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Does Variability Across Events Affect Verb Learning in English, Mandarin, and Korean?

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Abstract

Extending new verbs is important in becoming a productive speaker of a language. Prior results show children have difficulty extending verbs when they have seen events with varied agents. This study further examines the impact of variability on verb learning and asks whether variability interacts with event complexity or differs by language. Children (aged 2½ to 3 years) in the United States, China, Korea, and Singapore learned verbs linked to simple and complex events. Sets of events included one or three agents, and children were asked to extend the verb at test. Children learning verbs linked to simple movements performed similarly across conditions. However, children learning verbs linked to events with multiple objects were less successful if those events were enacted by multiple agents. A follow-up study rules out an influence of event order. Overall, similar patterns of results emerged across languages, suggesting common cognitive processes support children's verb learning.

Keywords: Verb learning; Variability; Generalization; Cross-linguistic; Comparison; Preschoolers

A current focus of verb learning research is to examine how children go beyond an initial link between a learned verb and a single event, and extend the verb to new contexts (e.g., Childers & Paik, 2009; Haryu, Imai, & Okada, 2011; Scott & Fisher, 2012; Waxman, Lidz, Braun, & Lavin, 2009). This ability to extend verbs is important because children must be able to spontaneously and productively use verbs in appropriate new contexts to become fully proficient speakers of a language. For example, English-speaking children learning the verb "eat" at some point need to be able to extend it to contexts of eating various foods, with or without utensils, and to events with both human and

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nonhuman actors (e.g., dogs). At the same time, they should keep from using the verb for events with liquids (for which "drink" might be more appropriate), events without animate actors (typically, although a vacuum cleaner may be allowed), or events not including ingestion at all. This is a problem because verbs vary in the number and types of elements in an event that are important to a verb's meaning (e.g., Gentner & Boroditsky, 2001), and because the verb category itself varies across languages (e.g., Talmy, 1975, 1985; also see Brown, 1998; Majid, Bowerman, et al., 2007).

1. Introduction

Noun researchers have tackled this question of extension by proposing and providing evidence for the use of constraints including the taxonomic constraint (children extend new nouns based on category membership, e.g., Markman, 1990) and the shape bias (children extend new nouns to objects that are similar in shape, e.g., Landau, Smith, & Jones, 1988, 1998). However, no single strategy will be useful for verb learning (in the way these biases have been shown to be for noun learning) due to the nature of events, and variations both between individual verbs within a language and the verb category as used across languages. Because research has only recently begun to examine verb extension, the question of how children solve this difficult problem is currently largely unexplained.

One type of information available to children that could help them with the generalization of new verbs is found in the range of events they have seen linked to a new verb. If children can compare events to each other, the variability across the set of events linked to a particular verb could be useful for guiding their verb extensions. In other domains, variability has been found to be useful to young children. For example, in the categorization literature, there are many studies with infants and children that show that variability assists them in forming and extending categories. Specifically, Quinn and Bhatt (2010) showed that 6- to 7-month-old infants who could not initially perceive an overall organization of simple shapes benefitted from seeing a set of three different examples of shapes within different organizations during a learning phase, and subsequently succeeded at test. In addition, in Oakes and Spalding (1997), 10-month-old infants shown a frequent exemplar that is similar to other exemplars form narrow categories of land versus sea animals but form a more inclusive category if shown a dissimilar exemplar.

There are also results with preschool-aged children that provide support for the view that experience comparing varied examples is useful. For example, in Namy and Gentner (2002, Study 1), children who saw pictures of two objects from the same superordinate level category (e.g., an apple and a pear) were able to choose a third category member at test (e.g., a banana) over an object that was similar in shape to a prior example (e.g., a balloon) but was from a different category. In contrast, children who saw two examples of objects that were perceptually similar to each other (e.g., an apple and a light bulb), but that could not be aligned because they were from different categories, chose an object at test that was perceptually similar to both prior objects but fit a third category (e.g., a balloon). Thus, in this study, preschoolers were able to successfully compare two objects, even though the objects varied in their perceptual properties, and this comparison helped them focus on deeper conceptual similarities when extending a new word. Interestingly, in a subsequent study, preschoolers who saw two identical objects during the learning phase performed more poorly than did preschoolers who saw similar, but not identical objects, to compare (Namy, Gentner, & Clepper, 2007).

These studies (and others) suggest that variability information during learning is helpful in object categorization. However, is it helpful in verb learning? An important prior study in verb learning suggests it may not be. In this study, 2½- to 3-year-old children had difficulty learning a new verb if they are shown a set of events in which the agent varied as opposed to a set with a single repeated agent (Maguire, Hirsh-Pasek, Golinkoff, & Brandone, 2008). Children learned two new verbs that referred to relatively simple actions involving whole body movements. Half of the children saw four different female actors (wearing differently colored shirts) perform the same action before test, and half saw a single female actor perform the action four times before test. At test children saw two new female actors, one performing the action seen in the learning phase and one performing a distractor action, and they were asked to extend the verb. Results showed that there was no difference across age, and that children's responses were significantly greater than chance in both the single actor and multiple actor conditions. However, a greater percentage of children succeeded in the single actor condition as compared to the multiple actor condition, which suggests that variation in actors could be problematic for young verb learners.

This finding is somewhat surprising because having access to variability when learning a verb could provide useful information about how to extend that verb. For example, it could be helpful to see multiple agents and hear the verb "eat" (a dog, a baby, a parent) if children could deduce from those examples the notion that the verb (usually) refers to an animate agent. Thus, if children either have seen only a single agent, or if they were unable to process this variation, then it should be more difficult for the child to extend that verb to new agents. In addition, the argument that children have difficulty learning a verb if it is seen with multiple agents seems especially unlikely given that children often would see this type of variation when learning new verbs (e.g., it is highly unlikely that any language would reserve a particular verb for a single individual). At the same time, these results from Maguire et al. (2008) are important and worth further examination.

There are a few previous studies that show that variation is useful in verb learning, at least by 3 years. Specifically, in Forbes and Farrar (1995), 3-year-olds, 10-year-olds, and adults were shown videotaped novel events that had agent, instrument, manner (or the way in which the action is performed, e.g., walking vs. running), and outcome components. In two of the conditions relevant here, participants were shown only a single event or a set of three events in which one component varied (e.g., agent change). Three-year-olds who saw the single event mostly resisted extending a new verb to new events (extending only to changes in manner), but 3-year-olds who saw events in which one component varied could extend new verbs to new events, extending to changes in agent, instrument, and outcome. A second study (Behrend, 1989, cited in Behrend, 1995) included 3-year-olds, 5-year-olds, and adults. Participants saw multiple examples of new verbs that were constructed such that the action, instrument, or result varied. In this study, even the youngest children could accept variation in actions and results, and the ability to use variation information increased with age.

Two more recent studies have also included variation during a verb learning phase. In one study, 2½-year-old children were shown a complex event followed by new events that preserved only the action from the initial event, only the result, or no new events. Children seeing three events that varied but preserved the action produced more creative extensions at test that included that action, whereas children who saw a set of varied events that preserved the result produced more result extensions than in the other conditions. Children who saw a repeated target event before test mostly imitated that event at test, failing to extend the verb as often as in the other conditions (Childers, 2011). Thus, in this study in which there was ample variation between comparison events, children as young as 2½ years were able to benefit from exposure to these events. In another study, English-speaking and Korean-speaking children heard new verbs and were shown either events with objects that were similar in shape and were moved in similar ways, or events with varied objects that were moved in different ways (Childers & Paik, 2009). Across language, children who saw the set of events with varied objects again were more creative at test, extending the verb by including more varied objects in their enactments at test. In fact, as in Namy et al. (2007) and Childers (2011), children who experienced very similar events extended the new word less frequently overall. If children are able to compare varied events, and if this helps them extend new verbs, why would children have performed better in Maguire et al. (2008) when seeing a single agent as opposed to different agents?

To investigate this question, we decided to conduct a study that was similar to Maguire et al. (2008)'s study but that asked whether this result was linked to seeing four agents as opposed to three agents, whether it varied depending on the complexity of the events that were shown, and whether it was unique to English language learners living in the United States. We wondered whether the prior results were impacted by seeing four examples because most of the prior studies showing that children as young as 2½ can compare have used either three examples (e.g., Childers, 2011) or two examples (Namy and Gentner's studies). Thus, does the difficulty highlighted in Maguire et al. (2008)'s study stem from children's inability to attend to or compare across four examples? Secondly, we hypothesized that event complexity could interact with children's ability to compare varied events. In a recent study by Scott and Fisher (2012, Study 1), 2.5-year-olds hearing intransitive sentences were shown pairs of video events with varied agents showing overall body movements. Children's looking was coded frame-by-frame, and these toddlers were able to look longer at a target event than a distractor event. Thus, children in this study were able to disregard agent variation across these events with whole body movements and were able to link different instances of events to a single new verb. A second study included transitive sentences ("She's pimming her toy") and events in which both the agent and the affected object varied. In this study, 2.5-year-olds had more difficulty processing variation across these more complex events, although they could succeed if they were in a high vocabulary group. However, children in this second study were experiencing variation in both agents and objects across trials, and thus it remains unclear whether they could have succeeded if only the agent or object had varied across events.

As described, in this study we sought to further examine and extend the prior results from Maguire et al. (2008) in multiple ways. Children saw three comparison events instead of four, and in the varied agent condition, our actors varied by ethnicity, whereas others have varied by shirt color (Maguire et al., 2008; Scott & Fisher, 2009). We also included sets of simple events (whole body movements) and more complex ones, and we tested this question across multiple languages, including children in San Antonio, Texas (English speakers), Chengdu, China (Mandarin), Seoul, Korea (Korean speakers), and Singapore, Singapore (English bilingual speakers).

One reason to include children in these different countries and language groups was to be able to test the generalizability of our results. However, there are also specific reasons why data from these particular languages are important. First, children learning Mandarin have not been reported to have a "noun bias" early in language development (producing relatively more nouns than verbs) as is seen for English-speaking children (Tardif, 1996; Tardif, Shatz & Naigles, 1997; Tardif, Gelman & Xu, 1999). Similarly, Korean-speaking children have been described as producing more verbs early in development than are English-speaking children (Gopnik & Choi, 1995; see also Au, Dapretto, & Song, 1994; Kim, McGregor, & Thompson, 2000). Thus, children learning Mandarin or Korean may have a different pattern of early word learning than do children learning English, a pattern in which verbs seem to be as easy to learn as nouns. Secondly, verbs can be more specific, or highly imageable, in Mandarin than they are in English (Ma et al., 2009; Tardif, 1996). For example, there are 26 different verbs in Chinese that can be translated into the single English verb "carry," and that differ depending on the type of carrying (and part of the body) involved (Ma et al., 2009). Similarly, in Korean, verbs can have a narrower range of uses than in English. For example, in a longitudinal study of Korean-speaking children, Choi (1997) found that young Korean-speaking children "made finer and different distinctions" in their verb productions as compared to English-speaking children in the United States, including "acquiring specific verbs ... related to different body parts and to different figure-ground relations" (p. 57). Thus, children learning these languages may expect verbs to refer to more specific actions than do children learning English. If verbs have more specific meanings, it could be that children learning Mandarin or Korean are not asked to compare sets of events that are as varied when learning a new verb, and this could affect their processing of new verbs.

We also had the opportunity to collect data from a sample of children in Singapore who were Mandarin–English bilingual speakers and were tested in English. We could not run two samples at that site, which would have allowed us to test this group in both languages, and if we had tested a single sample in both languages, the design for that sample would not have fit the design in the other languages. Thus, we decided to test them in one language and chose English. This sample provides a unique chance to test Asian children who have learned Mandarin (and may use verb knowledge from that language), but who also have access to verb patterns in English. However, because it is hard to quantify how much exposure to each language these children had, we planned to analyze the data both with and without this sample. More generally, by including children from multiple language groups, we can ask whether children's comparisons across events when learning a new verb are influenced by their prior experience learning verbs in their language.

In sum, we hypothesized that children would benefit from seeing different agents engage in an action while learning new verbs, but that this benefit may vary depending on the complexity of the event shown, and may vary across language/culture.

2. Study 1: Main study

2.1. Method

2.1.1. Participants

Twenty-five English-speaking children were recruited in San Antonio, Texas, USA (see Table 1 for demographic information). Parents were identified using a regional database, then postcards followed by phone calls were made to schedule an appointment at an on-campus laboratory. In nearby preschools, letters were sent home to parents who returned signed consent forms to the child's teacher. Most children were from middle-income or upper-middle-income homes, and self-identified as Caucasian (14), Hispanic (10), or African American/Hispanic (1). Any children who were experiencing a speech delay or exposed to multiple languages in the home (> 20% of the time) were excluded. Additional children participated but were excluded from the final sample because they only pointed to one side of the screen (8), they pointed incorrectly on both practice trials (1), they failed to point during one or more test trials (9), or there was an experimenter error (5).[1]

The Mandarin-speaking children (n = 29) lived in Chengdu, China,[2] and the Korean-speaking children (n = 16) lived in Seoul, Korea (see Table 1). In these sites, children were recruited through preschools, none was reported as having a language delay, and, in both language groups, native speakers of each language served as the experimenters. English–Mandarin bilingual speakers (n = 29) who lived in Singapore also were included; they were recruited and screened as in the other sites and English–Mandarin bilingual speakers served as experimenters. The experimenters in these sites did not report any

Table 1
Demographic information

Language, Site	N	M_{age} (Range)	Gender
English, San Antonio (S1)	25	2;9 (2;3–3;5)	10 girls, 15 boys
Mandarin, Chengdu	29	3;0 (2;2–3;6)	10 girls, 18 boys, 1 unk.
Korean, Seoul	16	3;2 (2;8–3;6)	8 girls, 8 boys
English–Mandarin, Singapore	29	3;0 (2;2–3;6)	10 girls, 18 boys, 1 unk.
English, San Antonio (S2)	20	3;2 (2;5–3;11)	11 girls, 9 boys

Notes. An independent samples t-test shows responses in the complex event sets differ by condition, and a paired t-test shows responses differ within the Different Agent condition, *ps< .01. One sample t-tests show all responses differ from chance except those in the Different Agent, Complex event sets. Error bars = SEM. A paired t-test shows responses differ within the Different Agent condition, *ps< .01.

needed exclusions based on children's pointing performance, and there were no experimenter errors.

2.1.2. Materials

Video events were created and edited using iMovie. For the warm-up phase of the study, two pairs of videos were filmed, with one pair showing a static truck and a static cow, and the other pair showing a person's hand using a rake to rake confetti and a person's hand making an elephant dance. Each pair was edited to be presented as a split screen single trial.

Four sets of novel events were created for the experimental trials. Two of the events depicted body movements and were filmed as they were performed by either one female actress or three different female actresses (see Fig. 1). As in Maguire et al. (2008), these events only involved body movements. In one of these events, the actor used an outstretched arm with a flat hand to slowly tap the top of her head. In a second simple event, the actor fully extended both arms, one to each side of her body, and then brought her hands to her face, covering her eyes with her open hands. These events were labeled "simple events" because they did not include any other objects (e.g., tools, affected objects).

One difference between these simple events and those tested in Maguire et al. (2008) was that these movements involved the upper torso, whereas the movements in Maguire et al. (2008) involved the whole body. Upper torso events were designed because, in the complex events, the actor sat at a small table allowing only her upper body to be shown; thus, if we had included whole body movements in the simple event sets, the two types of events would have differed in multiple ways. Although these events differ somewhat from Maguire et al. (2008), the results should extend our understanding of simple events to include this type of simple event. In addition, if anything, movements that include the head should be more linked to particular agents than are whole body movements. Thus, if variability harms verb learning, that influence should be stronger for these two simple events in these results.

Test events depicted a new actor performing either the same event as seen in the learning phase or a distractor event. In one set, the events created for the test trial showed a new actor performing the tapping action or the same new actor turning her head from side to side. In the other set, test events showed a new actor performing the covering action or an actor moving both arms in a synchronous motion (moving both hands, palms forward from side to side in front of her body). Neither distractor event was a prototypical example of a known verb. All pairs of test events were edited to be shown in a single split screen trial. These test events were similar to those shown in Maguire et al. (2008).

Two more complex events, with an actor, a tool, and an affected object, also were constructed. In one, an actor held a mallet with a magnet on its end in her hand, and used the mallet to pick up a flat object from a table (see Fig. 2). Test events showed this picking up motion or the actor using the mallet to hammer the top of a box. A second complex event showed an actor pushing a toy cow down a ramp and into a small box. Test events showed this pushing event or showed the actor "walking" the toy cow across a square of artificial grass.

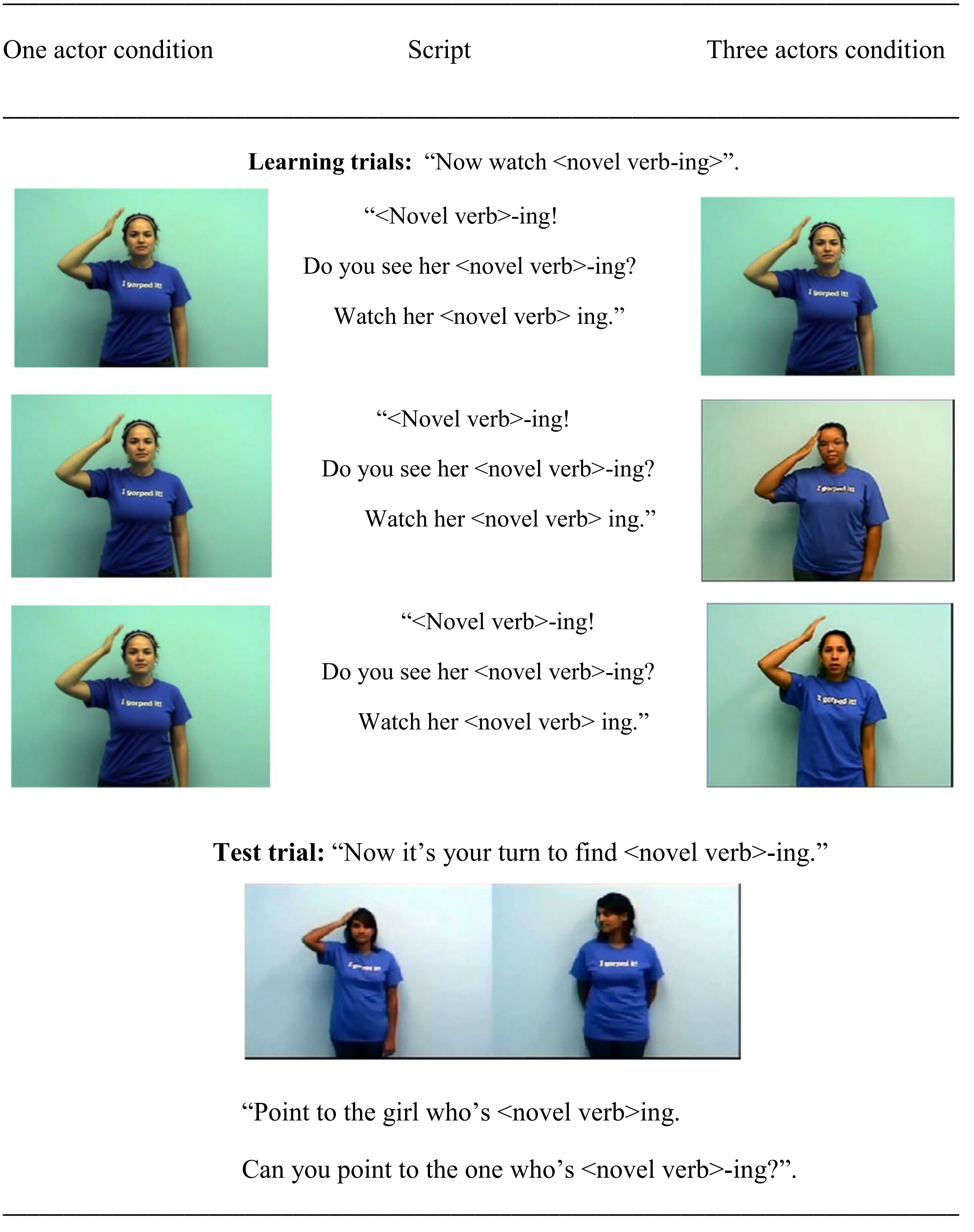

Fig. 1. Simple event example with learning trials and test trial.

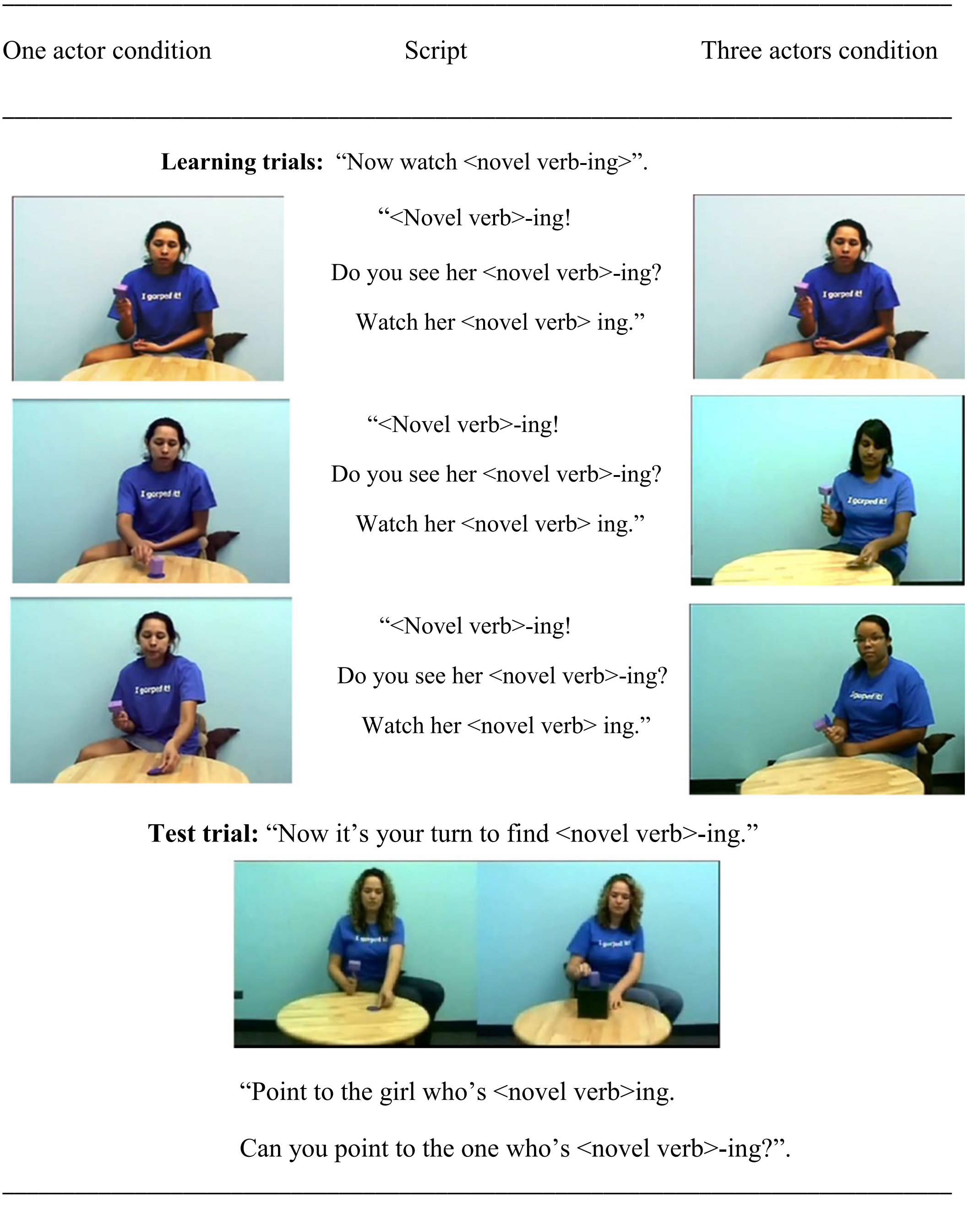

Fig. 2. Complex event example with learning trials and test trial.

To assess whether these events were perceived as simple or complex events, a set of adult participants (n = 33) were shown each event and asked to rate the event on a 5-point Likert scale with 1 labeled as "simple" and 5 labeled as "complex." Approximately half of the adults (n = 16) saw the two simple event sets first and the other half saw the two complex event sets first. A repeated-measures ANOVA with Order (simple first, complex first) as a between-subjects factor, and Event type (simple, complex) as a within-subjects factor revealed a significant main effect for Event type, $F(1, 31) = 6.94$, $p < .02$, and no effect or interaction with Order. Adults rated the simple events as more simple (M = 2.0, SE = 0.17) than the complex events (M = 2.7, SE = 0.19).

2.1.3. Design

Each child saw two sets of simple events and two sets of complex events, each linked to a different novel verb. Simple event sets were always shown first so that responses to these events could be directly compared to Maguire et al. (2008)'s study, which only included these kinds of events. The order of the side of correct choice was varied so that the correct side was not always on the left or the right (e.g., LRRL).

In each site, an approximately equal number of children were randomly assigned to one of two conditions (i.e., in the United States, China, and Singapore, there were 10–12 children in each condition; in Korea, there were 8 children in each condition). Thus, approximately half of the participants were randomly assigned to a One-Actor condition (the same video with a single actor was shown three times before test) and half were assigned to a Three-Actors condition (three different female actors were shown performing the action before test). In this study, the three actors varied in ethnicity but were wearing the same clothing. We chose to have them wear the same clothing to be sure no single clothing choice drew more attention, and because past studies had already examined children's responses to agents wearing differently colored shirts.

2.1.4. Procedure

For some children in the United States, an experimenter helped the family find the on-campus research laboratory. In the laboratory, a second experimenter introduced the consent form, and obtained informed consent from the parent while the first experimenter interacted with the child. For other children in the United States, and for the children in Singapore, researchers met children in their child-care center. Parents returned signed consent forms to their child's teacher and the study was conducted in a quiet room. In Korea and China, the director or other official in the school had the authority to give permission for children in the school to participate as a common cultural practice and did so before the study began. In these sites children were escorted (usually by their teacher) to a quiet room for the study.

Children sat in a small chair in front of either a 19-inch flat-screen video monitor or a laptop computer screen; the experimenter sat between their chair and the monitor/screen. In the laboratory, parents sat in a chair behind the child. Children's responses were coded by a second experimenter standing to the side behind the child. This second experimenter also used a video camera to film the children's responses for later coding.

2.1.4.1 Warm-up phase: The experiment began with two warm-up trials to allow the child to practice pointing to a video scene that matched a sentence the experimenter was producing. The experimenter asked the child either to point to a truck or cow on Trial 1 (e.g., "Can you point to the truck?) and to point to either a dynamic dancing event or raking event in Trial 2 (e.g., "Look at these things. Can you point to dancing?"). Trials were designed so that children were asked to point to an event on the left side and the right side of the screen (either LR or RL), with one response requested per pair of practice events.

2.1.4.2 Experimental phase: The experimental phase of the study began with the first set of novel events. The experimenter first paused the video and produced an introductory sentence; using the same sentence frames as in Maguire et al. (2008). In English, s/he said: "Now watch <novel verb-ing>." These sentences were translated into Mandarin and Korean by two linguists, one specializing in Mandarin (JE) and one a Korean language specialist (DS).[3] (See Appendix A for a complete list of sentences in all languages.) Children in Singapore were bilingual speakers and heard stimulus sentences produced by a bilingual Mandarin–English speaker in English.

Then s/he started the video and, while the child was seeing the first event in this learning phase, the experimenter said, "<Novel verb>-ing! Do you see her <novel verb>-ing? Watch her <novel verb> ing." S/he then showed two more events and repeated the same set of sentences. S/he next paused the video and said, "Now it's your turn to find <novel verb>-ing."

2.1.4.3 Test phase: The test events were shown as a split screen video event while the experimenter said, "Point to the girl who's <novel verb>ing. Can you point to the one who's <novel verb>-ing?" After the child pointed to his/her choice, the experimenter either said, "Good job! Let's see another one! and repeated the procedure until the child had heard four novel verbs or, at the end of the final set, the experimenter said, "We're all done. You did great!." Each test event was only shown once because in Maguire et al. (2008), only the first test trial was useful in the analyses.

2.1.5. Coding

One experimenter coded children's pointing responses during the experimental session. To evaluate whether coders could agree, a second blind observer who had not been present in the initial experiment session coded children's pointing responses from videotape. A third independent blind coder coded 25% of the sample from videotape (n = 12) and these two independent observers using the videotaped record agreed on 100% of the trials. In sum, children's first point to one side of the screen or the other was easy to code by multiple coders.

2.2. Results

Our first overall analyses exclude the bilingual Mandarin–English-speaking children tested in Singapore. However, some may be interested in our findings with the inclusion of bilingual speakers and, thus, in a second analyses, we ask these questions including this group.

A repeated-measures ANOVA with Language (3: English, Mandarin, Korean) and Condition (2: one actor, three actors) as between-subjects factors, and Event type (2: simple, complex) as a within-subjects factor was computed, with number of correct responses at test as the dependent variable. This analysis revealed a main effect of Event type, $F(1, 64) = 4.33$, $p < .05$ ($\eta_p^2 = 0.06$), and a significant Event type by Condition interaction, $F(1, 64) = 16.53$, $p < .001$ ($\eta_p^2 = 0.21$) (see Fig. 3). There was no main effect or interaction with Language. Post hoc paired *t*-tests with Bonferroni corrections showed that, only in the Different Agent condition, children correctly extended the verb more often when verbs were linked to simple events than complex ones, $t(34) = 3.37$, $p = .002$. An independent samples *t*-test with Bonferroni correction showed that responses differed across conditions only for the complex events, with children performing better in the Same Agent condition than the Different Agent one, $t(68) = -3.31$, $p = .001$. One sample *t*-tests showed children's responses differed from chance in all conditions and event types (*ps*< .001), except when they were in the Different Agent condition and saw complex events (see Fig. 3).

In our second analysis, we conducted the same type of analysis including the bilingual Mandarin–English-speaking children who were tested in Singapore. Results again revealed a significant interaction of Event type by Condition, $F(1, 93) = 19.50$, $p < .001$ ($\eta_p^2 = 0.17$). There was no main effect or interaction with Language. Post hoc paired *t*-tests with Bonferroni corrections revealed that, in the Same Agent condition, children were more successful in the complex event sets than the simple event sets, $t(49) = -2.59$, $p = .013$. However, in the Different Agent condition, children correctly extended the verb more often when verbs were linked to simple events than complex ones, $t(48) = 3.40$, $p = .001$. An independent samples *t*-test with Bonferroni correction showed that responses differed across conditions only for the complex events, with

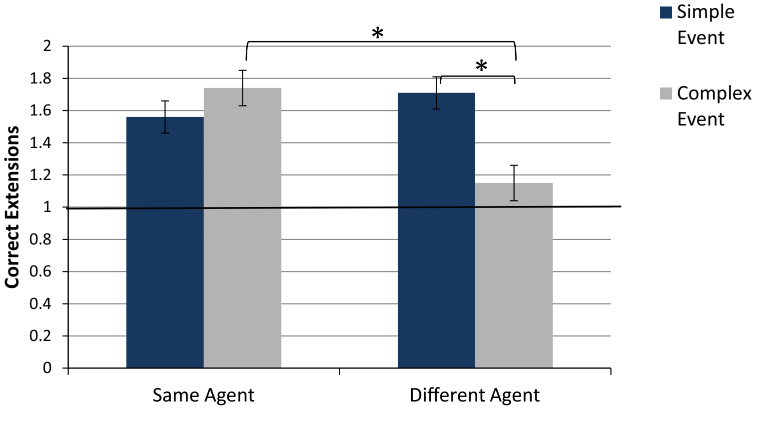

Fig. 3. Results including children learning English, Mandarin, or Korean, excluding bilingual Mandarin–English speakers tested in Singapore.

Note: An independent samples *t*-test shows responses in the complex event sets differ by condition, and a paired *t*-test shows responses differ within the Different Agent condition, **ps*< .01. One sample *t*-tests show all responses differ from chance except those in the Different Agent, Complex event sets. Error bars = SEM.

children performing better in the Same Agent than the Different Agent condition, $t(97) = -3.63$, $p < .001$. One sample *t*-tests showed children's responses differed from chance in all conditions and event types (*p*s< .01).

Finally, to test whether the Mandarin–English speakers in Singapore differed significantly from the English speakers in United States, we conducted an analysis with only data from these two sites. A repeated-measures ANOVA with Condition (2: one actor, three actors) and Country (2: United States, Singapore) as between-subjects factors, and Event type (2: simple, complex) as a within-subjects factor was computed; number of correct responses at test was the dependent variable. As in both prior analyses, results showed a significant interaction of Event type by Condition, $F(1, 50) = 7.19$, $p = .010$ ($\eta_p^2 = 0.31$), with no main effect or interaction with Country. Overall, the patterning of responses was similar to that shown than the other analyses (see Appendix B for graphs depicting results for each site).

2.3. Discussion

Overall, these results show that event complexity does have an important influence on children's ability to compare across varied examples when learning a new verb. When children were learning verbs linked to simple body movements, they were successful when they saw these events enacted by either a single agent or three different agents. These results were found across three languages, with no significant differences emerging between the different languages included in this study. They also did not differ in analyses that excluded a sample of bilingual Mandarin–English speakers in Singapore, or included these speakers. This main result is important for at least two reasons. One is that it suggests that children's verb learning, at least in terms of learning a verb linked to a body movement, is not hampered by variability across agents as had been previously proposed. In both our study and the prior study by Maguire et al. (2008), children's responses in the one- and multiple-agent conditions exceeded chance. However, in their study, children were even more successful in the one-agent versus the four-agent condition, whereas in this study, they were equally successful in both conditions. Our data also show that this result extends across different languages and cultures. On the other hand, the results do not show that variability can be helpful in verb learning, perhaps because children could successfully learn the verb without the variable information in this task. In prior studies with an enactment procedure, we have found that children benefit from variability (Childers & Paik, 2009), and thus future studies with different types of test trials are needed before the hypothesis that variability can be helpful can be ruled out.

In contrast, in the complex sets, our results show children were negatively impacted by the variation in agents, as had been proposed in Maguire et al. (2008). This result also emerged across languages, which is important. Children learning Mandarin or Korean may learn more verbs earlier in development than do children learning English (Mandarin: Tardif, 1996; Tardif et al., 1997; Tardif et al., 1999; Korean: Gopnik & Choi, 1995; see also Au et al., 1994), and a larger verb vocabulary could reflect greater experience comparing events. Thus, children in these groups could have differed from

English-speaking children, with children speaking Korean or Mandarin showing more verb extensions at test. However, an advantage for verb learning in these languages could have been offset by the types of verbs children may be learning. Both Mandarin (Ma et al., 2009; Pulverman et al., 2008; Tardif, 2006) and Korean (e.g., Choi, 1997) have been described as containing verbs that are fairly specific in their meanings. Thus, children learning these languages may have more experience learning verbs than do English-speaking children, but their comparisons may have been of similar events which link to a single (specific) new verb, and thus they may not have the experience comparing varied events that children may need to succeed in the complex event sets. In addition, these results in the complex event sets may reflect a genuine cognitive difficulty in processing more complex events. These findings are consistent with those from Scott and Fisher (2012) in which children could learn verbs across trials if the events depicted body movements, but had more difficulty in Study 2 which included more complex events with multiple objects.

A limitation of the design of this study is that the simple events were always shown before the more complex ones. We chose to present the stimuli in this way so that the results from the two simple event sets could be directly compared to the event sets used in Maguire et al. (2008) However, children may have benefitted from seeing the simple events first; for example, these may have helped them adjust to the video task and may have helped scaffold their growing ability to compare events. In one theory relevant to cross-situational learning, children benefit from seeing more similar comparisons before more varied ones, or learn from "progressive alignment" (Childers et al. 2016). To test whether the order of events was exerting an important influence in these results, we ran an additional sample of English-speaking children in a condition in which the two complex sets were shown before the two simpler sets depicting overall body movements.

3. Study 2

3.1. Method

3.1.1. Participants

Twenty additional English-speaking children in San Antonio, Texas, USA, were included in Study 2 (see Table 1 for demographic information). Participants were recruited in the same ways as described for Study 1, came from the same income levels, and self-identified as Caucasian (12), Hispanic (2), Caucasian/Hispanic (2), Caucasian/African American (1), African American (1), or did not identify a group (3). The same exclusion criteria used in Study 1 were also used in Study 2. Additional children participated but were excluded from the final sample because they only pointed to one side of the screen (4).

3.1.2. Materials and design

The same materials used in Study 1 were used in Study 2 with the exception that in this study, all new participants were shown the two video sets depicting complex events

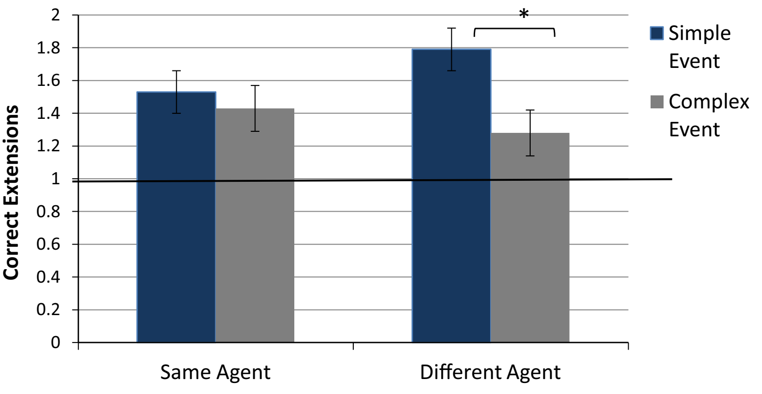

Fig. 4. Results including two groups of English-speaking children in the United States (Simple event first or Complex event first).
Note: A paired *t*-test shows responses differ within the Different Agent condition, **ps*< .01. One sample *t*-tests show all responses differ from chance except those in the Different Agent, Complex event sets. Error bars = SEM.

before the two sets depicted simpler events. An approximately equal number of children were randomly assigned either to the One-Actor condition or the Three-Actors condition.

3.1.3. Procedure

The same procedure used in Study 1 was also used in Study 2.

3.2 Results and discussion

The goal of Study 2 was to examine whether the order in which the events were shown influenced the results found in Study 1. To test this question, this analysis compares the responses of the English-speaking children (in the United States) in Study 1 (Simple first) with a new set of participants included in Study 2 (Complex first). A repeated-measures ANOVA was computed with Order (2: simple first, complex first) and Condition (2: one actor, three actors) as between-subjects factors, and Event type (2: simple, complex) as a withinsi-subjects factor; the number of correct responses at test as the dependent variable. Results showed a significant main effect of Event type, $F(1, 41) = 6.71$, $p < .02$ ($\eta_p^2 = 0.14$), with no main effect of Order or interaction with Order (see Fig. 4). The Event type by Condition interaction revealed a trend toward significance, $F(1, 41) = 3.16$, $p < .09$ ($\eta_p^2 = 0.9$). Even though this interaction only approached significance, to be able to compare the pattern of results found here with the pattern found in Study 1, post hoc paired *t*-tests with Bonferroni corrections were computed within each condition. These showed that children in the Same Agent condition did not differ across event type ($t(22) = 0.57$, ns). One sample *t*-tests showed children in this condition exceeded chance (1.0) in both the simple events ($M = 1.5$, SE = 0.14; $t(22) = 3.76$, $p = .001$) and the complex events ($M = 1.4$, SE= 0.14; $t(22) = 3.15$, $p = .005$). Children in the Different Agent condition did differ across event type ($t(21) = 2.93$, $p < .01$), with children performing better in the simple than the complex events. One sample t-tests showed children in this condition exceeded chance (1.0) in the simple events ($M = 1.77$, SE = 0.11; $t(21) = 6.86$, $p < .001$) and approached significance in the complex events ($M = 1.27$, SE = 0.14; $t(21) = 2.03$, $p < .06$). Importantly, this study did not show a significant effect of Order (simple first, complex first), which was our main concern.

4. General discussion

Studies of categorization with infants (e.g., Oakes & Spalding, 1997; Quinn & Bhatt, 2010) and young children (e.g., Namy & Gentner, 2002; Namy et al., 2007) have shown that learners can benefit from variability across a set when learning about objects. In addition, there are previous studies of verb learning showing children aged 2½ or 3½ years can learn from a set of events presented during a verb learning phase that includes some variability (Behrend, 1989; Childers, 2011; Childers & Paik, 2009; Forbes & Farrar, 1995). Thus, a study showing that variability across agents could impair children's verb extensions is important (Maguire et al., 2008), as is emerging evidence that children's ability to process variability across events interacts with event complexity (Scott & Fisher, 2009). This study was designed to further test the impact of variability on verb learning, and to expand this question to consider both simple and complex events, and different languages.

Our results show that when learning verbs linked to events depicting simple movements, children succeed in both the Single-Actor and Three-Actors conditions, showing no cost to seeing multiple actors across events. This result is similar to the results in a previous study (Maguire et al., 2008); in that study, children in both conditions also succeeded. A difference is, in Maguire et al. (2008), the rate of success in the single agent condition was greater than in the multiple agent condition, whereas in this study, no advantage for either condition emerged for these types of events. The result also held across three languages we tested even though children's verb learning may be more accelerated in some of these languages than in others (e.g., Mandarin), and verb systems vary across languages. Because the same pattern was found across languages, this suggests that, even though these languages vary, there may be one or more underlying cognitive processes that support verb learning and extension across languages.

In this study, children succeeded in extending new verbs in the complex event sets when shown a single agent while learning a verb, but their responses were not above chance when shown three different agents. The pattern of results seen in these complex event sets also did not differ by language. This result was surprising to us, given that variability while comparing events should help children form good inferences about verb extension because it should help them generalize from the initial example to new examples. However, these results fit those in Scott and Fisher (2012), with both showing that young children can have difficulty comparing events when they include variation and multiple elements. This result also fits the overall argument made by Maguire et al.

(2008) that seeing events with multiple agents may impair early verb learning. These results also fit some recent studies of word learning from picture books, which show that 3- and 4-year-old children learn more new nouns when read the same book multiple times than when read different books with the same number of repeated target nouns (Horst, 2013; Horst, Parsons, & Bryan, 2011). This effect was particularly evident in tests of children's word learning after a delay, suggesting children formed a better memory of these words. An inference in these studies is that variation across contexts in different storybooks distracted children from learning the new words. In sum, prior studies have shown variation can be difficult to process, and it can be linked to poorer performance. However, when children can make use of variation, it can help young children focus on relevant versus irrelevant information (e.g., Gómez, 2002) and can lead to greater transfer (e.g., Perry, Samuelson, Malloy, & Schiffer, 2010).

A question is why variability has been shown to be helpful in infant categorization studies, and in categorization studies with preschool-aged children, but may not be as helpful in some verb learning contexts. The infant categorization results in particular suggest to us that young children can attend to and make use of variation across static objects. However, learning a new verb is a more difficult task because it requires attention to objects in motion within a larger dynamic scene, and often attention to objects in relation to other objects. Thus, there are processing demands children face when seeing a single dynamic event, much less when comparing across multiple dynamic events, and it may not be too surprising then that they would have more difficulty making sense of variation within events than is seen in object categorization tasks. At the same time, we had found attention to variability in prior verb studies (e.g., Childers & Paik, 2009), and thus future studies are needed to best understand the conditions under which children can benefit from variability across examples in verb learning.

Furthermore, although we counterbalanced the side that the correct event was shown at test, both within conditions and across participants, in preferential looking studies, the scenes shown at test are counterbalanced such that the correct video for one condition is the incorrect video for another (e.g., Fisher, 2002). However, this practice is often omitted (e.g., Haryu et al., 2011; Imai, Haryu, & Okada, 2005; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009; Waxman et al., 2009), particularly in pointing studies, and the previously published study by Maguire also did not counterbalance in this way. In addition, in studies in which the experimenter creates an event depiction that appropriately extends a verb or does not, it remains unclear how different the distractor event should be. In our events, we kept the actor and (most of the) objects the same across both choices, but varied the action performed such that one action was irrelevant. However, how the test trials are constructed has a major influence on children's ability to extend the verb, and varying the level of difficulty of the test trial would likely affect the results. Studies are needed that test different types of variability, across different time delays, with different levels of extension (more similar extensions, more varied), for different ages of children.

Although there are many questions that remain, to become fluent speakers, children must become productive, creative users of language. In verb learning, children must use their knowledge of a new verb to make appropriate inferences about how to extend verbs in new situations, to include new objects, and/or to new sentence types. Cross-situational information could be useful to learners grappling with how to extend a new verb. If children can remember past events that have been linked to a particular verb, and if they can compare them, they could use this information to guide inferences about new contexts that might be appropriate for a particular verb's extension. Our results show similarities in children's verb learning across three different languages, including two languages in which children may be 'verb experts' (at least as compared to more noun-biased English-speaking children). In addition, they show the processing of variability across comparisons interacts with the complexity of scenes linked to a new verb. This also is an important finding as it suggests a perhaps universal cognitive processing limitation. Additional studies examining how children develop an ability to compare events, and process variability, will be important for future research.

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Notes

1. In hindsight, some children probably needed for the video to be paused to be able point at test.
2. The children in Chengdu are primarily exposed to Mandarin but, as is common in provinces and most cities in China, their parents and elders also speak a distinct regional dialect. Thus, the children have some exposure to the Chengdu dialect as well.
3. The Mandarin translation was completed by Dr. Edmonson and his colleagues, a linguist who has specialized in Mandarin. The Korean translation was provided by Dr. Silva, a linguist specializing in Korean. Both linguists sought to create

sentences that were as close to the English sentences as possible, but were tailored to each language and appropriate for children.

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Appendix A: Stimulus sentences

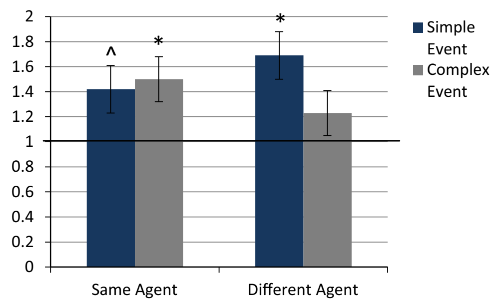
E says during a blank screen before Video 1 learning phase.		
English	Mandarin (‘len’ set)	Korean (‘mikka’ set)
Now watch <novel verb-ing>.	仔细看看 len	미까지?
	Zixi kan-kan len	mikka-ci
	ADV Carefully look-REDUPL len	mikka-PART
	‘Look carefully (at) <novel verb-ing>’	‘(She) mikkas (yeah?)!’
E says as child sees first event:		
English	Mandarin	Korean
<Novel verb>-ing!	你 看到	여자가 미까지?
	Len!	yeca-ka mikka-ci
	‘<Novel verb>!’	girl-NOM mikka-ci
		The girl mikkas (yeah?).’
Do you see her <novel verb>-ing?	她在 len 吗?	여자가 미까는 거 보이니?
	Len ni kandao ta zai len ma	yeca-ka mikka-nun ke poi-ni
		Girl-NOM mikka-ADNOM thing be.seen-
	Len you look at 3SF PROF len INTERROG	INTERROG
	‘You look at her <novel verb-ing>?’	‘Can you see the girl mikka?’
Watch her <novel verb> ing.	仔细 看看 吧	여자가 미까는 거 봐봐.
	zixi kan-kan ba ta zai len!	yeca-ka mikka-nun ke pwapwa
	observe look-look PART requesting assent 3SF PROG len!	girl-NOM mikka-ADNOM thing see-see
	‘(Please) look (at) her <novel verb> ing.’	‘Take a look at the girl mikka.’

(continued)

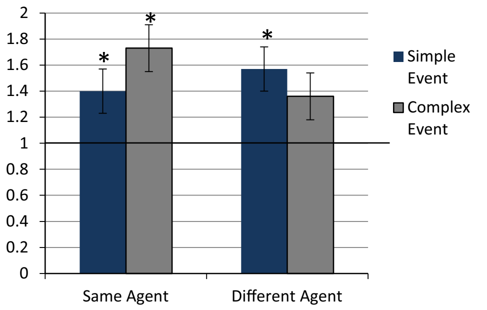
Appendix A. (continued)

E then showed two more events and repeated the same set of sentences. S/he next paused the video and said		
English	Mandarin	Korean
Now it's your turn to find <novel verb>-ing	现在 轮到 你 去 找 len 了	자 이제, 어린이가 미까는 거를 찾아봐요.
	Xianzai lundao ni qu zhao len le.	ca icey elini-ka mikka-nun ke-lul chaca-pwa-yo.
	Now turn arrived 2S go search len PART change of state	So/well now child-NOM <mikka>-ADNOM thing-ACC search for-see-INF_POL.
	'Now it's your turn to find novel verbing.'	'So now it's your turn to find the "mikka"-ing.'
Test phase		
The test events were shown as a split screen video event while the experimenter said,		
English	Mandarin	Korean
Point to the girl who's <novel verb>ing.	指出 那个 在 的 女孩 len	손가락으로 누가 미까는 건지 집어봐요.
	Zhichu nage zai de nühai len.	Sonkalak-ulo nwu-ka mikka-nun ken-ci cipe-pwa-yo.
	Point to that CLS PROG REL girl len	finger-INST who-NOM <mikka>-ADMON thing-CONJ pick-see-INF_POL.
	'Point to the girl who's novel verbing.'	'With your finger, try to pick out someone who is mikka-ing'
Can you point to the one who's <novel verb>-ing?	你 能 指出 那个在len吗?	누가 미까는 건지 집어 볼수 있겠어요?
	Ni neng zhichu nage zai len ma?	nwu-ka mikka-nun ken-ci cipe pol-swu iss-kess-e-yo
	2S can point to that CLS PROG len INTERR	Who-NOM mikka-ADNOM thing-CONJ pick see-ability exist-IRREAL-INF_POL
	'Can you point to the one who's novel verbing?'	'Are you able to pick out who is mikka-ing?'

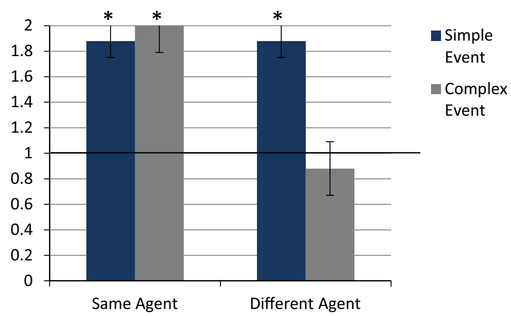
Appendix B: Individual results by country



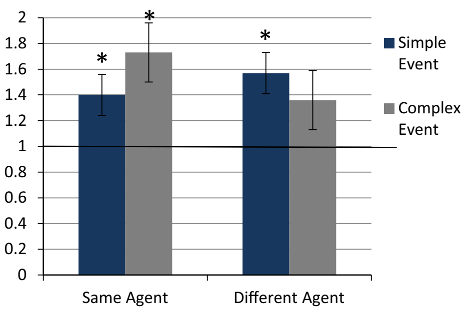
Note: English sample in the United States.



Note: Mandarin sample in China.



Note: Korean sample in Korea.



Note: English/Mandarin sample in Singapore.

Note: In the above graphs, line denotes chance responding; *one sample t-tests, $p < .05$; ^$p < .06$.