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A tale of two hands: children's early gesture use in narrative production predicts later narrative structure in speech*

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ABSTRACT

Speakers of all ages spontaneously gesture as they talk. These gestures predict children's milestones in vocabulary and sentence structure. We ask whether gesture serves a similar role in the development of narrative skill. Children were asked to retell a story conveyed in a wordless cartoon at age five and then again at six, seven, and eight. Children's narrative structure in speech improved across these ages. At age five, many of the children expressed a character's viewpoint in gesture, and these children were more likely to tell better-structured stories at the later ages than children who did not produce character-viewpoint gestures at age five. In contrast, framing narratives from a character's perspective in speech at age five did not predict later narrative structure in speech. Gesture thus continues to act as a harbinger of change even as it assumes new roles in relation to discourse.

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INTRODUCTION

Speakers of all ages spontaneously gesture as they talk. Early in development, these gestures not only precede children's linguistic milestones, but they also predict them (Goldin-Meadow, 2012). For example, names for objects that young children indicate in gesture are more likely to quickly become part of their spoken vocabularies than names for objects that they do not indicate in gesture (Iverson & Goldin-Meadow, 2005). Similarly, the age at which children first combine words and gestures to convey sentence-like information (e.g. pointing to a jar while saying *open*) predicts the age at which they will produce their first two-word utterance (e.g. *open box*) (Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005). We ask here whether gesture serves a similar role with respect to a much later linguistic milestone, children's ability to produce a well-structured narrative: Does gesture signal upcoming development in children's narratives?

Narratives constitute a central component of children's daily experiences, beginning with the early exposure to storybooks, oral tales, and movies. Producing their own narratives presents unique challenges for children. Children's earliest talk is about the here-and-now, but producing a good narrative requires mastery of extended discourse that focuses on the there-and-then. In addition, narratives are structured at both the micro- and macro-levels and typically use syntactically complex and semantically diverse and explicit language (Ninio & Snow, 1996). Macro-level narrative structure, the focus of our study, gives narrative content a schematic organization and ties the different parts of the narrative to each other in a meaningful way (Bamberg & Marchman, 1990; Berman & Slobin, 1994; Stein & Albro, 1989). Although macro-level narrative structure has been operationalized in different ways in the literature, there is agreement that a well-structured narrative is organized around the goals and attempts of the story characters (Labov & Waletzky, 1997; Stein & Albro, 1989). In narrative development, five- to six-year-old children begin to organize their narratives around goals and attempts and they reliably and frequently refer to the main components of narrative structure (initial orientation, complication, and resolution) (Berman & Slobin, 1994; Reilly, 1992). Children's narrative structure continues to develop during the school years, extending into adolescence (Applebee, 1978; Berman & Slobin, 1994; Stein & Albro, 1989; Warden, 1976).

The literature on narrative development has focused primarily on children's speech, but children often produce gestures along with their narratives (Capirci, Colletta, Cristilli, Demir, Guidetti & Levine, 2010; McNeill, 1992), and these gestures have the potential to serve as a unique window onto children's narrative development (Cassell & McNeill, 1991).

In earlier stages of language development, specific uses of gestures predict specific language milestones (Özçalışkan & Goldin-Meadow, 2009; Özçalışkan, Levine & Goldin-Meadow, 2013; Rowe & Goldin-Meadow, 2009).What kinds of gestures might reveal an understanding of well-structured narratives? Co-speech gestures physically reflect simulations that underlie narratives, and the viewpoint of a gesture can reveal the perspective that a narrator takes on a story. We argue that character-viewpoint gestures, in which the narrator aligns her body with the character's body and performs the character's actions from a first-person point of view, have the potential to signal children's burgeoning narrative understanding and predict upcoming changes in speech.

Labov and Waletzky (1997) characterize a narrative as a sequence of temporally related clauses that are narrated from a particular point of view. Recent experimental studies show that when adults read, listen, or watch a story, they create a coherent and integrated mental representation of the events described, also referred to as a mental model (Gernsbacher, 1990; Johnson-Laird, 1983; Kintsch, 1998). The literature suggests that in creating these narrative mental models, adults mentally simulate characters' perceptual, motoric, and psychological experiences (Morrow, Bower & Greenspan, 1989). Simulations vary in perspective, with some events being simulated from the point of view of a character in the story and others from the point of a view of an observer of the story (Brunyé, Ditman, Mahoney, Augustyn & Taylor, 2009; Parrill, 2010; Rall & Harris, 2000). Importantly, when perspective is left ambiguous or unspecified, adults spontaneously construct mental representations of narratives as if they themselves were involved in the narrative situation, and mentally simulate experiences of story characters from an internal, first-person perspective (Barsalou, 2008; Ditman, Brunyé, Mahoney & Taylor, 2010; Glenberg & Kaschak, 2002; Zwaan & Rapp, 2006). For example, Horton and Rapp (2003) asked participants to read a story describing characters observing their environment. In one condition, a critical object was occluded from the story character (e.g. it was behind a curtain); in the other condition, the critical object was out in the open and visible to the character. Participants looked longer to evaluate the existence of the object when it was occluded from the character's viewpoint than when it was visible, suggesting that they had assumed the first-person, bodily perspective of the story character (for similar results see Morrow, Greenspan & Bower, 1987; Morrow *et al.*, 1989). Recent neuroimaging studies of narrative comprehension support these behavioral results, and suggest that brain regions that are activated during narrative processing overlap with those that are activated during direct perception and action. For example, in a recent study, when a story character handled an object in a new way, the narrator's left precentral and parietal areas, brain regions typically involved

in grasping hand movements, were activated (Speer, Reynolds, Swallow & Zacks, 2009).

Simulating narrative events from a first-person perspective appears to confer benefits on narrative comprehension and memory. Shift in narrative perspective from first-person character viewpoint to observer viewpoint leads to comprehension difficulties in narrative processing (Black, Turner & Bower, 1979). In addition, individuals who have first-person experience with a character's actions (e.g. hockey players who have enacted hockey plays) have better comprehension of sentences about these actions than individuals who have only observed these actions from a third-person perspective (i.e. hockey fans: Beilock, Lyons, Mattarella-Micke, Nusbaum & Small, 2008; Holt & Beilock, 2006). Narrative information is retained better when events are simulated from a first-person perspective compared to a third-person perspective. Ditman and colleagues (Ditman, Brunyé, Mahoney & Taylor, 2010) presented individuals with short discourse structures in which action statements were preceded by the pronoun *you* or the pronouns *he* or *I*, and found that narrative events that simulated the first-person perspective (*I*) were retained better in a follow-up questionnaire than events that simulated second- (*you*) or third– (*he*) person perspective; the effects persisted over a 3-day period.

Somewhat surprisingly, in view of these findings, the role of character perspective in narrative production remains unexplored. Speech provides multiple linguistic tools to express a character's perspective on story events, through quotes, emotion, cognitive and perception verbs, or modals (Bamberg & Damrad-Frye, 1991; Reilly, Zamora & McGivern, 2005). However, linguistic forms cannot easily capture the perceptual and motor simulations that underlie mental representations of narratives (O'Neill & Shultis, 2007; Rall & Harris, 2000). In contrast, gesture is able to capture these perceptual and motor representations and make the perspective that the narrator is taking more apparent (Hostetter & Alibali, 2008; Kita & Özyürek, 2003; McNeill, 1992). First-person perspective is found in character-viewpoint gestures, where the gesturer takes on the role of the character – for example, moving the upper body and head back and forth to describe pecking from a bird's point of view. Character-viewpoint gestures allow the gesturer to take on the role of the character by aligning her own body with the character's body (Hostetter & Alibali, 2008). Third-person perspective is found in observer-viewpoint gestures, where the gesturer distances herself from the character and uses a body part, primarily the hand, to represent the character – for example, moving a beak-shaped hand back and forth to describe pecking from the point of view of someone watching a bird peck (Hostetter & Alibali, 2008; McNeill, 1992).

To our knowledge, our study is the first to explore the role of gesture viewpoint in predicting children's narrative development. The study had

three goals: (i) The first was to characterize developmental changes in narrative structure focusing exclusively on speech produced in a narrative task at five years of age as the predictor variable. We asked children to retell a wordless cartoon once a year between five and eight years of age, four times in total; we focused on this age range because these ages represent a transitional stage of narrative development. To evaluate the structure of children's narratives, we assessed whether they organized their narratives around goals and attempts (as measured by a narrative structure score; cf. Stein & Glenn, 1979). (ii) Next, we asked whether children at the earliest stage of narrative development (i.e. the five-year-olds) express a character's perspective in speech and in gesture. In speech, we focused on direct and indirect quotes, emotion, cognitive and perception verbs, and modals, all of which express characters' internal states. In gesture, we focused on character-viewpoint gestures, which have the potential to reveal when a narrator takes a first-person perspective on a story event. (iii) Finally, we asked whether the child's expression of character viewpoint in speech and/or gesture at age five signals upcoming changes in a child's ability to tell well-structured spoken narratives at ages six, seven, and eight.

METHOD

Participants

The participants were 38 children (22 girls) who were participating in a larger longitudinal study of language development (see Demir, Levine & Goldin-Meadow, 2010; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Huttenlocher, Waterfall, Vasilyeva, Vevea & Hedges, 2010; Özçalışkan & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009; Rowe, Levine, Fisher & Goldin-Meadow, 2009). Families in the larger study had been selected to represent the demographic range of the Chicago area. The sample for this study consisted of children who were administered the narrative task at age five. The sample included 23 Caucasian children, 6 African-American children, 6 children of mixed race, 3 Latino children and represented the same demographical profile as the larger sample. All children were being raised as monolingual English speakers. On average, parents had a mean of 16 ($SD = 2$; range 12 years, high school degree, to 18 years, Master's degree or more) years of education. Family annual income levels varied from \$7,500 to over \$100,000 ($M =$ \$85,460, $SD =$ \$94,524).

Procedure

Children were visited in their homes as a part of the longitudinal study and were administered the narrative production task four times, once a year between ages five and eight. At each visit, they were asked to watch

a 3-minute wordless Tom and Jerry cartoon and then to describe the cartoon to an experimenter who watched the cartoon with them. Neutral prompts such as "Anything else?" were asked until the children reported that they had nothing else to add. Some of the children did not complete the narrative task at subsequent visits because of fatigue or experimenter error: 38 children participated at age five ($M = 5{\cdot}5$ years, $SD = 0{\cdot}18$, *Range*: 5·2 – 5·8); 29 at age six ($M = 6{\cdot}5$ years, $SD = 0{\cdot}22$, *Range*: 5·9 – 6·9); 33 at age seven ($M = 7{\cdot}5$ years, $SD = 0{\cdot}23$, *Range*: 6·9 – 7·8); and 31 at age eight ($M = 8{\cdot}4$ years, $SD = 0{\cdot}20$, *Range*: 7·9–8·8). We found no differences in narrative structure scores at age five between children who did and did not participate in the narrative task at subsequent years.

To get a measure of basic oral language skills, we gave the children a syntax comprehension test (Huttenlocher, Vasilyeva, Cymerman & Levine, 2002) at age 4;6 (five children were administered the task at age 4;2). Children were read a sentence and were asked to point to the picture that corresponded to the sentence; the task included both simple and multi-clause sentences.

Transcription and coding

Children's narratives were videotaped, and their speech and gesture transcribed and coded.

Speech. Spoken narratives were divided into clauses. A clause was defined as a subject (noun phrase or its equivalent) and its predicate (verb phrase and other accompanying elements such as object or complement). From a semantic perspective, a clause roughly corresponds to a single event, e.g. *The egg falls into a tulip/which bends down like a leaf* contains two clauses. A clause with more than one verb could, at times, be classified as a single clause if one of the verbs expressed an aspectual or modal specification of the main verb, e.g. *She had to go out to lunch, Egg starts popping, Tom wanted to put it back*.

Narrative structure in speech. Narrative structure was characterized using Stein and Glenn's (1979) story grammar approach. Stein and Glenn define a 'good' story as one organized around the protagonist's goal plan of action. According to their model, narratives are built out of four features, which determine the goodness of the narrative's organization: an animate protagonist, temporal structure, causal structure, and goal-directed action. Each feature is considered a prerequisite for the next, and stories with more features are considered more complex than stories with fewer features.

Temporal structure is considered to be present if multiple story events are temporally ordered. Two events are temporally ordered in time if the order of the two cannot be reversed without changing the meaning of the story. Causal structure is present if one event is followed by other event(s) in

time and, more importantly, it provides a reason for the occurrence of the following event(s). Two events are causally linked if the second event cannot occur without the first event and is a consequence of the first one. Goals can be overtly stated with a mental state verb (e.g. *Jerry wanted to put it [the bird]* back), which can stand on their own without an attempt towards the goal. Goals can also be indicated in an infinitive attached to an attempt to realize the goal (e.g. *He tries to sit down on it [the stool]*). A goal can also be inferred from the reported sequence of events, which includes internal states, attempts, and outcomes, connected through causal connectors; in the example *He [the bird] drilled that too. So he [Jerry] was mad. So he took him [the bird] to his nest. He tucked him in and then he said bye and he went away*, one can infer that Jerry's goal was to stop the bird from destroying his house.

After children's spoken narratives were divided into clauses, we used the information contained in the clauses and the relations between the clauses to identify the narrative features just described and to place the narrative into one of the following six categories: (1) descriptive sequence; (2) action sequence; (3) reactive sequence; (4) incomplete goal-based sequence; (5) complete goal-based story with one episode; and (6) complete goal-based story with multiple episodes. In order to categorize children's narratives, we identified each feature hierarchically. We first asked whether the story events were temporally organized, i.e. the events followed one another in time. If the story did not include a temporal structure and only contained the physical and personality characteristics of an animate protagonist, it was categorized as a descriptive sequence. If the events had temporal but not causal structure, i.e. one event causing the following event or events, the story was categorized as an action sequence. If the story included both temporal and causal structure, but did not include a goal, the story was categorized as a reactive sequence. If the story included temporal structure, causal structure, and goals and/or actions the protagonist performed to achieve the goals, but no information about the outcome, i.e. whether the protagonist reached the goal or not, it was categorized as an incomplete goal-based story. If the story included all the features above and one goal–attempt–outcome sequence, it was categorized as a complete goal-based story with one episode. Finally, if the story included all the features above and multiple goal–attempt–outcome sequences, it was categorized as a complete goal-based story with multiple episodes. Examples of stories in each category are provided in the 'Appendix'.

Perspective in speech. We then identified all direct and indirect quotations, cognitive, emotion and perception verbs, and modal verbs, all of which signal that a child was considering a character's point of view. In direct quotations (e.g. *Jerry says, "I know where to put this bird."*; or *He said, "I'm just gonna find out where this bird came from.*"), the child speaks for

the character. In indirect quotations (e.g. *Jerry told him to stop it*), the child paraphrases the character's comments (Clark & Gerrig, 1990). Attitudinal verbs convey a character's emotional (e.g. *cry, want*), cognitive (e.g. *think*), or perceptual (e.g. *see*) state, and modal verbs (e.g. *should, must, could*) express the character's state of likelihood, ability, permission, or obligation (Bamberg & Damrad-Frye, 1991; Reilly *et al.*, 2005). Because we were interested in whether the early expression of perspective in speech predicted later outcomes, these forms were identified only at age five.

Gesture. All meaningful communicative gestures produced during narrative production were transcribed. Movements were considered communicative gestures if they conveyed information and did not involve direct manipulations of objects (e.g. moving the hands as though pulling on a sock would be considered a gesture; actually pulling on the sock would not; see Cartmill, Demir & Goldin-Meadow, 2012, and Goldin-Meadow, 2003, for further details on defining and identifying gestures). Children produced four types of gesture in their narratives: deictic, iconic, metaphoric, and markers (conventional gestures such as head nods and side-to-side shakes). More than 90% of the gestures the children produced were iconic; we therefore focused exclusively on iconic gestures, particularly since adults use this type of gesture frequently when telling stories (Cassell & McNeill, 1991). Because we were interested in exploring whether gesture is a predictor of upcoming changes in speech, gestures accompanying narratives were coded only at age five.

Iconic gestures capture an aspect of their referent, and thus their forms change depending on the action or attribute they represent. We used cartoon context, speech content, the shape of the hand (if relevant), and the motion of the hand to assign meaning to iconic gestures. If an iconic gesture conveyed an attribute of a person or an object in the cartoon, it was classified as referring to that person or object (e.g. a child held two curved palms side-by-side facing up to describe the nest in which the mother bird sits, and thus was classified as referring to the nest). If an iconic gesture conveyed the actions performed by a person or object in the cartoon, it was classified as referring to the event (e.g. a child moved her index finger from the upper-left of her torso towards the lower-right of her torso to describe an egg rolling from the nest to a flower, and was thus classified as referring to the egg-rolling event).

Using McNeill's (1992) criteria, we also classified gestures according to viewpoint. Character-viewpoint gestures were those in which the gesturer enacted a character's actions and the gesture space enveloped the gesturer. In some character-viewpoint gestures, the hand was used to represent the character's hand (e.g. rotating two fists around the wrists in front of the torso to describe knitting); in others, the whole body was used to represent the character's body (e.g. rolling the whole body on the floor to describe

TABLE 1. *Narrative structure scores (means and standard deviations) across four ages for all children (top) and for children classified according to whether they did (+CV) or did not (–CV) produce character-viewpoint gestures at age five (bottom)*

	5 years Mean (Std Dev)	6 years Mean (Std Dev)	7 years Mean (Std Dev)	8 years Mean (Std Dev)
All children				
(*N*=38)	2·97 (1·59)	3·52 (1·53)	3·48 (1·39)	4·03 (1·28)
Children who expressed perspective in speech at age five				
+PS				
(*N*=16)	3·94 (1·65)	4·07 (1·44)	3·6 (1·45)	4·14 (1·35)
–PS				
(*N*=22)	2·27 (1·12)	3·0 (1·46)	3·39 (1·38)	3·94 (1·25)
Children who produced character-viewpoint gestures at age five				
+CV				
(*N*=15)	3·27 (1·53)	4·30 (1·70)	3·73 (1·44)	4·23 (1·48)
–CV				
(*N*=23)	2·78 (1·62)	3·11 (1·29)	3·28 (1·36)	3·89 (1·13)

an egg rolling off a leaf). Observer-viewpoint gestures were those in which the gesturer used a body part to represent the character in its entirety, thus looking at (rather than being) the character (e.g. moving the index finger downwards to describe the trajectory of a falling egg). In observer-viewpoint gestures, the gesture space was restricted to the area in front of the gesturer's head and torso.

A second researcher randomly selected 10% of the narratives and coded them to establish speech and gesture reliability. Agreement between the coders was high: 88% for dividing speech into clauses; 90% for identifying perspective in speech; 94% for isolating and identifying gestures; 88% for classifying gestures as character- or observer-viewpoint. Inter-class correlation for the story structure score was ·70, indicating substantial agreement (Landis & Koch, 1977).

RESULTS

Development of narrative structure in speech

We assessed narrative structure through the types of events conveyed in speech (i.e. goal-based stories) at ages five, six, seven, and eight. Children varied widely in their narrative performance at each time-point. At the first visit, at age five, children's narrative structure scores ranged from 1 to 6. At age five, the average narrative structure score received was close to 3, corresponding to cause and effect stories that did not include goals. At the three older ages, scores ranged from 2 to 6, and, at age eight, children were much more likely to produce stories that included one or more goals,

although the stories rarely included attempts to follow up on those goals. Children's average narrative structure scores increased steadily with age (see Table 1). To examine the effect of age on narrative structure score, we used a linear mixed-effects model, which is appropriate for analyses of longitudinal data with missing data points (Baayen, 2008). The model with narrative structure score as the dependent variable, age (five, six, seven, eight years) as a fixed factor, and children as a random factor, revealed a main effect of age on narrative structure score, indicating that children's stories were indeed improving over time ($b = 0{\cdot}06$, $SE = 0{\cdot}02$, $t = 2{\cdot}79$, $p < {\cdot}01$).

Characters' perspective in speech

Perspective in speech. We found that 16 of the 38 children produced quotations, emotion, cognitive or perception verbs, or modals indicating the characters' viewpoint at age five ($M = 2{\cdot}0$, $SD = 1{\cdot}22$). Of these 16 children, 1 child produced one quotation, 10 produced cognition verbs ($M = 1{\cdot}1$, $SD = 0{\cdot}32$), 3 produced emotion verbs ($M = 1{\cdot}3$, $SD = 0{\cdot}58$), 6 produced perception verbs ($M = 1{\cdot}83$, $SD = 1{\cdot}17$), and 4 produced modal verbs ($M = 1{\cdot}25$, $SD = 0{\cdot}5$). Our next question was whether expressing perspective in speech in stories at age five was associated with better story-telling skills at later ages.

Does speech at age five predict changes in narrative structure at ages six through eight?. Before exploring whether expressing perspective in speech in their stories at age five was associated with better story-telling skills at later ages, we examined concurrent relations between perspective in speech and narrative structure in speech at age five. As described earlier, stories that were organized around the characters' goals received higher story structure scores than stories that did not include goals. Since goals were frequently stated with a cognitive verb, using a cognitive verb was necessarily associated with achieving a higher narrative structure score. To confirm this association, we treated perspective in speech as a categorical variable, and divided children into those who expressed perspective in speech at age five (+PS, $N = 16$) and those who did not (−PS, $N = 22$). We conducted an analysis of covariance with narrative structure score at age five as the dependent variable, and perspective in speech (+PS, −PS) as the independent variable. We included children's scores on the syntax comprehension test administered at age 4;6 as a control for oral language skills. The average narrative structure score was 3·93 ($SD = 1{\cdot}65$) for the +PS group, 2·27 ($SD = 1{\cdot}12$) for the −PS group, and the scores were significantly different from each other ($F(1,35) = 13{\cdot}12$, $p < {\cdot}01$). Although higher scores on the syntax test were associated with higher narrative structure scores, syntax was not a significant covariate ($F(1,35) = 0{\cdot}24$, $p = {\cdot}63$).

We next asked whether children who expressed perspective in speech at age five produced better-structured narratives at later ages than children

who did not express perspective in speech at five. We fit a linear mixed-effects model to the data, with one dependent variable, narrative structure score, and five independent variables. The four fixed factors were perspective in speech at age five (+PS, −PS); age at test (six, seven, eight years); syntax comprehension scores at age 4;6 (a control variable); and initial narrative structure score at age five (another control variable); the one random factor was children. The model revealed no significant effect of perspective in speech at age five ($b = 0{\cdot}03$, $SE = 0{\cdot}08$, $t = 0{\cdot}35$, $p = {\cdot}73$), indicating that perspective in speech at this early age was NOT associated with narrative structure scores at later ages. There was also no significant interaction between perspective in speech at age five and age at test ($b = 0{\cdot}07$, $SE = 0{\cdot}07$, $t = 0{\cdot}94$, $p = {\cdot}35$), indicating that the effect of perspective in speech did not significantly vary as a function of age (see Table 1). Initial narrative structure score was a significant predictor of later narrative structure score ($b = 0{\cdot}27$, $SE = 0{\cdot}13$, $t = 2{\cdot}11$, $p = {\cdot}04$), but syntax comprehension was not ($b = 0{\cdot}01$, $SE = 0{\cdot}01$, $t = 0{\cdot}72$, $p = {\cdot}47$).

The added value of looking at gesture

Perspective in gesture. We then asked whether children used iconic gestures at age five, and, if so, whether any of those gestures were character-viewpoint. We found that 22 of the 38 (58%) five-year-olds produced at least one iconic gesture ($M = 4{\cdot}9$, $SD = 4{\cdot}5$). Of those 22 children, 15 produced character-viewpoint gestures, 17 produced observer-viewpoint gestures, and 10 produced both. Children who produced character-viewpoint gestures produced, on average, 2·8 of these gestures ($SD = 2{\cdot}14$); children who produced observer-viewpoint gestures produced, on average, 3·8 ($SD = 3{\cdot}6$) of these gestures. Five (out of 15) children who produced character-viewpoint gestures produced only whole-body gestures, e.g. one girl placed two upward-facing hands in front of her torso, as if carrying an object, and walked away from the experimenter to describe the mouse carrying the bird back to its nest). Four (out of 15) children produced only hand character-viewpoint gestures, e.g. one child produced a wrapping motion in front of his torso to describe the mouse wrapping the bird in a blanket. The remaining 6 children produced both whole body and hand character-viewpoint gestures. Thus, 15 children used character-viewpoint gestures that told the tale from a character's point of view. Of these 15 children, only 6 also used speech to express perspective, and there was no association between using character-viewpoint gestures and expressing character perspective in speech (χ^2 (1, $N = 38$) = 0·02, $p = {\cdot}88$).

Does gesture at age five predict changes in narrative structure at ages six through eight?. Before exploring whether character-viewpoint gestures predict upcoming developmental change in narrative story structure in

speech, we examined concurrent relations between character-viewpoint gestures and narrative structure in speech at age five. Since character-viewpoint gestures were, on the whole, relatively rare, we treated character-viewpoint gesture as a categorical variable, and divided children into those who produced character-viewpoint gestures at age five (+CV, $N = 15$) and those who did not (−CV, $N = 23$). We conducted an analysis of covariance with narrative structure score as the dependent variable, and character-viewpoint gestures (+CV gesture, −CV gesture) as the independent variable. We included the children's scores on the syntax comprehension test administered at age 4;6 as a control for oral language skills. The average narrative structure score was 3·27 ($SD = 1·53$) for the +CV gesture group, and 2·78 ($SD = 1·62$) for the −CV gesture group, and these scores did not significantly differ ($F(1,35) = 0·80$, $p = ·38$). Although higher scores on the syntax test were associated with higher narrative structure scores, syntax was not a significant covariate ($F(1,35) = 1·04$, $p = ·32$).

We next turned to our main question – whether children who produced early character-viewpoint gestures at age five produced better-structured narratives at later ages than children who did not produce these gestures at five. We fit a linear mixed-effects model to the data, with one dependent variable, narrative structure score, and five independent variables. The four fixed factors were character-viewpoint gesture at age five (+CV, −CV); age (six, seven, eight years); syntax comprehension scores at age 4;6 (as a control variable); initial narrative structure score at age five (another control variable); the one random factor was children. Initial narrative structure score was a marginally significant predictor of later narrative structure score ($b = 0·24$, $SE = 0·10$, $t = 2·39$, $p = ·02$); syntax comprehension was not ($b = 0·01$, $SE = 0·01$, $t = 1·16$, $p = ·25$). More importantly for our purposes, the model showed a reliable effect of character-viewpoint gesture group at age five ($b = 0·17$, $SE = 0·07$, $t = 2·32$, $p = ·03$). Children who produced character-viewpoint gestures at age five earned significantly higher narrative structure scores based on speech later in development than children who did not produce these gestures at age five (see Table 1). There was no significant interaction between character-viewpoint gesture group and age at test ($b = 0·08$, $SE = 0·07$, $t = 0·16$, $p = ·25$), indicating that the differences between the two groups (+CV, −CV) did not vary as a function of time.

Results were replicated using two confirmatory analyses. A comparable analysis focusing on the subset of children who produced at least one iconic gesture ($N = 22$, 15 children who produced character viewpoint gestures [with or without observer viewpoint gestures] vs. 7 children who produced only observer viewpoint gestures) yielded similar results – character-viewpoint use was a significant predictor of narrative structure scores, controlling for syntax comprehension scores and narrative structure score at age five. The analyses were also repeated using a continuous variable

of CVPT gesture count instead of using CVPT as a categorical variable. The continuous variable on its own was not a significant predictor of narrative development ($b = 0{\cdot}01$, $SE = 0{\cdot}02$, $t = 0{\cdot}54$, $p = {\cdot}59$). This result suggests that, given the low number of gestures children produce, at this young age, the essential factor is whether children produce any CVPT gestures rather than the number of CVPT gestures they produce.

To determine whether the effect was specific to character-viewpoint gestures, we conducted a similar analysis using observer-viewpoint gesture at age five (+OV, $N = 17$; −OV, $N = 21$) as a fixed factor. Initial narrative structure was a significant predictor of later narrative story structure ($b = 0{\cdot}29$, $SE = 0{\cdot}11$, $t = 2{\cdot}64$, $p = {\cdot}01$); syntactic comprehension was not ($b = 0{\cdot}01$, $SE = 0{\cdot}01$, $t = 0{\cdot}65$, $p = {\cdot}52$). Importantly, there was no significant effect of observer-viewpoint gesture group ($b = 0{\cdot}01$, $SE = 0{\cdot}07$, $t = 0{\cdot}19$, $p = {\cdot}85$), and no interaction between observer-viewpoint gesture group and age ($b = 0{\cdot}04$, $SE = 0{\cdot}07$, $t = 0{\cdot}64$, $p = {\cdot}52$).

We also conducted a comparable set of analyses using the production of any iconic gestures at five years as a categorical variable (+IG, $N = 22$; −IG, $N = 16$) as a fixed factor. Initial narrative structure was a significant predictor of later narrative story structure ($b = 0{\cdot}28$, $SE = 0{\cdot}11$, $t = 2{\cdot}65$, $p = {\cdot}01$); syntactic comprehension was not ($b = 0{\cdot}01$, $SE = 0{\cdot}01$, $t = 0{\cdot}90$, $p = {\cdot}37$). Moreover, there was no significant effect of iconic gesture group ($b = 0{\cdot}06$, $SE = 0{\cdot}07$, $t = 0{\cdot}83$, $p = {\cdot}41$) and no interaction between iconic gesture group and age ($b = 0{\cdot}01$, $SE = 0{\cdot}07$, $t = 0{\cdot}13$, $p = {\cdot}90$).

In a final analysis, we included both perspective in speech and character-viewpoint gesture in the same model. In this analysis, initial narrative structure score ($b = 0{\cdot}21$, $SE = 0{\cdot}12$, $t = 1{\cdot}73$, $p = {\cdot}09$) and syntactic comprehension score ($b = 0{\cdot}01$, $SE = 0{\cdot}01$, $t = 1{\cdot}69$, $p = {\cdot}10$) were marginally significant predictors. Perspective in speech was not a significant predictor ($b = 0{\cdot}04$, $SE = 0{\cdot}08$, $t = 0{\cdot}51$, $p = {\cdot}61$). Most importantly, controlling for perspective in speech, character-viewpoint gesture group remained a significant predictor ($b = 0{\cdot}17$, $SE = 0{\cdot}07$, $t = 2{\cdot}33$, $p = {\cdot}03$). The interaction between character-viewpoint gesture group and age was not significant ($b = 0{\cdot}08$, $SE = 0{\cdot}07$, $t = 1{\cdot}11$, $p = {\cdot}25$). Taken together, these analyses indicate that the production of character-viewpoint gesture at age five in the context of a narrative task is a SPECIFIC predictor of later narrative skill; in contrast, neither perspective in speech, nor other kinds of iconic gesture, predict later narrative skill.

DISCUSSION

We found that, at age five, many children used gestures that captured a character's perspective. Children who produced character-viewpoint gestures at age five did not differ from children who did not produce these

gestures in terms of the spoken narratives they told at age five. However, the two groups did differ in the spoken narratives they told at later ages: Narratives told by children who produced character-viewpoint gestures at age five were more structured than narratives told by children who did not produce these gestures (controlling for early syntactic skill, initial level of narrative structure, and the production of observer-viewpoint gestures). Thus, capturing a character's perspective early in development in gesture signaled upcoming developments in narrative skill in speech. Children also expressed character perspective in speech at age five through direct or indirect quotations, emotion, cognitive and perception verbs, and modals, consistent with previous findings (Bamberg & Damrad-Frye, 1991; Reilly *et al*., 2005). Importantly, however, perspective taking in speech did NOT predict future narrative skill in speech. We discuss these findings and their implications in the next sections.

We have found that individual differences in the ability to use gesture to convey narrative events from a first-person perspective early in development predicts subsequent skill in spoken narrative structure later in development. Our findings add to the existing literature showing that gesture predicts milestones in vocabulary and syntactic development (Cartmill, Hunsicker & Goldin-Meadow, 2014; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009), and make it clear that gesture continues to signal upcoming changes in more advanced aspects of language at later ages, just as it does for a variety of other cognitive tasks (Goldin-Meadow, Alibali & Church, 1993; Pine, Lufkin & Messer, 2004). Our findings suggest that iconic gestures can serve as a harbinger of change in speech at a discourse level.

For each aspect of language in which early gesture predicts later milestones in speech, it is important to characterize the particular role that gesture is playing. We suggest that the character-viewpoint gestures that a child produces early in development predict well-formed narratives later in development because these gestures reflect the child's ability to assume a character's first-person perspective on events. Representing narrative events from a first-person perspective has been found to be central to narrative processing in adults (Black *et al*., 1979; Ditman *et al*., 2010; Horton & Rapp, 2003; Zwaan & Rapp, 2006). Here we show, for the first time, that taking a character's perspective (as reflected in early gesture) early in development is related to subsequent narrative skill and, in this sense, is central to narrative production in children. Our study does not, however, tell us whether the act of producing a character-viewpoint gesture merely reflects skill in taking another's perspective (and thus plays no causal role in narrative development), or whether it paves the way for narrative development. For example, producing a character-viewpoint gesture could

encourage a child to focus on the character's goals, which in turn could make the child more aware of the structure in the narratives she hears or produces. Future work manipulating the gestures children produce when telling a narrative will be needed to address this question.

Children, like adults, are able to interpret story events from the perspective of the characters in the story (Rall & Harris, 2000) and can take the characters' mental states into account (O'Neill & Shultis, 2007). Importantly, however, previous studies have not specified whether children take a first-person and embodied perspective on narrative events, or whether they represent narrative events from an external, third-person perspective, as an observer. The devices available for expressing perspective in speech typically do not easily distinguish between character and observer viewpoint (O'Neill & Shultis, 2007; Rall & Harris, 2000). For example, when a child uses an emotional verb, it is unclear whether she is adopting the character's internal perspective and 'stepping into the character's shoes', or whether she is interpreting and reporting the character's experiences as an outsider. Producing a direct quotation might be considered to indicate that the speaker is assuming the character's role, and thus taking a first-person perspective on the event; however, the children in our sample produced very few direct quotations (only one child produced one direct quote). In contrast, gesture more clearly represents the character's perspective and, as a result, might be a more sensitive index of children's ability to take a character's viewpoint than speech (Hostetter & Alibali, 2008; McNeill, 1992). Indeed, we found that perspective-taking in gesture predicted subsequent narrative structure whereas perspective-taking in speech did not.

Our findings have theoretical, methodological, and practical implications. In terms of theory, the findings add to work suggesting that the relation gesture holds to speech changes over development. In the earliest stages of language development, gesture stands in for words, often conveying word-like information that is not found in the accompanying speech. For example, young children can combine a gesture with a word to convey a sentence-like meaning at a time when they can only produce one word at a time (Iverson & Goldin-Meadow, 2005). As language skills develop, gesture takes on new roles that resemble the roles co-speech gesture plays in adult speakers. Speech conveys meaning by segmenting and organizing units into hierarchically structured strings following the rules of the language; but co-speech gesture, at least in adult speakers, is holistic, multidimensional and not constrained by standards of well-formedness (Goldin-Meadow & McNeill, 1999). Gesture conveys information using a different representational format than does speech, and thus has the potential to enrich the information conveyed in speech. Our study adds to the small but growing literature showing that, at a certain point in development, gesture can play

an important role in providing structure at the discourse level; for example, by highlighting information introduced to the listener for the first time (So, Demir & Goldin-Meadow, 2010), by highlighting information not accessible to the listener (Demir, So, Özyürek & Goldin-Meadow, 2012), or by setting up discourse referents in space that can be used for co-reference (So, Kita & Goldin-Meadow, 2009). Future studies should explore how the role of gesture changes as children's discourse skills develop.

In terms of methodological implications, our findings suggest that looking at multiple modalities, including gesture, is important to gaining a comprehensive picture of children's narrative skills. A narrower window that includes only speech may miss the earliest steps children take toward narrative development. We found that first-person gesture use was not concurrently related to narrative skill, but it signaled later narrative skill in speech. This finding is in line with the previous literature suggesting that, at transitional stages of development, gesture provides information not revealed in speech and predicts upcoming changes, but it might not be necessarily associated with concurrent skill in speech (Alibali & Goldin-Meadow, 1993; Sauer, Levine & Goldin-Meadow, 2010). Because narrative skill provides a link between early language development and later literacy, and is therefore relevant to academic success (e.g. Dickinson & Snow, 1987; Griffin, Hemphill, Camp & Wolf, 2004), it is important to accurately characterize and assess its development using multiple methodologies starting from early ages.

In terms of practical applications, it is possible that not only encouraging children to 'tell' but also to 'show' what they have heard or seen can enhance the development of narrative skill. In addition to predicting children's later skills as a narrator, gesture has the potential to play an active role in fostering those skills. The iconic gestures that children produce may help them organize their thoughts and may play a role in translating implicit representations into a more explicit verbal format (Hostetter & Alibali, 2008; Kita & Özyürek, 2003). Practice taking on the bodily perspective of story characters through character-viewpoint gestures could enable children to better understand the goals behind the characters' actions and the effects of these actions, which might, in turn, lead to more coherent narrative structures. For example, in a recent study, asking five- to eight-year-old children to tell and enact personal narratives about emotionally laden events led to an increase in the amount of information provided, compared to a condition in which children were asked only to tell about the events (Wesson & Salmon, 2001). Doing gesture thus has the potential to enhance both story comprehension and story production. These findings are consistent with studies of children's mathematical (Cook, Mitchell & Goldin-Meadow, 2008; Goldin-Meadow, Cook & Mitchell, 2009) and spatial thinking (Goldin-Meadow, Levine, Zinchenko, Yip, Hemani &

Factor, 2012), which show that children who are taught to practice a problem-solving strategy in gesture are more likely to learn how to solve the problem than children who practice the strategy only in speech or simply watch another person's gestures.

To conclude, we have found that children who produced character-viewpoint gestures in their narratives at age five went on to produce better-structured stories at later ages than children who did not produce character-viewpoint gestures at age five. In contrast, expressing perspective in speech did not predict better-structured stories at later ages. Gesture thus provides a unique window into children's narrative developmental trajectory at a time when speech does not.

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APPENDIX: examples of each of the six narrative structure categories

(1) **Descriptive sequence**
Well, he put in the nest, and he chopped lots of things in his house.

(2) **Action sequence**
The mother was knitting maybe a sheet or some pants, and she put on the sign, saying "be back in ten minutes," and the egg was bouncing, and well it rolled off so many things. It busted through the door to Jerry's house, and he got under, popped up, and he had so many problems. The bird kept eating wood, and well end.

(3) **Reactive sequence**
The girl get in a mouse house. It poinked on this back. He felt it and he coming back to his tree and lay down.

(4) **Incomplete goal-based sequence**
The bird ate the chair and ate everything that was worthy, even the chair. Then Tom wanted to put it back where it was.

(5) **Complete goal-based story with one episode**
First the mother bird was leaving and then it rolled all the way to Tom's house and then his tummy got fat because he was under him. Well when he sat, when he put the chair down, it broke through. Whenever that he saw the xx, he popped through it, and then Tom went out of his house. He saw a nest. So he bring it back to his nest and then he came down.

(6) **Complete goal-based story with multiple episodes**
There's a mother bird. She had a baby, and then she left to go get food and then the baby started to crack, and it started popping. Then it fell out of the nest. Then it rolled, and it went through the spider web and then went into Tom's house, and then it woke up Jerry, and then it started to crack, and it started to open, and then the egg hatched, and then the bird thought that this was his home and Jerry was his mom, so he started pecking on all the wood to show his mom his talent and Jerry got mad, cause he was destroying his house, so then he got really mad at the bird, and then he brought the baby bird back up outside and then he looked around. Then he found it. Then he went all the way back up, and he found the nest, and then he got the nest, and then he put the bird in the nest, and then he walked back to his house.