs, the final model (see Table 4) included the main effects plus the two-way interaction between age group and intentionality. There was no effect of language on speakers’ transitivity preferences for novel verbs. Posthoc comparisons to explore the intentionality by age group interaction revealed that whereas both adults and five-year olds preferred transitive descriptions for intentional over accidental scenes (adults $M = 87\%$ intentional scenes, $M = 48\%$ accidental scenes, $p < .001$; five-year olds $M = 81\%$ intentional scenes, $M = 73\%$ accidental scenes, $p = .040$), three-year olds did not show this preference ($M = 62\%$ intentional scenes, $M = 61\%$ accidental scenes, $p = .906$). For intentional scenes, five-year olds and adults showed a stronger transitive preference than three-year olds ($p = .002$ and $p < .001$ respectively) whereas for accidental scenes, adults showed a weaker transitivity preference than both five-year olds and three-year olds ($p < .001$ and $p = .041$ respectively).

**Discussion**

In Experiment 2, we investigated whether intentionality affects English and Japanese adults’ preferences for transitive vs. intransitive sentences to describe causal scenes, and whether any effect can be seen in children. We tested the following predictions. First, if children operate with an “intention-to-cause bias” favoring causal descriptions for intentionally caused events carried out by animate agents over those unintentionally caused or caused by inanimate objects (Kanero et al., 2015; Muentener & Lakusta, 2011), we would expect to see a similar preference for causal language to describe intentional over accidental scenes in both English and Japanese children at three years of age. In fact, what we found was that with familiar verbs, all speakers showed a greater preference for transitive descriptions of intentional over accidental scenes, but this difference increased with age. With novel verbs, the younger children failed to show an event-type preference and in fact children of both ages demonstrated a stronger transitive preference than adults for accidental scenes. Taken together, these results suggest that the children show a much weaker differentiation than adults in their mapping of intentional and accidental events to language, in contrast to the predictions of the “intention-to-cause bias” hypothesis, highlighting the importance of comparing children’s and adults’ responses on the same task.

Second, based on the findings of Fausey et al. (2010), we predicted that both English and Japanese adults would prefer causal descriptions for intentional over accidental scenes, but that this difference might be more pronounced in Japanese speakers (reflecting the observation from typological studies that Japanese speakers tend to defocus the agent of accidental events). Fausey et al. (2010) asked English and Japanese adults to describe test scenes freely, and noted that in both languages, adults used transitive descriptions with intentional scenes to a similar degree, but with accidental scenes they produced fewer transitive constructions.
(with a greater reduction in Japanese than English speakers). Our study (which takes account of transitivity bias) confirms this for familiar verbs, with similar patterns observed in the novel verb data.3

Finally, we predicted that if it takes developmental time for children to integrate their ability to adopt the perspectives of others, sensitivity to cues such as cultural acceptability of blame assignment, and developing linguistic representations, any more pronounced preference for transitive descriptions of intentional over accidental scenes in Japanese over English-speakers should increase over development. In addition, we predicted that sensitivity to intentionality might be stronger for novel verbs reflecting participants’ lack of experience with their specifics of use. We found that with familiar verbs, even three-year-olds showed sensitivity to intentionality to guide sentence selection, but we observed larger differences between intentional and accidental events both across development and between languages. With unfamiliar verbs, this difference was not seen in the three-year-olds, and although it did still hold for five-year-olds and adults, there appeared to be a smaller difference in the five-year-olds between the English and Japanese data. Thus, we can conclude that children do not need a fully developed understanding of other minds (such as that indicated by consistently passing false belief and theory of mind tasks, Gopnik, 1990) to show sensitivity to the role of intentionality in sentence selection (as seen with familiar verbs). However, the changes in performance over development may reflect the difficulty children face in coordinating different sources of information, as observed in other areas of language use. Although children are sensitive to the intentionality of actions from at least 12 months of age (Carpenter et al., 1998), interpreting intentionality in terms of its relation to perspective taking and choice of sentence structure is more complex. For the kinds of unfamiliar verbs and actions adopted in the current study, it may be more difficult for children to identify intended vs. accidental outcomes and/or map this difference onto language (see e.g. Abbot-Smith, Imai, Durrant, & Nurmsoo, 2017).

It is interesting to note that whereas we found language differences at five years of age in Experiment 1 (where the depicted actions were intentional), with English children selecting transitive descriptions more often than Japanese children, no such effects were observed for intentional scenes in Experiment 2. This difference between the experiments provides further insight into the difficulties that children may face in identifying and integrating different sources of information in their selection of form-meaning mappings. It appears that the direct contrast between intentional and accidental scenes in Experiment 2 may have highlighted “intentionality” and its relation to form-meaning mappings for the intransitive and transitive constructions, leading Japanese children, in particular, to mark the different events by selecting the transitive construction more often for intentional scenes. The lack of a direct contrast in Experiment 1 may have made the intentionality of the actions less salient for children, as may the use of stimuli depicting animations (Experiment 1) vs. videoed actors (Experiment 2). As a result, their selection of sentence structure in Experiment 1 appears more tightly tied to their knowledge based on the input they hear.

To summarize, our results suggest that although speakers of both Japanese and English prefer transitive sentences for intentional, causal events, children learning these languages are sensitive to language-specific differences in the use of transitive sentences to describe accidental scenes by three years of age (at least for familiar verbs). However, this sensitivity does not equate to adult-like knowledge as children in both language groups demonstrate different preferences than their adult counterparts for both event types, in general failing to differentiate the two events to the same extent as adults.

3The lack of a language by intentionality interaction in our novel verb data reflects (i) a lack of power to detect a three-way interaction between age, language & intentionality in the subset of novel verb data; only the Japanese three-year-olds fail to show any preference for transitive descriptions of intentional over accidental scenes, and (ii) the Japanese five-year-olds show a much weaker intentionality preference with novel than familiar verbs, and thus more closely resemble the English children in their novel verb performance. In general, the Japanese children seem to treat the novel verbs in Experiment 2 differently from the familiar verbs whereas the English children do not. Thus, although the Japanese adults show the distinction between intentional and accidental scenes to a greater degree than English adults with both familiar and novel verbs, this does not reach significance in the novel data alone.
**General discussion**

In these studies, we investigated through corpus analysis and experimentally the emergence of sentence structure preferences in the encoding of causal events in English- and Japanese-speaking children (aged three- and five-years) and the corresponding preferences in adults. These two languages have been reported to differ in how causal events map onto syntactic structure. In our Corpus study and Experiment 1 we focused on the extent to which there are differences in form-meaning mappings for causal scenes between the two languages, and in Experiment 2 on the role of intentionality in sentence selection. We now consider the broader implications of our results.

Previous studies have suggested that Japanese speakers have a greater tendency than English speakers to describe causal actions using intransitive sentences, reflecting a cultural preference to defocus the agent of causal actions (Kittila, 2002; Tsunoda, 1991). We found evidence in support of this observation, when controlling for verb, in our caregiver child-directed speech corpus, and in the children’s and adults’ performance in experimental settings with reference to accidental events. Given the broad support for the existence of a language difference, we suspect that the lack of consistent language-specific differences in our participants’ responses for intentional events is likely to reflect both a preference to mark these kinds of highly intentional events transitively, and, for adults at least, their metalinguistic assessment of the requirements of the experimental task, and subsequent preference for maximally informative linguistic descriptions (e.g. Theakston, 2012), leading to ceiling effects.

We then asked what factors influenced the observed preferences, and when and to what extent children are sensitive to these same factors. In Experiment 1, we observed a different developmental trajectory in the two languages. At age five, English children showed a stronger transitive preference than Japanese children, and while Japanese five-year-olds were similar to three-year-olds, English five-year-olds were similar to adults. We interpret these developmental findings as support for usage-based theories of language acquisition, which assume that children only gradually develop the abstract form-meaning mappings that underpin use of specific syntactic constructions, and do so in ways which reflect the distributional statistics of their input (e.g. Ambridge et al., 2015). Our Corpus analysis demonstrates that Japanese children are less often exposed to transitive sentences with our test verbs, and even when they do hear transitives there is frequent argument ellipsis. Moreover, the word order of the language (subject-object-verb) means that the positioning of a noun relative to the verb is not a reliable cue to the participant’s role in the event. In contrast, English child-directed speech contains more transitive sentences with these verbs with full arguments, and its subject-verb-object word order provides a useful cue in determining a referent’s role in an event. Consequently, Japanese children are expected to have a weaker knowledge of the form-meaning mappings for the full transitive construction, a prediction supported by our results.

The intentionality of an action is also thought to determine choice of sentence construction and use of causal language in adult speakers (e.g. Wolff, 2003), although in Japanese there may be a more general bias toward intransitive, non-causal structures (Fukuda & Choi, 2009; Nishimitsu & Pardeshi, 2010). Children are sensitive to intentionality from early in development (Carpenter et al., 1998), but it is unclear when they become able to map their knowledge onto language. Muentener and Lakusta (2011) argued that a conceptual bias toward causal events, means that children will initially associate causal language with intentionally caused events. However, our results from Experiment 2 suggest that children’s sensitivity to intentionality as a cue for sentence selection increases over development, in line with similar developments in children’s ability to integrate pragmatic information with the use of appropriate linguistic forms in other areas of language (e.g. Matthews et al., 2006). Although our results contrast with those of Muentener and Lakusta (2011) and Kanero et al. (2015) in terms of the size of the preference for causal descriptions of intentional events in English three-year-olds, we note that the children in their studies were selecting between a simple transitive sentence (e.g. “She broke the tower”) and a periphrastic or passive construction (e.g. “She made the tower break”/”The tower was broken”). The periphrastic and passive
constructions are less frequent in child-directed speech than the simple intransitive adopted in the current study, so it is possible that children’s experience with these constructions and the kinds of events they are used to encode led to differences in response strategies. A detailed analysis of the nature of the events these structures are used to describe in the input to children would be needed to gain a clearer understanding of the possible interaction between form-meaning mappings in the input and any cognitive biases children might bring to the language learning task. In addition, the children in these studies were three years of age, and in various areas of language development, three-year-olds have been observed to demonstrate some degree of sensitivity to language-specific form-meaning mappings (e.g. Allen et al., 2007; McDonough et al., 2003). This does not preclude the possibility that younger children might demonstrate more similar cross-linguistic patterns of language use, based on universal cognitive biases.

Taken together, our results suggest that children’s developing knowledge of the language-specific contexts for use of the intransitive and transitive constructions to describe causal events is influenced by the distributional properties of their input and the degree of intentionality on the part of the agent. Children’s sentence selections seemed to reflect their developing knowledge of the transitive construction, based on their relative exposure to its full form in their input to denote causal events: note that in both studies, participants’ responses were predicted by the transitivity bias of the verbs in child-directed speech. In contrast, information about intentionality may not always be salient in the visual scene, and requires children to integrate multiple sources of information (e.g. Gelman, Spelke, & Meck, 1983) concerning the linguistic form, the event type, and the motivations of the protagonist. In our data, the youngest children were initially sensitive to this cue only with familiar verbs whereas adults and older children were able to utilize this information in the processing of novel verbs, suggesting that intentionality cues may be more dependent on the familiarity of a particular event structure for their interpretation.

It is clear that understanding how children map linguistic structure to event structure requires consideration of cognitive factors such as the hypothesized “intention-to-cause bias”, which might be expected to hold across languages (to the extent to which they can be considered independent of language), children’s developing socio-pragmatic abilities, and the language-specific factors which interact with them. To that end, it would be informative to determine to what extent the language-specific input differences and intentionality-related transitivity preferences with our experimental verbs reflect the broader patterns of usage in child-directed speech. However, this is a far from simple issue due to the widespread occurrence of argument omissions in Japanese, and difficulties in determining the mapping of causal and non-causal language to events in (often audio-recordings of) child-directed speech.

One final issue that our data do not directly speak to is the question of the direction of effect between developments in cognition and their associated developments in language. In areas such as the development of false belief/theory of mind understanding and the acquisition of complement clause constructions, there is considerable debate as to the precise nature and direction of influence (see e.g. Astington & Baird, 2005). In other research, some studies with adults suggest that East-Asian and European/American people show cultural differences in perception (Chua, Boland, & Nisbett, 2005; Goto, Ando, Huang, Yee, & Lewis, 2010) with East-Asian populations focusing more on the background in an event than their European/American counterparts. It is thus possible that developments in language can shape aspects of cognition, perhaps by changing a speaker’s focus of attention, but any such effects are subject to considerable debate, and are likely to be bidirectional.

**Conclusion**

In these studies, we examined the role of language and agent intentionality on sentence structure preferences in Japanese- and English-speaking children and adults. We found developmental effects and language-specific differences in the trajectory of acquisition, as well as effects of
intentionality. We conclude that children’s developing knowledge of the full transitive construction and its use to encode causal events is dependent on sensitivity to the distributional properties of their input. In addition, when Japanese and English children hear familiar verbs used to describe causal actions, intentionality is important in their choice of sentence construction. However, sensitivity to this cue is only seen in older children and adults for unfamiliar verbs, and the magnitude of the difference between event types increases over development. Interpreting intentionality and its mappings into language is complex and takes developmental time to learn. These findings have important implications for our understanding of how children’s developing representations of causality map onto their developing knowledge of linguistic structure, and point to the need for further detailed study of the precise properties of the language that children are exposed to. This will allow the development of theoretically motivated predictions about the acquisition of causal language, and more sophisticated models of linguistic representation, processing, and its interplay with other aspects of human cognition over development.

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Appendix

Appendix 1: Transitive and intransitive sentences in Experiment 1 (Familiar verbs).

| Verb: English (Japanese Intransitive/Transitive) | Animate/Inanimate patient | Intransitive sentences | Transitive sentences |
|-------------------------------------------------|---------------------------|------------------------|----------------------|
| Drop (Ochiru/Otosu)                             | Cat/Rock                  | The cat/the rock dropped. | She dropped the cat/the rock. |
|                                                 | Neko/Iwa                  | Neko-wa/Iwa-wa ochita   | Kanojyo-wo iwa-wa otoshita. |
| Melt (Tokeru/Tokasu)                            | Snowman/Ice               | The snowman/the ice melted. | He melted the snowman/the ice. |
|                                                 | Snowman/Koori             | Sunoman-wa/Koori-wa toketa | Kare-wo sunoman-o/koori-o tokashita. |
| Stop (Tommaru/Tomatta)                          | Man/Car                   | The man/the car stopped. | She stopped the man/the car. |
|                                                 | Otoko/Kuruma              | Otoko-wa/Kuruma-wa tomatta | Kanojyo-wo otoko-o/kuruma-o tometa. |
| Close (Shimaru/Shimeru)                         | Mr.Box/Box                | Mr.Box/The box closed.  | He closed Mr.Box/the box. |
|                                                 | Mr.Box/Hako               | Mr.Box-wa/Hakowa-shimatta. | Kare-wo Mr.Box-o/hako-o shimeta. |
| Roll (Korogaru/Korogasu)                        | Hedgehog/Ball             | The hedgehog/The ball rolled. | She rolled the hedgehog/the ball. |
|                                                 | Harinezumi/Boru           | Harinezumi-wo/Boru-wo korogatta. | Kanojyo-wo harinezumi-o/boru-o korogashita. |
| Float (Uku/Ukaberu)                             | Baby/Boat                 | The baby/the boat floated. | He floated the baby/the boat. |
|                                                 | Akachan/Boto              | Akachan-wa/Boto-wo uita. | Kare-wo akachan-o/boto-o ukabeta. |
| Ring (Naru/Narasu)                              | Mrs.Bell/Bell             | Mrs.Bell/The bell rang.  | She rang Mrs.Bell/the bell. |
|                                                 | Beruchan/Beru             | Beru-cha-wo/Beru-wo natta. | Kanojyo-wo Beruchan-o/beru-o narashita. |
| Freeze (Katamaru/Katameru)                      | Snowman/Water             | The snowman/the water froze. | He froze the snowman/the water. |
|                                                 | Sunoman/koori             | Sunoman-wa/Koori-wa katamatta. | Kare-wo sunoman-o/koori-o katameta. |
| Spin (Mawaru/Mawasu)                            | Girl/Top                  | The girl/the top spun.   | He spun the girl/the top. |
|                                                 | Onnannoko/Koma            | Onnannoko-wo/Koma-wo mawatta. | Kare-wo onnannoko-o/koma-o mawashita. |
| Bend (Magaru/Mageru)                            | Girl/Tree                 | The girl/the tree bent.  | He bent the girl/the tree. |
|                                                 | Onnannokonokoshi/Ki       | Onnannokonokoshi-wo/Ki-wo magatta. | Kare-wo onnannokonokoshi-o/ki-o mageta. |
| Break (Kowareru/Kowasu)                         | Mrs.Bell/Camera           | Mrs.Bell/the camera broke. | He broke Mrs.Bell/the camera. |
|                                                 | Beruchan/Kamera           | Beruchan-wa/Kamera-wo kowareta. | Kare-wo Beruchan-o/kamera-o kowashita. |
| Open (Aku/Akeru)                                | Mr.Box/Box                | Mr.Box/the box opened.   | She opened Mr.Box/the box. |
|                                                 | Mr.Box/Hako               | Mr.Box-wa/Hako-wo aita.  | Kanojyo-wo Mr.Box-o/hako-o aketa. |
Appendix 2: Novel actions for novel verbs in Experiments 1 & 2.

Expt. 1  Meeking  The Agent stands with a foot on one end of a see-saw. As the Agent pushes this end to the ground, the Patient/Object, sitting at the other end, is catapulted off.
Blicking  The Object (a guitar) is lying inside the bottom of a large parabolic object which rests with its vertex on the ground. When the Agent rocks it by hand, the Object is displaced upwards along the curve from its resting position before falling back.
Lorping  The Agent jumps up to catch the end of a rope suspended out of reach above him. The rope runs over a pulley above, attached to a sack which is pulled up off the ground as the Agent lands holding the rope.
Daxing  The Patient/Object sits on a circular platform mounted in the end of a vertical coiled spring. When the Agent presses down on the platform it recoils, momentarily throwing the Patient/Object into the air.

Expt. 2*  Meeking  Setting in motion (rocking or spinning) a self-righting ('roly-poly') toy.
Blicking  An Object suspended over the lower end of a seesaw is displaced vertically when the other end of the seesaw is pushed down.
Lorping  Displacing upwards one end of a seesaw causes the other end to move downward hitting the Object.
Daxing  Shallow dish connected to a solid base below by means of a very springy stem wobbles considerably when it is touched/moved, such that an Object contained in it is ejected.

*For the accidental scenes, a performer was engaged in an action (e.g. drinking coffee, walking) and then accidentally touched the object to cause the event to take place. For the intentional scenes, a performer touched the object directly to cause the event without being engaged in other actions.

Appendix 3: Transitive and intransitive sentences in Experiment 1 (Novel verbs).

| Verb           | Sentence type | Intransitive sentences                                                                 | Transitive sentences                                                                 |
|----------------|---------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Meek (Neku/Nekeru) | Training (Continuous tense) | The chicken/the rock is meeking                                                        | She is meeking the chicken/the rock.                                                 |
|                | Training (Past tense) | Niwatori-wa/iwa-wa neiteiru.                                                          | Kanojyo-wa niwatori-o/iwa-o neketeiru.                                              |
|                | Test sentence  | The chicken/the rock meeked.                                                           | She meeked the chicken/the rock.                                                     |
|                |               | Niwatori-wa/iwa-wa nekitta.                                                           | Kanojyo-wa niwatori-o/iwa-o neketta.                                                |
|                |               | The frog/the book meeked.                                                              | She meeked the frog/book.                                                            |
| Blick (Chimaru/Chimeru) | Training (Continuous tense) | The pig/guitar is blicking.                                                            | She is blicking the pig/guitar.                                                      |
|                | Training (Past tense) | Guita-wa/buta-wa chimatteiru.                                                          | Kanojo-wa buta-o/gita-o chimeteiru.                                                  |
|                | Test sentence  | The pig/the guitar blicked.                                                            | She blicked the pig/the guitar.                                                     |
|                |               | Buta-wa/gita-wa chimattei.                                                             | The pig blicked.                                                                     |
|                |               | The rabbit/the ball blicked.                                                           | She blicked the pig/the ball.                                                       |
|                |               | Usagi-wa/boru-wa chimattei.                                                            | Kanojyo-wa usagi-o/boru-o chimeteira.                                                |
| Dax (Hemaru/Hemeru) | Training (Continuous tense) | The fox/the train is daxing.                                                           | He is daxing the fox/the train.                                                     |
|                | Training (Past tense) | Kitsune-wa/densha-wa hematteiru.                                                       | Kare-wa kitsune-o/densha-o hemetteiru.                                              |
|                | Test sentence  | The foxt/the train daxed.                                                              | He daxed the fox/the train.                                                          |
|                |               | Kitsune-wa/densha-wa hematta.                                                          | Kare-wa kitsune-o/densha-o hemeta.                                                   |
|                |               | The girl/the rocket daxed.                                                             | He daxed the girl/the rocket.                                                        |
|                |               | Onnanoko-wa/roketto-wa hemetta.                                                       | Kare-wa Onnnakko-o/roketto-o hemeta.                                                 |
| Lorp (Ruku/Rukeru) | Training (Continuous tense) | The dog/bag is lorping.                                                                | He is lorping the dog/the bag.                                                       |
|                | Training (Past tense) | Inu-wa/fukuro-wa rukiteiru.                                                            | Kare-wa inu-o/fukuro-o ruketeiru.                                                    |
|                | Test sentence  | The dog/the bag lorpied.                                                               | Kare-wa fukuro-o ruketa.                                                             |
|                |               | Inu-wa/fukuro-wa rukita.                                                               | The dog/the bag lorpied.                                                             |
|                |               | The girl/the chair lorpied.                                                            | Kare-wa Onnnakko-o/isu-o ruketa.                                                    |
|                |               | Onnnakko-wa/isu-wa rukita.                                                             | He lorpied the girl/the chair.                                                      |
### Appendix 4: Transitive and intransitive sentences in Experiment 2 (Familiar verbs).

| Verb: English (Japanese Intransitive/Transitive) | Intransitive sentences | Transitive sentences |
|-----------------------------------------------|------------------------|----------------------|
| Drop (Ochiru/Otosu)                          | The keys dropped.      | He dropped the keys. |
|                                              | Kagi-wa ochita.        | Kanojyo-wa kagi-o otoshita. |
| Melt (Tokeru /Tokasu)                        | The ice cream melted.  | He melted the ice cream. |
|                                              | Aisukuriimu-wa toketa. | Kanojyo-wa aisukuriimuwo tokashita. |
| Stop (Tommaru/Tomatta)                       | The car stopped.       | He stopped the car.   |
|                                              | Kuruma-wa ochita.      | Kanojyo-wa kuruma-o tometa. |
| Close (Shimar/Sharu)                          | The box closed.        | He closed the box.    |
|                                              | Hako-wa shimatta.      | Kanojyo-wa hako-o shimeta. |
| Roll (Korogaru/Korogasu)                     | The ball rolled.       | He rolled the ball.   |
|                                              | Boru-wa korogatta.     | Kanojyo-wa boru-o korogashita. |
| Ring (Naru/Narasu)                           | The doorbell rang.     | He rang the doorbell. |
|                                              | Doaberu-wa natta.      | Kanojyo-wa doaberu-o narashita. |
| Spin (Mawaru/Mawasu)                         | The pedals spun.       | He spun the pedals.   |
|                                              | Pedaru-wa mawatta.     | Kanojyo-wa pedaru-o mawashita. |
| Bend (Magaru/Mageru)                         | The hanger bent.       | He bent the hanger.   |
|                                              | Hanga-wa magatta.      | Kanojyo-wa hanga-wo mageta. |
| Break (Kowareru/Kowasu)                      | The blocks broke.      | He broke the blocks.  |
|                                              | Burokku-wa kowareta.   | Kanojyo-wa brokku-o kowashita. |
| Open (Aku/Akeru)                             | The door opened.       | He opened the door.   |
|                                              | Doa-wa alta.           | Kanojyo-wa doa-o aketa. |
| Tear (Yabukuru/Yabuku)                       | The paper tore.        | He tore the paper.    |
|                                              | Kami-wa yabuketa.      | Kanojyo-wa kami-o yabuita. |
| Move (Ugoku/Ugokasu)                        | The trolley moved.     | He moved the trolley. |
|                                              | Kaato-wa ugoita.       | Kanojyo-wa kaato-o ugoashita. |

### Appendix 5: Transitive and intransitive sentences in Experiment 2 (Novel verbs).

| Verb                  | Sentence type            | Intransitive sentences | Transitive sentences |
|-----------------------|--------------------------|------------------------|----------------------|
| Meek (Ruku/Rukeru)    | Training (Continuous tense) | The flower is meeking. | He is meeking the flower. |
|                       |                          | Hana-wa rukiteiru      | Kanojyo-wa hana-o rukiteiru. |
|                       | Training (Past tense)    | The flower meeked.     | He meeked the flower. |
|                       |                          | Hana-wa rukita.        | Kanojyo-wa hana-wo rukita. |
|                       | Test sentence            | The doll meeked.       | He meeked the doll.   |
|                       |                          | Ningyo-wa ruketa.      | Kanojyo-wa ningyo-o ruketa. |
| Blick (Hemaru/Hemeru) | Training (Continuous tense) | The bag is blicking.  | He is blicking the bag. |
|                       |                          | Baggu-wa hemateiru.    | Kanojyo-wa baggu-o hemeteiru. |
|                       | Training (Past tense)    | The bag blicked.       | He blicked the bag.   |
|                       |                          | Baggu-wa hematta       | Kanojyo-wa baggu-o hemata. |
|                       | Test sentence            | The Bear blicked.      | He blicked the Bear.  |
|                       |                          | Kuma-wa hematta.       | Kanojyo-wa kuma-o hemeta. |
| Dax (Chimaru/Chimeru) | Training (Continuous tense) | The balloon is daxing. | He is daxing the balloon. |
|                       |                          | Fuusen-wa chimatteiru  | Kanojyo-wa fuusen-o chimatteiru. |
|                       | Training (Past tense)    | The balloon daxed.     | He daxed the balloon.  |
|                       |                          | Fuusen-wa chimatta.     | Kanojyo-wa fuusen-o chimata. |
|                       | Test sentence            | The ball daxed.        | He daxed the ball.     |
|                       |                          | Boo-ruha chimatta.      | Kanojyo-wa boo-ruha chimata. |
| Lorp (Neku/Nekera)    | Training (Continuous tense) | The clown is lorping. | He is lorping the clown. |
|                       |                          | Piero-wa neiteiru      | Kanojyo-wa piero-o nekteiru. |
|                       | Training (Past tense)    | The clown lorped.      | He lorped the clown.   |
|                       |                          | Piero-ha nekita.       | Kanojyo-wa piero-0 nekita. |
|                       | Test sentence            | The panda lorped.      | He lorped the panda.   |
|                       |                          | Panda-wa nekita.       | Kanojyo-wa panda-0 nekita. |
Appendix 6: Filler and practice sentences in Experiments 1 & 2.

| Item | Target sentence | Japanese | Distractor sentence | Japanese |
|------|-----------------|----------|---------------------|----------|
| **Expt. 1** | | | | |
| Filler1 | Duck was rocked by Rabbit. | Ahiru-wa usagi-o yurasareta. | Duck was pulled by Rabbit. | Ahiru-wa usagi-ni hipparareta. |
| Filler2 | Duck was tugged by Rabbit. | Ahiru-ha usagi-ni tsuyoku hipparareta. | Duck was stroked by Rabbit. | Ahiru-wa usagi-ni naderareta. |
| Filler3 | Rabbit was stroked by Duck. | Usagi-wa ahiruni naderareta. | Rabbit was bumped by Duck. | Usagi-wa ahiru-ni butsukarareta. |
| Filler4 | Rabbit was pulled by Duck. | Usagi-wa ahiruni hipparareta. | Rabbit was rocked by Duck. | Usagi-wa ahiru-ni yurasareta. |
| Filler5 | Rabbit was bumped by Duck. | Usagi-wa ahiru-ni butsukarareta. | Rabbit was tugged by Duck. | Usagi-wa ahiru-ni tsuyoku hipparareta. |
| Practice 1 | He danced. | Kare-wa odotta. | He sat down. | Kare-wa suwatta. |
| Practice 2 | She slept. | Kanojyo-wa nemutta. | The bird flew. | Tori-wa tonda. |
| Practice 3 | He rode his bike. | Kanojyo-wa karenoidensha-ni notta. | He lost his bike. | Kanojyo-wa karenoidensha-o nakushita. |
| **Expt. 2** | | | | |
| Filler1 | He was rocked by the girl. | Kanojyo-wa otoko-ni yusaburareta. | He was dried by the girl. | Kanojyo-wa otoko-ni kawakasareta. |
| Filler2 | He was stroked by the girl. | Kanojyo-wa otoko-ni naderareta. | He was hit by the girl. | Kanojyo-wa otoko-ni tatakareta. |
| Filler3 | He was pulled by the girl. | Kanojyo-wa otoko-ni hipparareta. | He was poked by the girl. | Kanojyo-wa otoko-ni tsuttsukareta. |
| Filler4 | He was bumped by the girl. | Kanojyo-wa otoko-ni butsukarareta. | He was scratched by the girl. | Kanojyo-wa otoko-ni hikkakareta. |
| Filler5 | He was pushed by the girl. | Kanojyo-wa otoko-ni osareta. | He was washed by the girl. | Kanojyo-wa otoko-ni awarareta. |
| Practice 1 | He danced. | Kanojyo-wa odotta. | He slept. | Kanojyo-wa nemutta. |
| Practice 2 | He jumped. | Kanojyo-wa tonda. | He stood up. | Kanojyo-wa tatta. |
| Practice 3 | He sat down. | Kanojyo-wa suwatta. | He walked. | Kanojyo-wa aruita. |