MANUSCRIPT ACCEPTED by the journal, "Language, Interaction, Acquisition" on the 22nd of December 2017

Running head: Gestural representation of motion events

Gestural depiction of motion events in narrative increases symbolic distance with age

Kazuki Sekine [a,b,]*, Catharine Wood [c], & Sotaro Kita [d]

[a] Radboud University, Faculty of Arts

[b] Max Planck Institute for Psycholinguistics, Nijmegen

[c] University of Bristol, Department of Experimental Psychology

[d] University of Warwick, Department of Psychology

* Corresponding author:

Kazuki Sekine

Max Planck Institute for Psycholinguistics, PO Box 310, 6500 AH Nijmegen, The Netherlands.

Telephone; +31 (0)43521508. Email; kazuki.sekine@mpi.nl

Gestural depiction of motion events in narrative increases symbolic distance with age

Abstract

We examined gesture representation of motion events in narratives produced by three- and nine-year-olds, and adults. Two aspects of gestural depiction were analysed: how protagonists were depicted, and how gesture space was used. We found that older age groups were more likely to express protagonists as an object that a gesturing hand held and manipulated, and less likely to express protagonists with whole-body enactment gestures. Furthermore, for older age groups, gesture space increasingly became less similar to narrated space. The older age groups were less likely to use large gestures or gestures in the periphery of the gesture space to represent movements that were large relative to a protagonist's body or that took place next to a protagonist. They were also less likely to produce gestures on a physical surface (e.g., table) to represent movement on a surface in narrated events. The development of gestural depiction indicates that older speakers become less immersed in the story world and start to control and manipulate story representation from an outside perspective in a bounded and stage-like gesture space. We discussed this developmental shift in terms of increasing 'symbolic distancing' (Werner & Kaplan, 1963).

Key words: gesture, speech, motion events, distancing, preschool children

1. Introduction

Research on co-speech gestures has revealed so far that gesture and speech are an integral part of our communicative practice, and they temporally and semantically synchronize in language production (Kendon, 2003; McNeill, 1992). Gestures are frequently used to depict various aspects of motion events, and it has been suggested that young children gesturally depict events in different ways from adults (McNeill, 1992). The current study examined how speakers gesturally depict protagonists in motion event narratives and examined the development of gesture semiotics in a cross-sectional study of children aged three and nine years, and adults. More specifically, the current study aims to demonstrate how the 'symbolic distance' (Werner & Kaplan, 1963) of gestures depicting motion events in narratives increases with age.

Co-speech gestures can be classified into different types (McNeill, 1992). In the current study, we focused on gestures which are called *representational gestures* that depict or indicate an action or the size, shape or location of an object because those gestures are frequently produced by children in our target age groups (three- and nine-year olds), and are more often used to depict the protagonists and the landscapes in story retelling than other types of gestures (Colletta et al., 2015). Representational gestures include *iconic* and *pointing* gestures in McNeill's (1992) typology; iconic gestures depict a referent based on the similarity to the referent, and pointing gestures indicate a referent based on spatial contiguity. Pointing gestures do not only point at concrete physical targets but also imaginary targets in the gesture space, especially during narratives ("abstract deixis" in McNeill, 1992). The form of representational gestures flexibly changes according to what is being expressed by the gestures, whereas other types of gestures, *beats* or *emblems*, do not change form depending on the context of use. Thus, we excluded beats and emblems from our analysis. Beats are gestures that are used to mark discourse boundaries or emphasize speech (McNeill, 1992), and their form is more or less constant regardless of the context of use. In emblems, the form-meaning relationship is determined by social convention (e.g., the 'OK' sign that is formed by making a ring shape with the thumb and index finger; McNeill, 1992). Thus, beats and emblems are less interesting for the current investigation of how gestural depiction of the same concept changes over the course of development.

Previous studies have reported the occurrence of different types of gestures at different points in child development. Pointing gestures in communicative contexts emerge at around the age of nine months (Butterworth, 2003). Pointing gestures dominate compared to other types of gestures, at least until around age four (Nicoladis, 2002). A study based on parental report indicated that at around 12-13 months, another form of gestures, 'symbolic gestures', emerges (Acredolo & Goodwyn, 1998).

Symbolic gestures depict concepts such as objects (flapping hands for 'bird'), requests (patting mother's chest for 'nursing'), attributes (raising arms for 'big'), replies (a shrug for 'I don't know'), and events (clapping for 'a baseball game'). A majority of these gestures appear when children's expressive vocabulary is still small (25 words or less). Symbolic gestures usually do not occur with speech, and the form-meaning relationship is conventionalised between the child and his or her family member (Acredolo & Goodwyn, 1994). In this sense, they are more similar to emblems than to iconic gestures. Although some symbolic gestures have iconic form-meaning mappings (e.g., 'bird' with flapping arms), it is not clear whether young children understand the iconic mapping. In fact, in an experiment in which children had to choose one of two objects to give to the experimenter (Namy, 2008), when the experimenter produced a novel iconic gesture congruent with one of the objects, 18-, 22- and 26-month-olds selected the congruent item at an above chance level, but 14-month-olds did not.

Spontaneous iconic gestures that accompany speech seem to emerge later than symbolic gestures. Iconic gestures depict information in an idiosyncratic way, and convey information relevant to the concurrent speech. Thus, unlike symbolic gestures, the form of an iconic gesture varies depending on context or speaker even when same referent is depicted; the meaning of an iconic gesture can be interpreted from its form, the concurrent speech, and the context. Heller and Rohlfing (2014) observed gestures longitudinally in interactions between German-speaking mothers and children from 10 to 24 months. In a report of one of the children's development, iconic gestures were observed from 16 months. Furman, Küntay, and Özyürek (2014) longitudinally observed gestures and speech in caused motion event expressions in interaction between Turkish-speaking parents and children from age one to three. The earliest emergence of iconic gestures in this corpus was at 19 months. Özçalışkan and her colleagues (Özçalışkan & Goldin-Meadow, 2011; Özçalışkan, Genter, & Goldin-Meadow, 2014) observed interactions between English-speaking children and their parents from 14 to 34 months of age, and they found that the frequency of iconic gestures abruptly increases at 26 months. After 24 months, the frequency of iconic gestures increases with the increasing complexity of sentences at least until age three and a half (McNeill, 2014; Mayberry & Nicoladis, 2000). Similarly, in McNeill's (1992) observation, the youngest age at which an English-speaking child produced an iconic gesture was two and a half years.

Two factors affect the development of representational gestures. One factor is language development: the expression of iconic gestures changes with language development. Özyürek, Kita, Allen, Brown, Furman and Ishizuka (2008) examined how English-speaking and Turkish-speaking children aged three, five, nine years, and adults depicted manner and path components of a motion event by gesture and speech. Speakers in all age groups verbally encoded manner and path in language specific ways: English speakers encoded both pieces of information within a single clause, whereas Turkish speakers used two clauses (verbs) to encode the same information. Similarly, adults encoded manner and path through gesture in language specific ways: English speakers tended to predominantly use conflated gestures (i.e., two components are conflated into a single gesture), whereas adult Turkish speakers tended to use two separate gestures for the two components. In contrast, gestures by three- and five-year-olds did not show language specificity. More specifically, regardless of language, their gestures depicted the manner and path components separately using two gestures just like Turkish adults, despite the fact that English-speaking three- and five-year-olds linguistically encode manner and path in one clause. From this result, the authors concluded that young English-speaking children do not have sufficient processing capacity to plan utterances with the clause as a planning unit, but use smaller planning units. As English speakers get older, their planning units become bigger and they start to produce gestural depictions different from Turkish speakers, who have to separate manner and path across two planning units regardless of age. Gullberg & Narasimhan (2010) also demonstrated the relationship between iconic gesture and language development by focusing on how Dutch-speaking children expressed object placement events. In Dutch, when one describes an event in which someone puts something at a certain location, you have to choose one of two caused posture verbs. The choice is made based on whether the located object is placed horizontally or vertically; *leggen* 'to make something lie' and *zetten* 'to make something stand or sit'. Some Dutch-speaking children aged three to five overextend *leggen* to all placement events and underextend the use of *zetten*, but other children can use the two verbs in an adult-like way. The authors found that children who over-used *leggen* produced only gestures about the path of the caused motion, whereas children who used the two verbs differentially incorporated not only the path but also the placed object (e.g., a specific hand shape to show an object) in gestures like adults. That is, when the children were sensitive to object orientation in their verb choice, they gesturally expressed objects when talking about a placement event. Thus, these studies have shown that the semantic categories in a language affects how gestures depict the referent, and that gestures and language develop in parallel.

The second factor affecting representational gestures is the development of cognitive ability to use nonverbal symbols. The current study focused on this second factor. The relationship between the form of representational gestures (pointing and iconic gestures) and the referent shows developmental changes (Werner & Kaplan, 1963). Werner and Kaplan first explained the development of gestures as an example of 'symbolic distancing'. That is, the distance between signifier (symbol form such as gesture or spoken word) and signified (the concept, meaning, or thing indicated by the signifier) increases with age.

One instantiation of symbolic distance is the similarity between the signifier and the signified; thus, when symbolic distance increases, similarity decreases and arbitrariness increases. Werner & Kaplan gave an example of symbolic distancing from an observation by Piaget (1951). In order to express the concept of drinking, Piaget's daughter (1;07) first enacted drinking with a glass of water, but later on she pretended to drink out of an empty glass. Eventually she performed the action with an empty hand, without a glass. Thus, gesture gradually increases the distance (reduces the similarity) from the real action. A similar developmental trend was also found by Iverson, Capirci, and Caselli

(1994). Iverson et al. studied toy play between a child and a caregiver and found that the proportion of gestures produced empty handed increased from 16 to 20 months, although this age difference was not statistically significant.

In a similar vein, symbolic distancing in children was examined in pantomiming (gesturing without speech) object manipulation (e.g., Boyatzis & Watson, 1993; O'Reilly, 1995). O'Reilly (1995) examined pantomime in three- and five-year-olds and found that three-year-olds tend to depict the object by using a part of their body (e.g., for brushing teeth, the extended index finger is moved back in and forth as if the index finger is a toothbrush), whereas five-year-olds depict the object by using the hand as if they were manipulating the imaginary object (e.g., for brushing teeth, a fist hand shape is made to the side of the mouth, as if the child is holding an imaginary tooth brush). This change can be interpreted as increasing symbolic distance, because younger children tend to produce referents that are closer to a fuller picture of tooth brushing (the tooth brush and the action), whereas older children depict only the hand action and require listeners/observers to imagine a toothbrush. According to McNeill (1992: 296-297), in gestures occurring during adults' narratives, the hands can freely be designated to take on different meanings, and even the same hand shape can represent different referents such as characters' hands, entire characters, objects, or abstract ideas. In this sense, adults' gestures are symbols in that the distinction between signifier and signified is clear. In contrast, the freedom is less developed in children, and their gestures are less symbolic in that they remain closer to enactment.

Another manifestation of symbolic distancing in gestures space is how similar the following two relative scales are: the relative scale between a protagonist and the environment in which the protagonist moves, and the relative scale between a gesturer and gesture space. In young children, the relative scale for a gesturer and gesture space is similar to the relative scale for narrated (referent) events. This difference in gesture space between children and adults has been observed in previous studies. McNeill (1992) elicited speech-accompanying iconic gestures by showing an animated cartoon (Tweety & Sylvester) to participants and asking them to retell the story. In one of the scenes, the cat swallows a bowling ball and rolls down to the bowling alley with the bowling ball inside him. To describe this scene, an adult speaker simply moved her flattened left hand at stomach level from left to right while saying "and roll down the street". A two-and-a-half-year-old girl described the same scene by sweeping her hand from above her head to the far right while saying "he went away with that". Then, she turned around in the chair and pointed to the room behind her for the cat's final destination while saying "in there". Based on this type of qualitative observation, McNeill (1992) inferred developmental shifts in the use of gesture space during the preschool period. Young children's gestures can take advantage of the whole space that surrounds them, and they perform gestures as if they are in the scene of the narrated event. In contrast, adult gesture space is confined to the front of the speaker's torso, taking the form of a shallow disk. This suggests that children's gesture space is immersive and has a scale similar to the environment in which a protagonist moves in narrated space. The scale of gesture space becomes less similar to (and smaller than) narrated space with age (McNeill, 1992). A similar change in gesture space was found in gestures during route descriptions by four- to six-year-old children (Sekine, 2009, 2011). Four-year-olds often produced gestures that were anchored to the geographic locations of the actual route, even if the target route was behind the child, whereas six-year-olds often produced gestures that created imaginary routes or landmarks in front of the speaker. Thus, these findings indicate that the similarity in relative scale between the protagonist (walker) and his/her environment and that between the gesturer and gesture space decreases with age.

2. **The current study**

There are limitations to previous demonstrations that symbolic distancing in gestures increases with age. Most evidence has been qualitative (e.g., McNeill, 1992; Piaget, 1951; Werner & Kaplan, 1963) or quantitative but statistically not significant (Iverson *et al*., 1994). O'Reilly's (1995) study on pantomime gestures is an exception to this general trend; however, it did not investigate speech-accompanying gestures. Sekine's (2009, 2011) studies showed the change of gesture space in children, but did not investigate the difference between children and adults. In addition, the data came from route descriptions, not from narratives. Thus, in the current study, we quantitatively investigated age-related symbolic distancing in speech-accompanying representational gestures in children's and adults' narratives by focusing on these two aspects of gestural depiction: how protagonists in a story are depicted, and how spatial relationships in a story are depicted.

Another limitation in previous quantitative demonstrations is that the evidence of symbolic distancing has so far come from studies that used tasks requiring children to describe their own physical experience. For example, object manipulations (Boyatzis & Watson, 1993; O'Reilly, 1995) and route descriptions (Sekine, 2009) were used to elicit gesture and speech from children. In these tasks, speakers' own physical movement is an important part of the referent (e.g., familiar object manipulation or routes taken by the participants). With these tasks, symbolic distancing between gestures and their referents may occur because young children may start by basing their gestural depiction on their own experience with the physical world, which would lead to gestural depiction with small symbolic distance. As the starting point is a smaller symbolic distance, the most likely developmental trajectory is to increase the distance towards representation that is more removed from the gesturer's own experiences in the physical world. However, it was not clear whether symbolic distancing with age would generalise to gestures that accompany narratives about others' experiences, especially in an imaginary world. Thus, in this current study, we used a narrative task where participants watched animated cartoons depicting motion events and retold them to a listener.

Recounting a motion event has been shown to be an effective task in the study of the development of representational gestures since even three-year-olds can easily produce gestures and speech (e.g., Özyürek, Kita, Allen, Furman, Brown, & Ishizuka, 2008). Other studies have used different commercial cartoons for children such as *Tweety & Sylvester* (e.g., McNeill, 1992; Sekine & Furuyama, 2010) or *Tom & Jerry* (e.g., Colletta *et al.*, 2015). These cartoons include motion events but they are complicated or have too much information for young children. Thus, in the current study we used the animated motion events that were created as an experiment stimulus by Özyürek, Kita and Allen (2001), and the animated motion events, consisting of two protagonists moving in various manners in simple landscapes, are so simple that even young children can understand them. They have been successfully used in developmental studies (Allen, Özyürek, Kita, Brown, Furman, Ishizuka, & Fujii, 2007; Özyürek, *et al.*, 2008; Furman, Küntay, & Özyürek, 2013).

We focused on three- and nine-year-olds in the current study because they are important periods in which to examine symbolic distancing. First, from the age of three, children start to show a good understanding of narratives (e.g., Nye, Thomas, & Robinson, 1995; Reilly, Zamora, & McGivern, 2005; Ziegler, Mitchell, & Currie, 2005). In addition, by age three, children start to produce a substantial number of iconic gestures in narratives (McNeill, 1992; Özyürek, *et al*., 2008), but they do not show fully developed symbolic distancing in gesture (O'Reilly, 1995). Thus, we can see how young children start using representational gestures in motion event narratives. By nine years old, children start using the pronominal system to track reference in discourse (Karmiloff-Smith, 1985) and can produce all kinds of gestures that adults use in discourse (McNeill, 1992). However, gestures for structuring discourse are much less frequent in nine-year-olds than in older children and adults (Cassell, 1991; Sekine & Furuyama, 2010; Sekine & Kita, 2015). Thus, we can see how children who start being able to create cohesive discourse use representational gestures**.**

We hypothesised that representational gestures in narratives would show greater symbolic distance in older participant groups. In particular, we examined symbolic distancing in the depiction of protagonists in narratives, and in the use of gesture space. Two aspects of gestural depiction were examined; how protagonists are depicted, and the use of gesture space.

As for the depiction of protagonists, we examined how protagonists were depicted when their location was in focus, and how protagonists were depicted when moving. For both analyses, we predicted that younger children would tend to act out the protagonist by using their whole body or a hand as a protagonist, whereas older children or adults would tend to depict protagonists as imaginary objects that are held or manipulated by the gesturing hand. That is, younger children's gestural depiction should have a smaller symbolic distance because children's gestural depictions tend to map protagonists' body onto the gesturer's body, whereas adults' gestural depiction should tend to map only the protagonists' body on to hands.

As for gesture space, we examined two properties of gesture space. Firstly, we examined the contact with physical surfaces. We predicted that if gesture space becomes the space of narrated events for young children as proposed by McNeill (1992), then young children should depict surfaces in the narrative event (e.g., the ground on which the protagonist moved), using physical surfaces in the speech event more often than older children and adults. Thus, because stimulus events are mostly movement on a surface, young children's gestures should make contact with physical surfaces more often than gestures by older children and adults. Secondly, we examined the change of the size of gesture space by focusing on whether young children use a larger gesture space vertically (Figure 2) and horizontally (Figure 3) than older children and adults. As mentioned before, changes in symbolic distancing for gesture space should also be observed in the similarity between the relative scale of a gesturer and gesture space and that of protagonists and the environment in which they move. Because in our stimulus cartoons protagonists move in a landscape that is larger than the protagonists' bodies, we predicted that young children would use a vertically and horizontally larger gesture space than adults. For vertical gesture space we examined whether young children produced more gestures in outer gesture space (see Figure 2) than older children and adults. For horizontal gesture space we examined whether young children produced more gestures in a larger space than older children and adults. The cartoon stimuli involved the protagonists being located at the top of a hill, the bottom of a hill, and on a flat surface. Thus, young children should use more extreme upper gesture space when expressing the top in the stimulus event, and more in the lower gesture space (see Figure 3) when expressing the bottom in the stimulus event.

3. Method

3.1 Participants

The participants were 64 native speakers of English, consisting of three different age groups: 20 three-year-olds (mean age: 3;8, range: 3;3 to 4;3, 19 females), 21 nine-year-olds (mean age: 9;4, range: 8;10 to 10;0, 14 females), and 23 adults (mean age: 23, range: 18 to 40, 13 females). All participants were recruited in the Boston area, USA.

3.2 Data

The data used in this study was collected as part of a study investigating the cross-linguistic syntactic packaging of ‘path’ and ‘manner’ information in motion events (Allen, *et al.,* 2007; Kita, Özyürek, Allen, Brown, Furman, & Ishizuka, 2007; Özyürek, et al., 2001; Özyürek *et al*., 2008).

3.3 Materials

To elicit gesture and speech from the participants, we used cartoon video stimuli, the ‘Tomato Man movies’, developed by Özyürek *et al.* (2001). The original video stimuli have 10 short clips, but in the current study we analysed descriptions of only five clips (*Spin+up, Spin+down, Roll+up, Roll+down, and Jump+around*; see Appendix 2 for details). We chose clips with as similar manner of motion as possible to have a sufficient number of observations of similar types of gestures to reduce noise in the data. Each video clip showed a motion event consisting of a two-dimensional animation involving a simple two dimensional scene and two protagonists, a red circle with a smiling face (Tomato Man) and a green triangle with a frowning face (Triangle Man). The protagonists moved in a landscape, for example from the top of a hill, down the hill to the bottom. The two protagonists entered the landscape, and one of the protagonists performed a motion event with manner and path, for example Triangle man spinning down the hill (see Figure 1). Apple Quick Time Player was used to display the video stimuli. The duration of each video clip was between 6 and 15 seconds and contained three salient phases; the initial event, the central event, and the final event (see Appendix 2 for the three phases for each event). A blank screen was displayed at the end of each video clip.

Insert Figure 1

3.4 Procedure

Participants were tested individually in a quiet location known to them. All participants were videotaped during the test phase for coding and analysis purposes**.** They sat in front of a female listener (a research assistant). All video clips were presented on a laptop computer, which was set up next to the participants. Every time they watched a video stimulus on the computer screen, they turned 90 degrees to their right or left side where an experimenter sat. The experimenter controlled the stimuli on the laptop computer. The listener could not see the computer screen from the place where she was sitting.

The participants were first shown the protagonists and the landscape involved in the video clips to familiarise them with the key elements in the stimulus videos. In the practice phase, two test video clips were used to familiarise participants with the procedure. Each video clip was played twice. Immediately after participants watched the clip for the second time, the movie player showed a black screen so that participants would not refer to the computer screen during narration, e.g., with pointing gestures. The experimenter prompted the participant to describe what happened to the listener, who did not see the stimulus video. Participants turned to the listener, and narrated the events to her. After the participants had understood the task (that is, narrating the stimuli to the listener) in the practice phase, the test phase was conducted in the same way. Participants were shown ten video clips in total (only five of the narrations, as specified in the Material section, were used to reduce coding effort).

3.5 Coding

3.5.1. Speech segmentation

All speech was transcribed, and was segmented into clauses, which were separated by a coordinating conjunction, for example ‘and’, ‘but’ or ‘so’, or when a significant pause was made. Then, each clause was coded for the relevant narrative phase: the initial, central, final events, or null (not relevant). Many participants used more than one clause within each phase; in these cases, all relevant clauses were coded. A clause was classed as irrelevant and coded null, if it was not directly related to the above events (e.g., “Mr Tomato guy was smiling as usual”), if it involved a memory from another video clip (e.g., “And instead of hopping like he did the first time”), or if it was an irrelevant comment about the video clips (e.g., “So kind of farther back so kind of at a farther angle”).

3.5.2. Gesture coding

We focused our analysis on gestures depicting the protagonists and the landscape (iconic and deictic gestures, respectively, in McNeill's (1992) terms). Each gesture was composed into the following gesture phases, as defined by McNeill (1992): preparation, stroke, hold, and retraction phases. The preparation is a phase that prepares to execute the stroke phase. The stroke phase is the main part of a gesture, as it is the main meaning-bearing part of the gesture, and is carried out with the most effort or tension. The hold is a phase where the hand is held in mid-air in the same position, and may be observed before or after the stroke. The retraction is a phase where the hand returns to its rest position. Note that only the stroke phase is obligatory in forming a gesture. Thus, we sometimes recorded gestures lacking preparation, hold, and/or retraction phases. The meaning of a gesture was interpreted on the basis of the shape and movement of the stroke phase, the speech concurrent with the stroke phase, and the stimulus video.

Next, gestures were coded for the following six features: a) how the protagonist’s location was depicted, b) how the moving protagonist was depicted, c) contact with the body or an object surface, d) gestures made exclusively in outer gesture space, e) gestures expressing the location of the top of the hill in the stimulus event, and f) gestures expressing the location of the bottom of the hill in the stimulus event. The subcategories (in italics) and the definitions are described in Table 1.

Insert Table 1

Insert Figure 3

3.6 Reliability

The first author coded the entire data set. To ensure the reliability of the gesture coding, 60% of the data was re-analysed by a trained and independent native English-speaking student. Ten participants from each age group (30 participants in total) were randomly selected and re-coded by the second coder. Point-to-point percentage agreement was calculated. The two coders agreed on the number of gestures 83% of the time for three-year-olds, 87% of the time for nine-year-olds, and 90% of the time for adults. We calculated the percentage agreement for each gesture category by collapsing age groups. The two coders agreed on the number of gestures displaying contact with the body or an object surface 95% of the time, and on the number of gestures that were made exclusively in outer gesture space 97% of the time. The Cohen's kappa statistic was used to assess inter-rater reliability for coding with more than two categories. Agreements between the two independent coders were overall high; for gestures depicting the protagonist's location kappa = .81; for gestures depicting the moving protagonist kappa = .82; for gestures expressing the location of the top of the hill in the stimulus events kappa = .91; and gestures expressing the location of bottom of the hill in the stimulus events kappa = .90. Any coding disagreements were resolved through discussion and subsequent consensus.

4. Results

The analyses are based on the elicited speech from watching five stimuli. The mean proportion of relevant sentences per participant was 27.2 % (*SD* 12.3 %) in the three-year-olds, in nine-year-olds 29.6 % (*SD* 8.0 %) and in adults 41.6 % (*SD* 12.8 %).

4.1 Gestural depiction of protagonists when their location is in focus

On average, three-year-olds (n = 18) produced 6.8 gestures (*SD* = 5.6, Range 1-18), nine-year-olds (n = 21) 14.4 gestures (*SD* = 6.0, Range 3-25), and adults (n = 23) 20.0 gestures (*SD* = 12.3, Range 1-44) that showed the location of the protagonist. These gestures were classified into one of the following five subcategories: *protagonist + plane*, *manipulated protagonist*, *hand as protagonist*, *point at protagonist,* and *head pointing*. For each participant, the proportion of each gesture type depicting the location of the protagonist was calculated. After arcsine transformation of the proportion data, we conducted Kruskal-Wallis tests to examine the age difference (see Figure 4 for the mean for each age group, and Appendix 1 for the standard error for each age group). The alpha level is set to p = .05 throughout the paper.

The age difference was significant for *manipulated protagonist,* χ^2 (2, N = 62) = 8.83, $p < .05$, *pointing at the protagonist*, χ^2 (2, N = 62) = 8.22, $p < .05$, and marginally significant for *head pointing*, χ^2 (2, N = 62) = 5.64, $p < .10$. The test was not significant for *protagonist + plane*, χ^2 (2, N = 62) = 6.10, p = .74, and *hand as protagonist*, χ^2 (2, N = 62) = 1.28, p = .53. Post hoc comparisons (Mann-Whitney tests) compared the age groups. We did not correct the alpha level for posthoc comparisons of age groups throughout the paper because Howell (2002) indicates it is unnecessary to correct for multiple comparisons when there are only three means. Adults produced significantly more gestures depicting *manipulated protagonist* than three-year-olds (*U*= 104, $p < .01$, $r = .42$) and nine-year-olds (*U*= 152, $p < .05$, $r = .32$), and three-year-olds produced significantly more gestures depicting *pointing at the protagonist* than adults (*U*= 102, $p < .01$ $r = .43$). It also showed that adults produced marginally significantly more gestures depicting *head pointing* than three-year-olds (*U*= 171, $p < .10$, $r = .29$).

To summarise the developmental trends of gestures showing the protagonist's location, gestures depicting *manipulated protagonist* and *head pointing* increased with age, and *pointing at the protagonist* decreased with age.

Insert Figure 4

4.2 Gestures showing how moving protagonists are depicted

On average, three-year-olds ($n = 20$) produced 8.9 gestures (*SD* = 3.7, Range 2-17), nine-year-olds ($n = 21$) 10.8 gestures (*SD* = 5.9, Range 4-27), and adults ($n = 23$) 12.3 gestures (*SD* = 5.0, Range 4-28) that showed how the moving protagonists were depicted. These gestures were classified into one of the following six subcategories: *protagonist + plane, manipulated protagonist, hand as protagonist, point at protagonist, body as protagonist* and *head pointing*. For each participant, the proportion of each gesture type depicting the moving protagonist was calculated for each participant. After arcsine transformation of the proportion data, we conducted Kruskal-Wallis tests to examine the age difference (See Figure 5 for the mean for each age group, and see Appendix 1 for the standard error for each age group).

The age difference was significant for *body as protagonist*, $\chi 2$ (2, N = 64) = 12.62, $p < .01$, and *head pointing*, $\chi 2$ (2, N = 64) = 7.13, $p < .05$, and marginally significant for *manipulated protagonist*, $\chi 2$ (2, N = 64) = 4.88, $p < .10$, for *hand as protagonist*, $\chi 2$ (2, N = 64) = 4.71, $p < .10$, and for *point at protagonist*, $\chi 2$ (2, N = 64) = 5.73, $p < .10$. The test was not significant for *protagonist + plane*, $\chi 2$ (2, N = 64) = 1.14, $p = .57$. Post hoc comparisons (Mann-Whitney tests) showed that three- (*U*= 126, $p < .001$, $r = .54$) and nine-year-olds (*U* = 161, $p < .05$, $r = .45$) produced significantly more gestures depicting *body as protagonist* than adults, and that nine-year-olds (*U* = 150, $p < .05$, $r = .29$) and adults (*U* = 160, $p < .01$, $r = .41$) produced significantly more gestures depicting *head pointing* than three-year-olds. It also showed that adults produced significantly more gestures depicting *manipulated protagonist* (*U* = 140, $p < .01$, $r = .36$) and *point at protagonist* (*U*= 134, $p < .01$, $r = .36$)

than three-year-olds. Conversely, three-year-olds produced significantly more gestures depicting *hand as protagonist* than adults (U = 149, $p < .05$, r = .30).

To summarise the developmental trends of gestures showing how the moving protagonists are depicted, gestures depicting *head pointing*, *manipulated protagonist* and *point at protagonist* increased with age, and gestures depicting *body as protagonist* decreased with age.

Insert Figure 5

4.3 Gestures in which the gesture stroke made contact with the body or an object surface

On average, three-year-olds (n = 20) produced 23.3 gestures (SD = 11.9, Range 2-56), nine-year-olds (n = 21) 37.3 gestures (SD = 14.3, Range 16-66), and adults (n = 23) 51.4 gestures (SD = 21.1, Range 16-82) in which the gesture stroke made contact with the body or an object surface. For each participant, the proportion of gestures involving contact was calculated by dividing the number of gestures involving contact by the total number of gestures. The proportion was 0.20 (SD = 0.20) for three-year-olds, 0.12 (SD = 0.08) for nine-year-olds, and 0.03 (SD = 0.05) for adults.

After arcsine transformation of the proportion data, a Kruskal-Wallis test was conducted to evaluate differences among three age groups. The test was significant, $\chi 2$ (2, N = 64) = 20.88, $p <$ .001. Post hoc analyses (Mann-Whitney tests) indicated that three- (U = 87, $p < .001$, r = .55) and nine-year-olds (U = 63, $p < .001$, r = .65) produced significantly more gestures which made contact with the body or an object surface than adults. This result indicated that compared to adults, children more frequently used their own body or objects to depict the surface on which the protagonist was located or moved.

4.4 Gestures made exclusively in outer gesture space

On average, three-year-olds (n = 20) produced 9.9 gestures (SD = 4.2), nine-year-olds (n = 21) 11.9 gestures (SD = 6.1), and adults (n = 23) 14.8 gestures (SD = 5.3) made exclusively in outer gesture space. For this analysis, we only included gestures that depicted the motion events that had both manner and path (e.g., Panels 2 and 3 in Figure 2). We focused on these events because they cover a majority of the horizontal span of the scene, and thus it is unlikely that adults would exclusively use outer gesture space (high gesture space). For each participant, the proportion of gestures made exclusively in the outer gesture space was calculated by dividing the number of gestures made exclusively in outer gesture space by the total number of gestures. The proportion was 0.40 (SD = 0.10) for three-year-olds, 0.02 (SD = 0.50) for nine-year-olds, and 0 (SD = 0) for adults.

After arcsine transformation of the proportion data, we conducted a Kruskal-Wallis test to examine the age difference. The proportion of gestures made in outer gesture space differed significantly across age groups, $\chi 2$ (2, N = 64) = 7.71, $p < .05$. Post hoc analyses (Mann-Whitney tests with Bonferroni correction, $p < .05$) indicated that three-year-olds produced significantly more gestures in outer space than adults ($U = 151$, $p < .01$, $r = .43$). This result indicated that gesture space gets narrower with age.

4.5 Gestures expressing the location, the top of the hill, in the stimulus events

On average, three-year-olds (N = 16) produced 2.4 gestures (*SD* = 1.4, Range 1-5), nine-year-olds (N = 15) produced 2.5 gestures (*SD* = 1.6, Range 1-6), and adults (N = 22) produced on average 5.6 gestures (*SD* = 2.8, Range 1-11) that express the location, the top of the hill, in the stimulus events. These gestures were classified one of the following three subcategories; extreme upper, upper, and middle gesture space. For each participant, the proportion of each gestures type was calculated (See Table 2 for the mean for each age group).

After arcsine transformation of the proportion data, we conducted Kruskal-Wallis tests to evaluate differences among three age groups on the mean proportion of each category. The test was significant for extreme upper space, $\chi 2$ (2, N = 53) = 15.31, $p < .001$, and upper space, $\chi 2$ (2, N = 53) = 6.14, $p < .05$, and for middle gesture space, $\chi 2$ (2, N = 53) = 8.42, $p < .05$. Post hoc analyses (Mann-Whitney tests) indicated that three-year-olds produced significantly more gestures in the extreme upper gesture space than adults ($U = 66$, $p < .001$, $r = .61$). It also indicated that adults produced significantly more gestures in the upper gesture space than nine-year-olds ($U = 99$, $p < .05$, $r = .34$). nine-year-olds ($U = 58$, $p < .05$, $r = .47$) and adults ($U = 96$, $p < .05$, $r = .40$) produced significantly more gestures in the middle gesture space than three-year-olds. Again, this result showed that the gesture space gets narrower with age.

Insert Table 2

4.6 Gestures expressing the location, the bottom of the hill, in the stimulus events.

On average, three-year-olds ($n = 16$) produced 2.8 gestures (*SD* = 1.4, Range 1-5), nine-year-olds ($n = 19$) 2.9 gestures (*SD* = 1.9, Range 1-7), and adults ($n = 21$) 8.5 gestures (*SD* = 3.9, Range 2-16) that expressed the location, the bottom of the hill, in the stimulus events. These gestures were classified into one of the following three subcategories; upper, middle and lower gesture space. For each participant, the proportion of gestures locating the bottom of the hill was calculated (See Table 3 for the mean for each age group).

After arcsine transformation of the proportion data, Kruskal-Wallis tests were conducted to evaluate differences among the three age groups on the mean proportion of each category. The test was significant for middle gesture space, $\chi 2$ (2, N = 56) = 17.35, $p < .001$, and for lower gesture space, $\chi 2$ (2, N = 56) = 13.34, $p < .01$. The proportion of gestures made in the upper gesture space did not differ significantly across age groups, $\chi 2$ (2, N = 56) = 4.31, $p = .116$.

Post hoc analyses (Mann-Whitney tests) indicated that nine-year-olds ($U = 68$, $p < .01$, $r = .50$) and adults ($U = 43$, $p < .001$, $r = .66$) produced significantly more gestures in the middle gesture space than three-year-olds. It also indicated that three-year-olds produced significantly more gestures in the lower gesture space than adults ($U = 69$, $p < .01$, $r = .60$). This result showed that the use of the middle gesture space increased and the use of the lower gesture space decreased with age.

Insert Table 3

----

5. Discussion

In this study, we investigated how speakers gesturally depict protagonists in motion event narratives and quantitatively examined the developmental changes in gesture semiotics in a cross-sectional study of children aged three and nine years, and adults. More specifically, we investigated whether the symbolic distance (Werner & Kaplan 1963) of gestures depicting motion events increases with age. Symbolic distance was defined as the similarity between the signifier (form) and the signified (referent) of a gesture. We especially focused on two aspects of gestural depiction: how protagonists were depicted, and how gesture space was used.

Two findings on the depiction of protagonists demonstrated an increase in symbolic distance with age. First, three-year-olds used their whole body to depict protagonists (‘character viewpoint’ in McNeill 1992) more often than adults when depicting protagonists in motion. Second, adults used gestures that depicted protagonists as if the gesturing hand held and manipulated protagonists more often than children. This developmental change was seen both when depicting protagonists in movement and when protagonists' location was in focus. Thus, gestures mapped the protagonists' body onto the gesturer's body (i.e., ‘character viewpoint gestures’, McNeill, 1992) more often in children, but onto an imaginary object held by the gesturing hand more often in adults. Gestures with body-to-body mapping have a smaller symbolic distance than gestures with body-to-imaginary-object mappings. That is, gesture forms became more removed from their referents with age.

The two sets of findings on gesture space also reveal an increase in symbolic distance with age. First, three- and nine-year-olds produced gestures that made contact with the body or an object surface more often than adults. This indicates that children's gestures replicated physical contact with a surface in motion events. The second set of findings indicates a larger immersive gesture space for children. Three-year-olds produced more gestures than adults that were made exclusively in outer gesture space to express motion events spanning a large section in the middle of the scene (e.g., the slope in Figure 1). It is as if children were in the scene, standing just next to the slope (e.g., from the perspective of Tomato Man in Figure 1). When expressing the top of the hill in the scene, three-year-olds used extreme upper space in gestures more often than adults. When expressing the bottom of the hill, three-year-olds used lower space in gestures more often than adults. Because the protagonists moved in the landscape that was much larger than their body (Figure 1), children's gestures replicated this relative scale in their gesture space. In contrast, adults' gesture space was horizontally and vertically bounded in front of the upper torso and they used this small-scale gesture space like a stage upon which the story could be gesturally depicted. The two sets of findings indicate that gesture space resembles the narrated scene more in children's gestures than in adults' gestures.

The increase in symbolic distance in gesture with age is both compatible with, and goes beyond, the findings from previous studies. The shift to gestural depictions that involve an imaginary object held by the gesturing hand has also been seen as a descriptive trend (Iverson *et al.*,1994) or in qualitative observations (Werner & Kaplan, 1963), and in pantomimes (without speech) (Boyatzis & Watson, 1993; O'Reilly, 1995). The shift from large gesture space to small gesture space with age was also reported in McNeill's (1992) qualitative observations of adults' and children's gestures in narratives, and in comparisons of four- and six-year-olds in Sekine's (2009, 2011) study of route description, which did not include adult data. It is also important that the current study demonstrated symbolic distancing with age in gestures in narratives elicited by stimulus events. That is, symbolic distancing is not confined to gestures that refer to children's own physical experiences. Symbolic distancing allows the forms of symbols to be used more flexibly, as they are less strongly bound by similarity to the referents. For example, some information (e.g., the surface on which a protagonist moved, the protagonist itself) can be left to the imagination of the recipient. This increases the expressive power of symbols.

Based on his qualitative observations of gestures in cartoon retellings, McNeill (1992) argued that children's gestural depictions do not completely separate referents in the story and the real space in which the children are narrating. This indicates that children are more involved in the story, having an internal perspective on the events. However, gestures become more detached from real space surrounding children with age. This shift is reflected in the large immersive gesture space and the enactment of the protagonists' actions. By providing quantitative data, the current study has confirmed McNeill's observations and extended his interpretation of children's gesture space, and better characterised adults' use of gesture space. We suggest that adult speakers set up gesture space as if it is a stage, and manipulate and control protagonists on the stage in their gestural depiction of the story. Children depict the story from the protagonists' perspective as if they are inside the story, and treat the real world around them as a part of the story such as the landscape in the story. In contrast, adults often clearly separate the story world from the real word; that is, they often take an outside perspective and control where protagonists are located and move in the gesture space, detached from the real world. Thus, the increase in symbolic distance allows adults to control how the story is gesturally constructed in the gesture stage.

This developmental change in gesture dovetails with the evidence on children's understanding of narrative discourse, in which young children imagine themselves within a story (Ziegler *et al.*, 2005). Children may be re-living their own experience of observing or inhabiting the story world. The evidence from previous studies on children's understanding of narrative discourse (Reilly *et al.*, 2005; Ziegler *et al*., 2005) has shown that children become progressively detached from the story world as they grow older. Zeigler *et al.* (2005) studied the verbal recall of short narrative texts in children aged four and nine. Both age groups erroneously replaced a deictically neutral motion verb *go* with a deictic motion verb *come*. For example, in the sentence "the prince quickly jumped up and *went* into the corridor", 'went' would be replaced by 'came,' which indicated that children were engaging with the narrative by imagining themselves within the scene of the action. Reilly *et al.* (2005) examined specific vs. generic use of personal pronouns in children aged nine to 16, and adults, in spoken and written recounts of short video stimuli. Personal pronouns do not only refer to specific individuals (e.g., 'we' in "My mom said we had to go to our rooms for ten minutes"), but also to a generic referent (e.g., 'we' in "This is not right because all people are alike; we all have feelings.", Reilly *et al.*, 2005:189). The generic use of personal pronouns during narratives indicates a stance that is outside of narrated events. Reilly *et al.* found that the generic use of personal pronouns in narrativex became more frequent with age. These previous studies suggest that when children who are nine years old or younger produce narratives, they imagine themselves within the scene of the action, and find it hard to detached themselves from the narrated world; in contrast, adults are more detached from the narrated world, and take an objective stance to the story. This is similar to the current study's finding that adults use a spatially bounded gesture stage to construct a story by manipulating and controlling protagonists on the stage.

This study has several implications for future research. First, future research should examine how the symbolic distancing in gestures proceeds after age nine.

Second, it has to be examined whether participants in all age groups interpreted the task in the same way. In this study, all participants could describe the video stimuli, but it was not clear whether children and adults had the same understanding of what it means communicatively to tell another person what happened in the video stimuli. In other words, the age difference found in the current study could partly be attributed to the development of pragmatics, rather than to the development of symbolic abilities.

Third, socio-cultural factors influencing symbolic distancing is another important topic. In contrast to the view that gestures derive from mental representation or from the process of speaking (e.g., Kendon, 1980; McNeill, 1992), some researchers hold the view that gestures originate in ordinary non-symbolic exploratory and instrumental manipulations in the world of things (e.g., Le Baron & Streeck, 2000; Streeck, 2008). In this latter view, an instrumental manipulation becomes a gesture (symbol) by being abstracted into components of the shared communicative repertoire based on the gesturer's and the recipient's cultural or situational knowledge. "Gestures, as they always are for particular recipients, appeal to those recipients' knowledge, knowledge that may have been acquired over the course of the current situation or in a cultural and physical world that is in some part the shared property of the members of a single society or cultural group" (Le Baron & Streeck, 2000:137). From this viewpoint, it is possible to think that cultural practice also influences the developmental change in gestural representations because children may change their gesture use by observing adults' gestures. Given that previous research has reported that the use of gesture space varies from culture to culture (e.g., Kita, 2007; Müller, 2001; Pettenati, Sekine, Congestrì, & Volterra, 2012), it is important to examine cultural influences in the development of gesture space in the future.

Finally, deictic gestures that refer to protagonists showed interesting patterns. Adults used pointing gestures to indicate protagonists more often than children when the protagonists were moving, but less often than children when the location of protagonists was in focus. Adults also used pointing gestures with the head more often than children. The reasons for these patterns are not clear, and future research should further investigate developmental changes in the use of abstract pointing gestures to refer to protagonists in narratives.

Acknowledgments
The data collection in this study was financially supported by Grant BCS-0002117 from the National Science Foundation. This work was supported by a postdoctoral fellowship awarded to the first author by the University of Warwick. We would like to thank Marion Tellier for her help with the translation of the abstract into French. We would also like to thank the other PIs in the Tomato Man project team (Asli Özyürek, Shanley Allen) for the opportunity to analyse their data.

REFERENCES

Allen, S., Ozyurek, A., Kita, S., Brown, A., Furman, R., Ishizuka, T., & Fujii, M. (2007). Language-specific and universal influences in children's syntactic packaging of manner and path: A comparison of English, Japanese, and Turkish. *Cognition*, 102, 16-48.

Acredolo, L. P. & Goodwyn, S. (1994). Sign language among hearing infants: The spontaneous development of symbolic gestures. In V. Volterra & C. J. Erting (eds), *From gesture to language in hearing and deaf children* (68-78). New York: Springer-Verlag.

Acredolo, L. P. & Goodwyn, S. (1998). Symbolic gesturing in normal infants. *Child Development*, 59, 450-466.
Butterworth, G. (2003). Pointing is the royal road to language for babies. In S. Kita (ed), *Pointing: Where language, culture, and cognition meet* (9-33). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.
Cassell, J. (1991). *The development of time and event in narrative: Evidence from speech and gesture.* Unpublished doctoral dissertation. Chicago: University of Chicago.
Colletta, J-M., Guidetti, M., Capirci, O., Cristilli, C., Demir, O. E., Kunene-Nicolas, R. N., & Levine, S. (2015). Effects of age and language on co-speech gesture production: an investigation of French, American, and Italian children's narratives. *Journal of Child Language*, 42, 122-145.
Doherty-Sneddon, G. (2003). *Children's unspoken language*. London: Jessica Kinsley Publishers Ltd.
Furman, R., Küntay, A., & Özyürek, A. (2014). Early language-specificity of children's event encoding in speech and gesture: Evidence from caused motion in Turkish. *Language, Cognition and Neuroscience*, 29, 620-634.
Gullberg, M., & Narasimhan, B. (2010). What gestures reveal about how semantic distinctions develop in Dutch children's placement verbs. *Cognitive Linguistics*, 21, 239-262.
Heller, V. & Rohlfing, K. J. (2015). From establishing reference to representing events independent from the here and now: A longitudinal study of depictive gestures in young children. In G. Ferré, & M. Tutton (eds.), *Gesture and speech in interaction. Proceedings of the 4th GESPIN* (143–148). Nantes: HAL.
Howell, D. C. (2002). *Statistical methods for psychology (5th ed.)*. Pacific Grove, CA: Duxbury.
Iverson, J. M., Capirci, O. & Caselli, M. C. (1994). From communication to language in two modalities. *Cognitive Development*, 9, 23-43.
Karmiloff-Smith, A. (1985). Language and cognitive processes from a developmental perspective. *Language and Cognitive Processes*, 1, 61-85.
Kendon, A. (1980). Gesticulation and speech: two aspects of the process of utterance. In M. R. Key (ed), *The relationship of verbal and nonverbal communication* (207-227). The Hague: Mouton.
Kita. S. (2007) Cross-cultural variation of speech-accompanying gesture: A review. *Language and Cognitive Processes,* 24, 145-167.
Kita, S., Özyürek, A., Allen, S., Brown, A., Furman, R., & Ishizuka, T. (2007). Relations between syntactic encoding and co-speech gestures: Implications for a model of speech and gesture production. *Language and Cognitive Processes*, 22, 1212-1236.
LeBaron, C., & Streeck, J. (2000). Gestures, knowledge, and the world. In D. McNeill (ed), *Language and gesture: Window into thought and action* (118-138). Cambridge: Cambridge University Press.
Mayberry, R., & Nicoladis, E. (2000). Gestures reflect language development: evidence from bilingual children. *Current Directions in Psychological Science*, 9, 192-196.

McNeill, D. (1992). *Hand and mind*. Chicago: University of Chicago Press.

McNeill, D. (2014). Gesture-speech unity: Phylogenesis, ontogenesis, and microgenesis. *Language, Interaction and Acquisition*, 5, 137-184.

Müller, C. (2001). Gesture-space and culture. In C. Cavé, I. Guaïtella, & S. Santi (eds.), *Oralité et gestualité: Interactions et comportements multimodaux dans la communication* (565-571). Paris: L'Harmattan.

Nicoladis, E. (2002). Some gestures develop in conjunction with spoken language development and others don't: Evidence from bilingual preschoolers. *Journal of Nonverbal Behavior*, 26, 241-266.

Nye, R., Thomas, G. V. & Robinson, E. (1995). Children's understanding about pictures. In C. Lange-Küttner, & G. V. Thomas (eds), *Drawing and looking: Theoretical approaches to pictorial representation in children* (123-134). London: Harvester-Wheatsheaf.

O'Reilly, A. W. (1995). Using representations: Comprehension and production of actions with imagined objects. *Child Development*, 66, 999-1010.

Özçalışkan, Ş., Gentner, D., & Goldin-Meadow, S. (2014). Do iconic gestures pave the way for children's early verbs? *Applied Psycholinguistics*, 35, 1143-1162.

Özçalışkan, Ş., & Goldin-Meadow, S. (2011). Is there an iconic gesture spurt at 26 months? In G. Stam & M. Ishino (eds.), *Integrating gestures: the interdisciplinary nature of gesture* (163-174). Amsterdam, NL: John Benjamins.

Özyürek, A., Kita, S., & Allen, S. (2001). *Tomato man movies: Stimulus kit designed to elicit manner, path and causal constructions in motion events with regard to speech and gestures.* Nijmegen, The Netherlands: Max Planck Institute for Psycholinguistics, Language and Cognition group.

Özyürek, A., Kita, S., Allen, S., Brown, A., Furman, R., & Ishizuka, T. (2008). Development of cross-linguistic variation in speech and gesture: Motion events in English and Turkish. *Developmental Psychology*, 44, 1040-1054.

Pettenati, P., Sekine, K., Congestrì, E & Volterra, V. (2012). A comparative study on representational gestures in Italian and Japanese children. *Journal of Nonverbal Behavior,* 36, 149-164.

Piaget, J. (1951). *Play, dreams and imitation in childhood*. New York: Norton.

Reilly, J., Zamora, A. & McGivern, R. F. (2005). Acquiring perspective in English: the development of stance. *Journal of Pragmatics*, 185-208.

Sekine, K. (2009). Changes in frame of reference use across the preschool years: A longitudinal study of the gestures and speech produced during route descriptions. *Language and Cognitive Processes*, 24(2), 218-238.

Sekine, K. (2011). The development of spatial perspective in the description of large-scale environments. In G. Stam & M. Ishino (eds.), *Integrating gestures: The interdisciplinary nature of gesture* (175-186). Amsterdam: John Benjamins.

Sekine, K., & Furuyama, N. (2010). Developmental change of discourse cohesion in speech and gestures among Japanese elementary school children. *Rivista di psicolinguistica applicata*, 10(3), 97–116.

Streeck, J. (2008). Depicting by gestures. *Gesture,* 8, 285–301.

Werner, H., & Kaplan, B. (1963). *Symbol formation*. New York, NY: Wiley.

Ziegler, F., Mitchell, P. & Currie, G. (2005). How does narrative cue children's perspective taking? *Developmental Psychology*, 41(1), 115-123.

Résumé

Dans cette étude, nous avons analysé la représentation gestuelle d'éléments de spatialisation et de trajectoire (« motion events ») produite par des enfants de 3 et 9 ans et par des adultes. Les participants ont raconté l'histoire de cinq stimuli issus de courts dessins animés. Deux aspects de la représentation gestuelle ont été analysés: la façon dont les protagonistes étaient représentés et comment l'espace gestuel était utilisé. Les résultats indiquent que le développement gestuel coverbal continue progressivement à partir de 3 ans. Un changement majeur de développement vers l'utilisation de gestes de manipulation pour représenter les protagonistes a été mis en évidence. Quant à l'espace gestuel, les résultats montrent que son utilisation se recentre avec l'âge vers la poitrine du locuteur et que l'espace gestuel est utilisé comme une scène de théâtre où sont placés les éléments de l'histoire. Le développement des gestes révèle que les locuteurs plus âgés sont moins immergés dans le monde de l'histoire qu'ils racontent et commencent à contrôler et manipuler la représentation de l'histoire à partir d'un point de vue extérieur. Nous discutons de ce changement de développement en termes de « distanciation symbolique » (Werner & Kaplan, 1963).

Appendix 1

As Figures 4 and 5 do not have error bars, the standard errors for the means are presented in Tables 4 and 5.

Table 4. Standard errors for the means presented in Figure 4

	3 years	9 years	Adults
Protagonist + plane	0.04	0.04	0.03
Manipulated protagonist	0.06	0.05	0.06
Hand as protagonist	0.02	0.03	0.01
Point at protagonist	0.08	0.06	0.06
Head pointing	0.00	0.02	0.04

Table 5. Standard errors for the means presented in Figure 5.

	3 years	9 years	Adults
Protagonist + plane	0.02	0.02	0.02
Manipulated protagonist	0.02	0.03	0.03
Hand as protagonist	0.07	0.05	0.03
Point at protagonist	0.07	0.06	0.05
Body as protagonist	0.07	0.02	0.00
Head pointing	0.00	0.01	0.04

Appendix 2

Descriptions of five motion events and the three salient phases for each event.

Spin +up: The landscape is a large hill with flat ground at the base of the incline and a flat hilltop. In the initial event Tomato Man and Triangle Man enter the scene at the base of the hill. The central event involves Triangle Man moving in a spinning manner, turning on its vertical axis, up the incline of the hill. Tomato Man follows in a gliding manner up the incline the hill. In the final event Tomato Man exits the scene at the hilltop followed by Triangle Man.

Spin + down: The landscape is a large hill with flat ground at the base of the incline and a flat hilltop. In the initial event Tomato Man enters at the top of the hill and Triangle Man follows. The central event involves Triangle Man moving in a spinning manner, turning on its vertical axis, down the incline of the hill. In the final event Tomato Man and Triangle Man exit the scene together at the base of the hill.

Roll + up: The landscape is a large hill with flat ground at the base of the incline and a flat hilltop ending in a cliff that drops off into an ocean. In the initial event Tomato Man enters the scene at the base of the hill followed by Triangle Man who then pushes him up the hill. The central event involves Tomato Man moving in a rolling manner, turning on its horizontal axis, up the incline of the hill. In the final event Tomato Man rolls off of the cliff into the ocean and bobs up and down.

Roll + down: The landscape is a large hill with a flat hilltop and flat ground at the base of the incline where a tree is located. In the initial event Tomato Man enters the scene at the hilltop followed by Triangle Man who then pushes him down the hill. The central event involves Tomato Man moving in a rolling manner, turning on its horizontal axis, down the incline of the hill. In the final event Tomato Man bumps into the tree.

Jump + around: The landscape is a tree in the middle of flat ground. In the initial event Triangle Man and Tomato Man enter the scene. The central event involves Triangle Man jumping around the tree. In the final event Triangle Man and Tomato Man leave together.

Table 1. Definition of each subcategory of gesture.

Name of upper categories	Name of subcategories	Definition
a) Gestures showing how the protagonist's location is depicted	Protagonist + Plane	The gesture takes the form of a flat hand with the palm facing downwards; the gesture stroke is made downwards as if to mark the location of an imaginary protagonist, with the flat hand shape representing the flat plane on which the protagonist is located.
	Manipulated Protagonist	The gesture takes many forms in each case; the hand(s) moves as if to hold and/or manipulate an object, i.e., an imaginary protagonist.
	Hand as Protagonist	The gesture takes many forms, in each case; the hand shape depicts a protagonist. For example, the hand makes a fist shape, and the fist stands for the protagonist.
	Point at Protagonist	The index finger is used to point to a location in the gesture space to indicate an imaginary protagonist.
	Head Pointing	The head is tilted forwards, backwards or sideways to indicate the location of an imaginary protagonist.
b) Gestures showing how the moving protagonists are depicted	Protagonist + Plane	The gesture takes the form of a flat hand with the palm facing downwards; the gesture stroke is made along the movement trajectory of an imaginary protagonist, with the flat hand shape representing the flat plane on which the protagonist moved.
	Manipulated Protagonist	The gesture takes many forms, in each case; the hand(s) moves as if to hold and/or manipulate an object, i.e., an imaginary protagonist.
	Hand as Protagonist	The gesture takes many forms, in each case. The hand shape depicts the protagonist. For example a flat hand is rotated to depict the rotating action of an imaginary protagonist, where the hand stands for the protagonist.
	Point at Protagonist	The index finger is used to point to a location in the gesture space indicating an imaginary protagonist.
	Body as Protagonist	The actions of an imaginary protagonist are enacted by the speaker's whole body.
	Head Pointing	The head is tilted forwards, backwards or sideways to indicate the movement trajectory of an imaginary protagonist.
c) Gestures in which the gesture stroke makes contact with the body or an object surface	Contact with body or object used as surface	The gesture stroke makes contact with the body or a physical surface such as a chair or table, which depicts a protagonist having contact with the ground, incline or water.
d) Gestures made exclusively in outer gesture space that depict the motion event with manner and path, e.g., Panels 2 and 3 in Figure 1.		Gestures made exclusively in outer gestures space, as shown in Figure 2.
e) The highest point of the gesture stroke for gestures expressing the location of the top of the hill in the stimulus events: Gestures made with concurrent speech referring to	Extreme upper gesture space	Gestures made in extreme upper gesture space (see Figure 3).
	Upper gesture space	Gestures made in upper gesture space (see Figure 3).

the location of top, for example 'the top' or 'up'	Middle gesture space	Gestures made in middle gesture space (see Figure 3).
f) The lowest point of the gesture stroke for gestures expressing the location of the bottom of the hill in the stimulus events: Gestures made with the concurrent speech referring to the location of bottom, for example 'down'	Upper gesture space	Gestures made in the upper gesture space (see Figure 3).
	Middle gesture space	Gestures made in the middle gesture space (see Figure 3).
	Lower gesture space	Gestures made in the lower gesture space (see Figure 3).

Table 2. Proportion (Standard Deviation) of gestures made in extreme upper, upper, and middle gesture space to express location of top in the stimulus event among three- and nine-year-olds, and adults.

	3 years (N = 16)	9 years (N = 15)	Adults (N = 22)
Extreme upper space	0.55 (0.46)	0.19 (0.37)	0.04 (0.11)
Upper space	0.27 (0.39)	0.27 (0.30)	0.51 (0.36)
Middle space	0.19 (0.36)	0.54 (0.40)	0.44 (0.37)

Table 3. Proportion (Standard Deviation) of gestures made in upper, middle, and lower gesture space to express the location of bottom in the stimulus event among three- and nine-year-olds, and adults.

	3 years (N = 16)	9 years (N = 19)	Adults (N = 21)
Upper space	0.16 (0.30)	0.02 (0.08)	0.03 (0.08)
Middle space	0.49 (0.34)	0.83 (0.29)	0.95 (0.09)
Lower space	0.34 (0.36)	0.14 (0.27)	0.02 (0.06)

Figure captions

Figure 1. An example of the stimuli shown to participants. The triangle spun around as it went down the slope, and then both the triangle and the tomato left the scene to the left.

Figure 2. Diagram of inner and outer gesture space regions.

Figure 3. Diagram of extreme upper, upper, middle, and lower gesture space regions.

Figure 4. Proportions of gestures with various ways of representing how protagonists are depicted when their location is in focus among three- and nine-year-olds, and adults. * indicates gesture types for which the age difference was significant (p <.05), and † indicates those where the age difference was marginally significant (p <.10).

Figure 5. Proportion of gestures with various ways of representing how the moving protagonists are depicted among three- and nine-year-olds, and adults. * indicates gesture types for which the age difference was significant (p <.05), and † indicates those where the age difference was marginally significant (p <.10).

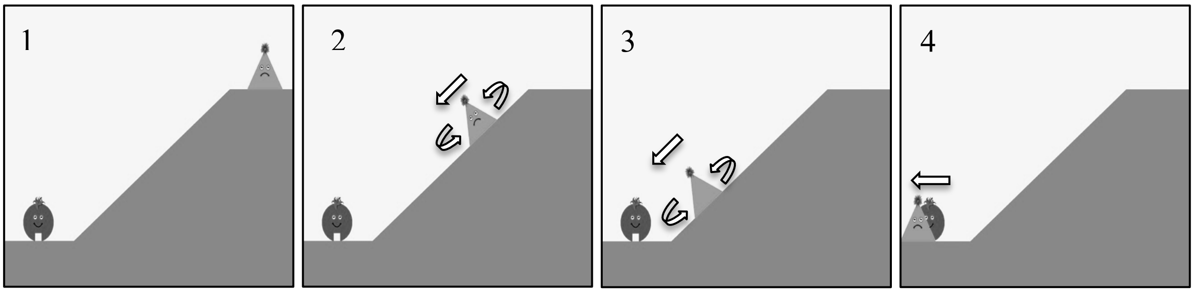

Figure 1. An example of the stimuli shown to participants. The triangle spun around as it went down the slope, and then both the triangle and the tomato left the scene to the left.

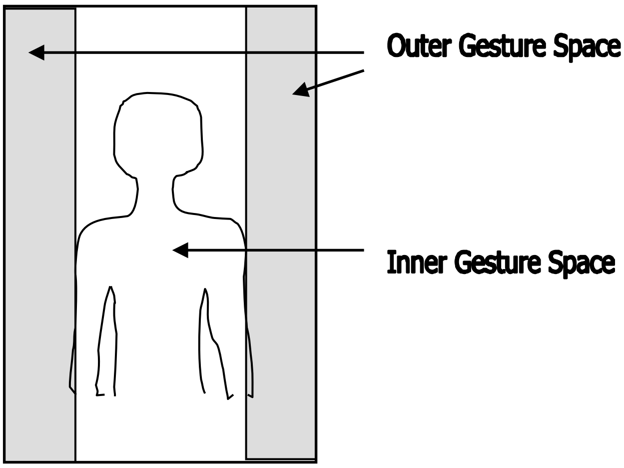

Figure 2. Diagram of inner and outer gesture space regions.

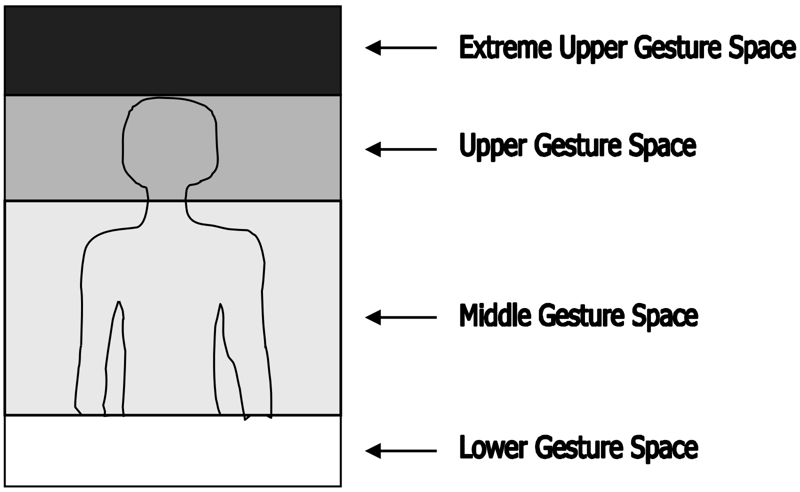

Figure 3. Diagram of extreme upper, upper, middle, and lower gesture space regions.

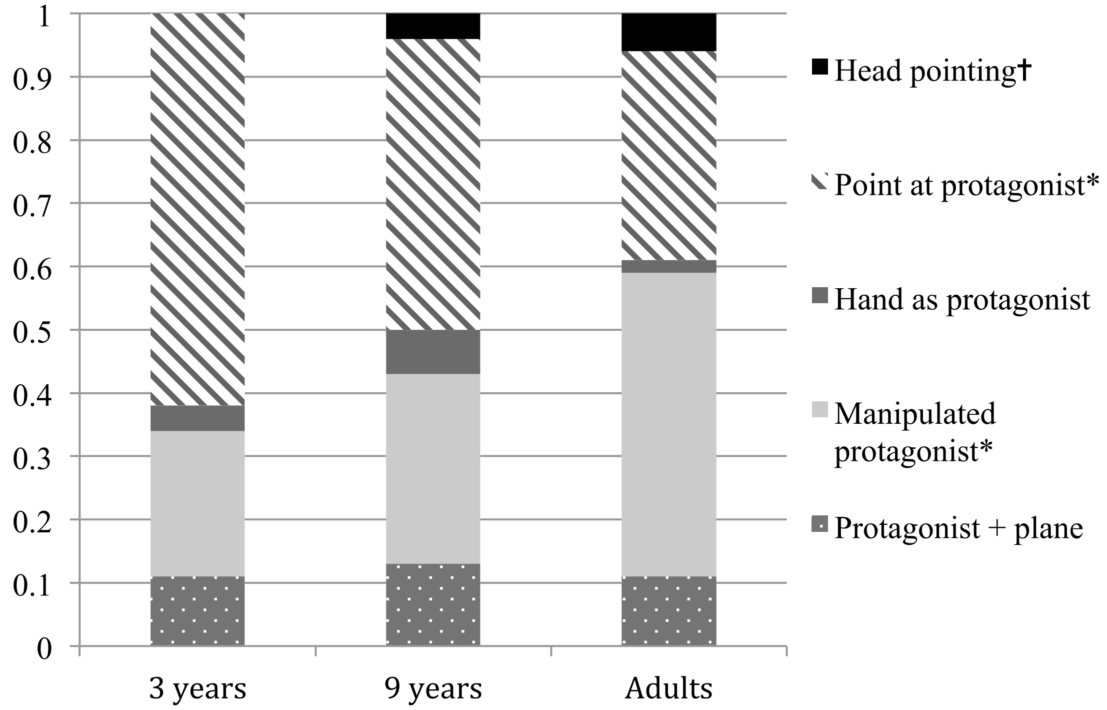

Figure 4. Proportions of gestures with various ways of representing how protagonists are depicted when their location is in focus among three- and nine-year-olds, and adults. * indicates gesture types for which the age difference was significant (*p* <.05), and † indicates those where the age difference was marginally significant (*p* <.10).

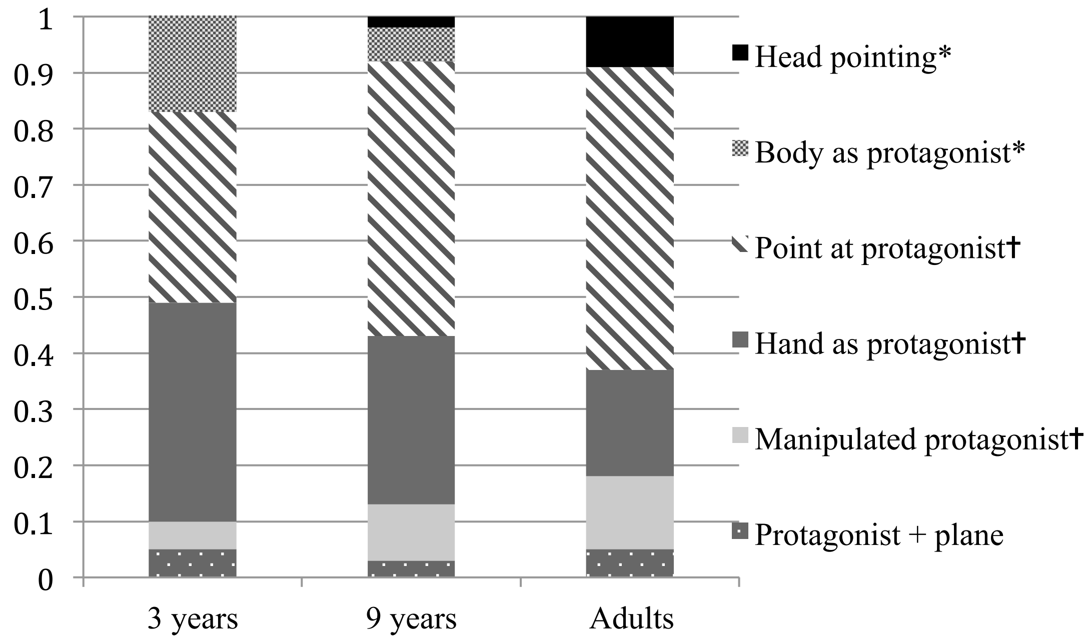

Figure 5. Proportion of gestures with various ways of representing how the moving protagonists are depicted among three- and nine-year-olds, and adults. * indicates gesture types for which the age difference was significant (p <.05), and † indicates those where the age difference was marginally significant (p <.10).