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Narrative Processing in Typically Developing Children and Children With Early Unilateral Brain Injury: Seeing Gesture Matters

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Narrative skill in kindergarteners has been shown to be a reliable predictor of later reading comprehension and school achievement. However, we know little about how to scaffold children's narrative skill. Here we examine whether the quality of kindergarten children's narrative retellings depends on the kind of narrative elicitation they are given. We asked this question with respect to typically developing (TD) kindergarten children and children with pre- or perinatal unilateral brain injury (PL), a group that has been shown to have difficulty with narrative production. We compared children's skill in retelling stories originally presented to them in 4 different elicitation formats: (a) wordless cartoons, (b) stories told by a narrator through the auditory modality, (c) stories told by a narrator through the audiovisual modality without co-speech gestures, and (e) stories told by a narrator in the audiovisual modality with co-speech gestures. We found that children told better structured narratives in response to the audiovisual + gesture elicitation format than in response to the other 3 elicitation formats, consistent with findings that co-speech gestures can scaffold other aspects of language and memory. The audiovisual + gesture elicitation format was particularly beneficial for children who had the most difficulty telling a well-structured narrative, a group that included children with larger lesions associated with cerebrovascular infarcts.

Keywords: gesture, narrative development, early brain injury

The question of how to scaffold young children's early narrative productions is of potential importance given that early narrative skill has been found to predict later reading comprehension and school achievement (e.g., Burns, Griffin, & Snow, 1999; Dickinson & McCabe, 2001; Paris & Paris, 2003). Here we examined whether children's skill at telling a well-structured narrative varies as a function of the story elicitation format. We asked this question with respect to two groups of kindergarten children: typically developing (TD) children, and children with pre- or perinatal unilateral brain injury (PL), a group that has been shown to have difficulty producing narratives even when their other language skills are in the normal range (e.g., Demir, Levine, & Goldin-Meadow, 2010; Reilly, Bates, & Marchman 1998; Reilly, Losh, Bellugi, & Wulfeck, 2004).

The narratives people construct can be based on firsthand experiences, on their imagination, or on information conveyed by others. Previous studies have examined the development of narrative skill using a variety of elicitation techniques that involve retelling a story from a wordless picture book (e.g., *Frog, Where Are You?* by Mercer Mayer;Bamberg, 1987, 1997; Berman & Slobin, 1994; Paris & Paris, 2003) and a wordless cartoon (e.g., "Tweety and Sylvester"; Alibali, Heath, & Myers, 2001; McNeill, 1992, 2005), creating a narrative based on a leading story stem such as "There once was a fox . . . " (Demir et al., 2010; Stein, 1988; Stein & Albro, 1997; Trabasso, Stein, Rodkin, Munger, & Baughn, 1992), or by drawing on personal experiences (e.g., McCabe, Bliss, Barra, & Bennett, 2008; Miller & Sperry, 1988). These studies all showed that narrative development has an extended trajectory, with narrative skills changing dramatically during the preschool and early elementary school years. During this period, children's narratives become more discursive, include more complex language and, most importantly, are better integrated in terms of narrative structure. Although a variety of probes have been used to elicit narratives from young children, there has been little systematic work examining variations in the narratives children construct as a function of the elicitation format—whether children tell better-structured narratives when given different kinds of elicitations. The one study that has examined narratives constructed in response to different probes compared personal versus

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fictional narrative in 7- to 10-year-olds and found that children's personal narratives were better structured than their fictional narratives (McCabe et al., 2008).

Here we focused on variations in the structure of children's narrative retellings following story presentations that used different elicitation formats. In particular, we asked children to retell stories (all based on the same characters with similar goal-based story structures) presented by a storyteller in the following formats: (1) the auditory modality (A), an audio recording of a storyteller (as would happen if the child were listening to a story on the radio); (2) the auditory and visual modalities (AV), an audiovisual presentation of a storyteller who did not produce co-speech gestures (as would happen if the child were listening to a storyteller holding a book while reading it); and (3) the auditory and visual modalities including gesture (AV-G), an audiovisual presentation of a storyteller producing co-speech hand gestures along with verbal input (as would happen if the child were listening to an oral storyteller). In a fourth elicitation format, children were asked to retell stories conveyed through (4) a cartoon that did not include words or gestures (C). In this last format, children were shown a set of cartoons that centered around the interactions between a small elephant and a mouse (the Maus cartoons; see http://www.diemaus.de). Thus, the four different elicitation formats differed in terms of the form and the quantity of the information conveyed. Importantly, however, each of the stories told to the children in the A, AV, and AV-G elicitation formats described one of the cartoons presented in elicitation format C. As a result, the stories presented in the four elicitation formats involved the same events and plot line.

The Effect of Elicitation Formats on Narrative Construction

We first focus on our three elicitation formats and ask whether the AV-G format helped scaffold children's narratives more than the other two elicitation formats (AV and A), neither of which contained co-speech gesture. At the earliest stages of language learning, children are able to integrate information across gesture and speech early in development, and doing so facilitates their language comprehension (Allen & Shatz, 1983; Clark, Hutcheson, & Van Buren, 1974; Hodapp, Goldfield, & Boyatzis, 1984). Morford and Goldin-Meadow (1992) found that one-word speakers were more likely to respond appropriately to a two-word utterance accompanied by gesture than to the same utterance produced without gesture. For example, after hearing the sentence, "Open the box," one-word speakers opened the box significantly more often when the utterance was accompanied by a point at the box than when it was produced without gesture. Adding gesture to the speech that toddlers heard improved their ability to understand that speech. Moreover, the gestures parents produce early in language development are related to the gestures children themselves produce during that period, which, in turn, predict the children's later vocabulary (e.g. Rowe & Goldin-Meadow, 2009). To our knowledge, however, no previous study has examined the role gesture plays in supporting a complex language task like narrative processing in children. However, we do know that, in adults, listening to a narrative that is accompanied by gesture leads to deeper processing of the story structure and more accurate inferences about the story, but not to better literal retention of the story details, than does listening to a narrative without gesture (Cutica & Bucciarelli, 2008). In the current study, we asked whether and how gesture facilitates narrative processing in children, as indexed by their subsequent narrative retellings. We specifically focused on the question of whether accompanying a story with co-speech gesture would lead children to retell the story using a more mature narrative structure that included the protagonist's goal (Stein, 1988; Stein & Albro, 1997).

We also asked whether children would construct more highly structured narratives after listening to a storyteller relate the story in words, or after seeing events unfold firsthand, unaccompanied by speech, as in our cartoon format. Children might be expected to produce less complex narratives in the cartoon format than in the three language formats simply because they need to generate the language to describe the cartoon content on their own. Furthermore, language input might help children categorize story events and attribute meaning to them. Thus, inferring the narrative structure without such linguistic support might be more challenging in the cartoon format. Alternatively, witnessing an event firsthand might make the goal of the event more salient; if so, children might tell better-structured narratives in the cartoon format than in any of the language formats. To our knowledge, this question has not been explored in previous studies of children's narrative skills.

The Effect of Elicitation Formats on TD Children Versus Children With PL

We compared the narrative retellings of TD children and children with early brain injury, asking whether elicitation format might play a different role for children in these groups. Children with PL exhibit marked plasticity for language, and after an initial delay in getting language off the ground, these children tend to perform within the normal or low-normal range during the early stages of language development (Bates & Dick, 2002; Feldman, 2005; Stiles, Reilly, Paul, & Moses, 2005; Thal et al., 1991; Woods & Teuber, 1978). However, recent evidence suggests that this plasticity might not extend to more complex language tasks, such as producing well-structured narratives (Demir et al., 2010; Feldman, MacWhinney, & Sacco, 2002; Weckerly, Wulfeck, & Reilly, 2004; Wulfeck, Bates, Krupa-Kwiatkowski, & Saltzman, 2004).

Most research examining the language development of children with PL has focused on the role of biological factors—lesion characteristics—in explaining variations in skill among children in this group. But recent studies indicate that environmental factors—notably, parent language input—also play an important role in the language development of children with PL, and that input may be even more important for these children than for TD children, particularly when more complex aspects of language are involved (Rowe, Levine, Fisher, & Goldin-Meadow, 2009). Such findings motivated our focus on the role of environmental factors (i.e., elicitation format), as well as the role of biological factors (i.e., presence vs. absence of a lesion; variations in lesion characteristics among children with PL), in children's narrative processing.

As in TD children, gesture and speech are tightly linked in children with PL, and early gesture predicts later language outcomes (Özçalışkan, Levine, & Goldin-Meadow, 2013; Sauer, Levine, & Goldin-Meadow, 2010). We therefore expected that the AV-G format would elicit narratives with more mature structures from both TD and PL children. However, a number of studies have reported that gesture has its greatest impact when language skill is low, raising the possibility that gesture may play an even more important role in scaffolding narrative production in children with PL than in TD children. For example, children with specific language impairment (SLI) have been found to make better use of information provided in gesture than have TD children in both simple and more complex language tasks, such as drawing inferences (Botting, Riches, Gaynor, & Morgan, 2010; Kirk, Pine, & Ryder, 2011). In light of these findings, children with PL, especially those who have difficulty producing well-structured narratives, may be particularly likely to benefit from information provided in gesture; if so, the AV-G format might narrow the gap between the narratives produced by TD children and those produced by children with PL. Alternatively, early brain injury may disrupt gesture–speech integration, which relies on the integrity of long-range brain networks (Feldman, 2005; Özyürek, Willems, Kita, & Hagoort, 2007; Skipper, Goldin-Meadow, Nusbaum, & Small, 2007, 2009). Children with PL may then be less likely to benefit from co-speech gesture in stories than TD children; if so, the gap between the narratives of the two groups may widen in the AV-G format.

The Effect of Elicitation Format on Children With PL as a Function of Lesion Characteristics

Several studies have shown that children with PL are a heterogeneous group, with lesion size and type of lesion (periventricular vs. cerebrovascular infarct), but less so lesion laterality, predicting language development (Brasky, Nikolas, Meanwell, Levine, & Goldin-Meadow, 2005; Levine, Brasky, & Nikolas, 2005; Rowe et al., 2009; Sauer et al., 2010; Stiles et al., 2005; but see Aram & Ekelman, 1986; Chilosi, Cipriani, Bertuccelli, Pfanner, & Cioni, 2001). In terms of lesion size, children with smaller lesions show normal or near-normal language acquisition, whereas children with larger lesions tend to fall behind TD children (e.g., Feldman et al., 2002; Levine, Huttenlocher, Banich, & Duda, 1987; Sauer et al., 2010; Weckerly et al., 2004). In terms of lesion type, children with cerebrovascular lesions show more marked delays in language development than children with periventricular lesions. Cerebrovascular lesions tend to be larger in size and also to occur later during the gestational period (third trimester versus second trimester for periventricular lesions), possibly leading to decreased plasticity (Rowe et al., 2009; Staudt et al., 2004). Effects of lesion laterality on early language development of children with PL are less pronounced than the laterality effects observed in adults with similar lesions, and side-specific effects tend to resolve by age 5 (Bates et al., 2001; Chapman, Max, Gamino, McGlothlin, & Cliff, 2003; Reilly et al., 1998, 2004; Reilly, Wasserman, & Appelbaum, 2013; Rowe et al., 2009). Finally, recurrent seizures have been found to be associated with lower levels of cognitive functioning (e.g., Bates et al., 1997; Huttenlocher & Hapke, 1990; Levine, Kraus, Alexander, Suriyakham, & Huttenlocher, 2005, but see Vargha-Khadem, Isaacs, van der Werf, Robb, & Wilson, 1992). Here we asked whether children with larger lesions and/or cerebrovascular infarcts would be more, or less, likely to benefit from the AV-G format, compared to children with smaller lesions and/or periventricular lesions (who tend to be similar to TD children in other aspects of their language development, e.g., Rowe et al., 2009; Sauer et al., 2010).

To summarize, we addressed two main questions in our study: (a) How does elicitation format affect the structure of the narratives produced by TD kindergarten children, and are the effects comparable for children with PL? If not, are certain elicitation formats (e.g., those containing gesture) particularly beneficial for children with PL, allowing them to produce narratives that are comparable in structure to those produced by TD children under the same conditions? (b) Do the narratives PL children produce differ as a function of lesion characteristics, and do lesion characteristics interact with elicitation format?

Method

Participants

Typically developing children. The narrative skills of TD children (n = 53; 25 girls, 28 boys) enrolled in a longitudinal language project in the greater Chicago area were assessed midway through their kindergarten year. The average age of the children at the time they participated in our study was 5.10 years (SD = 0.4 years, range = 5.2–6.6 years). Children and their families were recruited from the Chicago area via mailings to families and via an advertisement in a free parent magazine. Families were interviewed, and the sample was selected to represent the socioeconomic diversity of the Chicago area. Children were 14 months of age when they were first enrolled in the study and were visited in their homes every 4 months for a 2-hour session. The average number of years of primary caregiver (PCG) education was 16 (SD = 2 years, range = 12–20 years). In our sample, PCG education and family income were significantly correlated, $r = .42$, $p < .01$. Based on parental report, 31 children were Caucasian, 10 were African American, 6 were White Hispanic/Latino, and 6 were mixed race/ethnicity. Only monolingual English-speaking families were recruited for the study.

Children with pre- or perinatal unilateral brain lesion. Children with unilateral pre- or perinatal lesions (n = 19, 13 girls, 6 boys) who were enrolled in the same longitudinal language project were assessed midway through their kindergarten year. Their mean age was 6.0 years (SD = 0.4 years, range = 5.5–6.9 years), which did not differ significantly from the mean age for the TD children, $t(70) = 0.44$, $p > .10$, Cohen's $d = .11$. We recruited the children with PL by contacting physicians in the greater Chicago area and by establishing relationships with parent support groups in the area (Childhood Stroke and Hemiplegia Connections of Illinois; Pediatric Stroke Network; and Children's Hemiplegia and Stroke Association). We included every family that was interested as long as the child had experienced a unilateral pre- or perinatal unilateral brain injury and was monolingual English-speaking, regardless of socioeconomic status. The average number of years of PCG education was 16 (SD = 2 years, range = 12–20 years), and was not significantly different from the average number of years of education for parents of TD children, $t(70) = 0.53$, $p > .10$, Cohen's $d = .13$. Seventeen children with PL were reported to be Caucasian, and 2 were reported to be mixed race.

Coding characteristics of brain lesions. Lesion information came from films (n = 10), from MRI scans that we obtained for this study (n = 7), or from detailed medical reports provided by families ($n = 2$). All clinical and experimental scans were evaluated by two pediatric neurologists who coded lesions according to location, size, and type.

The specific lesion characteristics considered in the current analysis include lesion laterality (left, right), lesion type (periventricular, cerebrovascular infarct), and lesion size (small/medium, large). In addition, children were categorized in terms of their seizure history as having no seizure history (including children with only one febrile seizure) or recurrent seizures. Regarding lesion type, cerebrovascular infarcts (CIs) are primarily infarcts of the middle cerebral artery territory and tend to affect the inferior frontal, parietal, and/or superior temporal regions, with the lesion mainly impacting gray matter. Periventricular lesions (PVs) are primarily subcortical and involve white matter tracts, the thalamus, basal ganglia, and/or the medial temporal lobe. All children with PV lesions show evidence of subcortical injury, enlarged ventricles, or reductions in white matter tracts (especially the internal capsule), as noted in Table 1. Although periventricular leukomalacia in very low-birth-weight prematurely born children (before 32 weeks) has been the focus of much previous literature, PVs also occur in full-term children (Krägeloh-Mann & Horber, 2007). All children in our sample were born at or near term according to parental report (gestational age at birth of at least 36 weeks). Thus, our sample of children with PVs differs from samples of very premature children with periventricular leukomalacia.

Lesions also were classified according to size on the basis of the following criteria. Small lesions affected only one lobe or minimally affected subcortical regions. Medium lesions extended into more than one lobe or subcortical region. Large lesions affected three or four lobes and were all CIs; these lesions affected multiple cortical areas and involved the thalamus and subcortical regions. Children with small and medium lesions were categorized into a single group, as preliminary analyses indicated that the two groups did not differ from each other on various language measures. Lesion characteristics for each participant are reported in Table 1. We also report whether the child had experienced recurrent seizures, which were treated with medication.

Overall, the PL sample consisted of 10 children with left hemisphere (LH) lesions and 9 with right hemisphere lesions. Eleven of the children had lesions characterized as CIs, and 8 had lesions characterized as PVs. Eleven of the children had small/medium lesions, and 8 had large lesions. Neither lesion type and side nor lesion size and side were related to each other: $\chi^2(1, N = 19) = 0.04$, $p > .10$, Cramer's $V = .05$, $\chi^2(1, N = 19) = 0.54$, $p > .10$, Cramer's $V = .17$, respectively. However, as predicted, there was a significant association between lesion type and size, with all children with PV lesions having small/medium lesions, and 8 out of 11 children with CIs having large lesions, $\chi^2(1, N = 19) = 10.05$, $p < .01$, Cramer's $V = .73$. Of the 19 children, 14 had never experienced seizures (no seizures or a single febrile seizure during the first year of life), and 5 had experienced recurrent seizures for which they were being treated with anticonvulsant medications. Four of the five children with recurrent seizures had right hemisphere lesions, 3 had large lesions, and 4 had CIs. There were no significant associations between seizure presence and lesion laterality, $\chi^2(1, N = 19) = 2.99$, $p = .09$, Cramer's $V = .39$; lesion size, $\chi^2(1, N = 19) = 0.89$, $p > .10$, Cramer's $V = .22$; or lesion type, $\chi^2(1, N = 19) = 1.36$, $p > .10$, Cramer's $V = .27$.

Material and Procedure

Stories were based on short (30–73 s) cartoons shown in Germany about a small mouse (Maus) and his friends. These cartoons were chosen in part because we expected American children to be unfamiliar with them. The particular stories selected had at least one goal, an initiating event (the problem), multiple episodes (attempts to achieve the goal), and an outcome or resolution. Thus, each story was defined by a series of causally connected events. As described earlier, stories were presented to children in four different formats: auditory modality (A), an audio recording of a story-

Table 1
Lesion Characteristics for the 19 Children With Unilateral Early Brain Injury

ID no.	Gender	Side	Type	Size	Areas affected	Seizure history
30	F	LH	CI	Large	F, T, P, O, S	No
35	F	LH	PV	Medium	S	No
46	F	RH	CI	Large	F, T, P, S	Yes
93	M	RH	PV	Small	S	Yes
94	F	RH	PV	Small	T, P, S	No
117	F	RH	CI	Large	F, T, P, S	Yes
132	F	LH	PV	Small	S	No
135	F	RH	CI	Small	F, P	Yes
140	F	LH	CI	Large	F, T, P, S	No
144	M	LH	CI	Large	F, T, P, S	Yes
148	F	LH	CI	Large	F, T, P, O, S	No
150	F	LH	PV	Small	S	No
152	F	RH	CI	Large	F, T, P, O, S	No
157	F	LH	PV	Small	S	No
158	M	RH	CI	Medium	F, P, S	No
159	M	RH	PV	Small	T, S	No
160	M	RH	PV	Small	S	No
163	F	LH	CI	Large	F, T, P, S	No
164	M	LH	CI	Medium	T, P, S	No

Note. LH = left hemisphere; RH = right hemisphere; CI = cerebrovascular infarct; PV = periventricular; F = frontal; T = temporal; P = parietal; O = occipital; S = subcortical.

teller; auditory and visual modalities (AV), an audiovisual recording of a storyteller whose hands rested in her lap; auditory and visual modalities with gesture (AV-G), an audiovisual recording of a storyteller producing story-relevant gestures; and cartoon (C), Maus cartoons, which did not contain any language. Eight unique spoken stories were constructed based on eight different cartoons (see Appendix A for examples). The spoken stories included the same events, story structure, and plot line as the parallel cartoons (see Appendix A for three of the stories). These stories averaged 102 words and 19 clauses. All of the stories used language that was familiar to young children. The same storyteller recorded two different versions of each of the eight stories; one in which her hands rested on her thighs as she spoke (AV), and one in which she produced naturalistic co-speech gestures (AV-G). The soundtrack from the AV-G format was presented (without video) in the auditory format (A). The spoken content of a given story was identical across the three elicitation formats. The storyteller was instructed to gesture naturally during the AV-G recordings; gestures were not scripted. She primarily used iconic gestures (60% of her total gestures). She also produced beat gestures (rhythmic movements that convey no semantic information but synchronize with speech, 18% of her total gestures), which tended to co-occur with the goal information in the story (7/11 instances). The remaining 22% of her gestures were a mix of placeholder, deictic, conventional, and metaphoric gestures. The average number of gestures that the storyteller produced per story in the AV-G format was 18.5 (range = 17–20).

Each child was presented with eight stories, two stories per elicitation format (A, AV, AV-G, and C), yielding a total of eight unique stories; no child saw or heard the same story in more than one format. The stories were played to the child on a DVD player during a regular home visit. All TD children and all but 3 children with PL completed retellings of eight stories; these 3 children retold 7, 5 and 4 stories, respectively (in one case because of technical difficulties; in the others because of fatigue). Stories were presented in two fixed orders, and children were randomly assigned to receive the stories in one of the orders. In both orders, a cartoon story was presented first to engage the child and to introduce the characters. Further, in both orders, the first four stories consisted of one story from each of the four elicitation formats, as did the second four stories. The two story orders were as follows: (1) C, AV, A, AV-G, C, AV-G, A, AV and (2) C, AV-G, A, AV, C, AV, A, AV-G. Approximately half of the children in each group (TD, PL) received Order 1 first. For each elicitation format, the results were based on six different stories, and each story appeared in three different elicitation formats. For example, results for the A format were based on the hole, photo, socks, telephone, telescope, and unicycle stories, whereas results for the AV-G format were based on the hole, photo, snore, socks, telescope, and teapot stories (see Appendix A).[1]

Procedure

The experimenter sat next to the participant in front of the video camera and explained that he or she would be playing a storytelling game. Children were videotaped during all phases of the task (viewing the story or cartoon, retelling it, answering comprehension questions that followed each story or cartoon). The child was told that the stories sometimes would be cartoons and sometimes would be told by a storyteller. To introduce each story, a still picture appeared on a DVD player and the experimenter identified the characters by name. Key objects in the story were labeled (e.g., bicycle, camera, socks, telephone). The video and/or audio clip was then played through to the end. After playing the clip, the experimenter said, "Can you tell me the story, as much as you remember?" Children who did not respond were prompted with questions such as "Who was in the story?" or "Can you tell me what happened?" The retelling continued until the child indicated that he or she was done or until the experimenter asked, "Anything else?" and the child said, "No."[2] After each retelling, the experimenter asked three multiple-choice questions as a comprehension check. One question assessed the children's awareness of the problem the characters faced (e.g., "Why doesn't the phone work?"); the second assessed their awareness of the solution strategy that was used (e.g., "What does Maus use to fix the cord?"); and the third assessed their skill in making an inference based on the story (in each case, "What is a good title for this story?").

Measures

The language produced by each child for each of the narratives presented was transcribed and coded from the videotaped sessions. Stories were coded for narrative structure scores, using a system adapted from Stein and colleagues (Stein, 1988; Stein & Albro, 1997; Trabasso et al., 1992). Narratives were categorized as follows: (0) A narrative with no structure does not even contain a descriptive sequence; (1) a descriptive sequence is a narrative that includes the physical and personality characteristics of an animate protagonist with no mention of a sequence of actions; (2) an action sequence is a narrative with actions described in a temporal order (actions follow one another in time) but in which the actions are not causally organized; (3) a reactive sequence contains actions that are causally organized but does not include the protagonist's goal, the intention of the protagonist to act to achieve a specific end; (4) an incomplete goal-based narrative contains a goal statement and/or an attempt but no outcome following the goal; (5) a complete goal-based narrative with one episode includes not only temporal and causal structure but also a goal of the protagonist, an attempt to achieve the goal, and an outcome of these attempts; and (6) a complete goal-based narrative with multiple episodes includes multiple goal–attempt–outcome sequences. Examples of each kind of narrative are provided in Appendix B.

In addition to narrative structure measures, we assessed the number of clauses and the number of word types included in each narrative. Clauses included both independent clauses, defined as a subject (a noun clause or its equivalent) plus a predicate (a verb

[1] The average number of words was 99 in the stories presented in the AV-G format, 96 in the A format stories, and 100 in the AV format stories. The average number of clauses was 18 for stories presented in the A format and 19 for stories presented in the AV-G and AV formats. The average number of dependent clauses was 3 for stories in all three elicitation formats. Thus, the linguistic content of the stories presented in the three formats was comparable.

[2] Preliminary analyses revealed that, on average, children received a total of three prompt questions. Number of prompts did not vary as a function of elicitation format or group (TD vs. PL) but overall was negatively correlated with narrative structure score, $r = -.27$, $p < .05$.

phrase), such as "He fell in a hole," and subordinate clauses (either embedded or subordinate), such as "He knew *what to do.*" Children often produced several clauses connected by "and then" and "but"; each of these clauses was considered independent. Total number of clauses was based on the full clauses the child produced (approximately 90% were independent clauses, and 10% were dependent clauses). Word types included only unique words (i.e., different forms of the same word were coded as the same word type, e.g., "run," "ran" and "running" were considered one type).

Reliability was established for speech measures by having two coders analyze all eight stories produced by 6 TD children and 3 children with PL (11% of the data). Interclass correlation coefficients between the two raters were almost perfect: .93 for the number of clauses and .98 for the number of word types. The interclass correlation was substantial (.76) for the narrative structure scores as well (Landis & Koch, 1977). Discrepancies were resolved through discussion.

Results

The Effect of Elicitation Format on Narrative Comprehension and Production in TD Children and Children With PL

To test for effects of elicitation format on narrative comprehension and production in the TD children and children with PL, we performed statistical analyses with SPSS PASW 18 software, using GENLIN generalized estimating equations. This method allows analysis of repeated measures embedded within an individual and also specification of the distribution and link function for the models depending on the type of outcome variable. We had one measure of narrative comprehension: number of comprehension questions answered correctly. We had one measure of narrative structure: narrative structure score. We had two measures of narrative language: number of clauses and number of word types. To examine the effect of elicitation formats on narrative comprehension, structure, and language, we used an identity link function for interval data (comprehension questions answered correctly, narrative structure score, number of clauses, and number of word types). In each model, group (TD, PL) was a between-subjects variable, and elicitation format (A, AV, AV-G, C) was a within-subjects variable. We controlled for primary caregiver (PCG) education as a between-subjects variable, and story order as a within-subject variable. Child was the subject variable. Because all models included repeated measures, a compound symmetry covariance structure was assumed. We provide descriptive statistics for each outcome variable in each elicitation format in Table 2.

Narrative comprehension. We first explore how well the children understood the stories by looking at their responses to the comprehension questions. The average number of comprehension questions answered correctly across all elicitation formats for all participants was 2.35 (SD = 0.76) out of 3. Correct answers did not significantly differ by elicitation format, Wald $\chi^2(3, N = 552) = 6.07$, $p > .10$. A main effect of group emerged, with TD children answering significantly more comprehension questions correctly than children with PL, Wald $\chi^2(1, N = 552) = 7.08$, $p < .01$. There was no significant effect of elicitation format, Wald $\chi^2(3, N = 552) = 6.07$, $p > .10$., or interaction between group and elicitation format, Wald $\chi^2(3, N = 552) = 6.28$, $p = .10$. Neither story order, Wald $\chi^2(2, N = 552) = 2.67$, $p > .10$, nor PCG education, Wald $\chi^2(1, N = 552) = 0.28$, $p > .10$, was significantly related to narrative comprehension score (see Table 2).

Narrative production. We turn next to the effect of elicitation format on the structure of the narratives the children produced. The average narrative structure score across all elicitation formats for all participants was 3.60 (SD = 1.86) out of 6. Narrative structure score differed significantly by elicitation format, Wald $\chi^2(3, N = 555) = 19.39$, $p < .01$. In line with our hypotheses, pairwise comparisons using Bonferroni correction showed that children told more highly structured stories in response to the AV-G format than in response to any of the other formats: versus A. $p < .01$; versus AV, $p < .05$; and versus C, $p < .01$. None of the other formats differed significantly on this measure. A main effect of group also emerged, with TD children earning significantly higher narrative structure scores than children with PL, Wald $\chi^2(1, N = 555) = 5.47$, $p < .05$. There was no significant interaction between group and elicitation format, Wald $\chi^2(3, N = 555) = 2.33$, $p > .10$. Neither story order, Wald $\chi^2(2, N = 555) = 3.45$, $p > .10$, nor PCG education, Wald $\chi^2(1, N = 555) = 3.14$, $p > .10$, was significantly related to narrative structure score (see Table 2 and Figure 1).

Controlling for oral language measures in narrative production. To determine whether the differences between elicitation formats with respect to narrative structure were related to differences in the language children used in retelling the stories, we ran the analyses described above while controlling for number

Table 2
Means (and Standard Deviations) for Narrative Comprehension, Narrative Structure, and Language Outcome Measures by Elicitation Format for TD and PL Children

Measure	Children	Cartoon	Auditory	Audiovisual	Audiovisual + gesture	Average
Comprehension questions	TD	2.03 (0.76)	2.48 (0.70)	2.53 (0.61)	2.45 (0.72)	2.43 (0.71)
	PL	2.03 (0.86)	2.24 (0.82)	2 (0.89)	2.18 (0.81)	2.11 (0.84)
Narrative structure score	TD	3.65 (1.74)	3.56 (1.86)	3.70 (1.88)	4.31 (1.74)	3.81 (1.83)
	PL	2.58 (1.63)	3.00 (1.83)	2.89 (1.91)	3.56 (1.85)	3.00 (1.82)
Clauses	TD	7.15 (3.57)	6.80 (3.69)	7.14 (3.68)	7.12 (3.59)	7.05 (3.63)
	PL	5.19 (2.85)	4.82 (2.58)	5.37 (2.92)	5.24 (2.81)	5.16 (2.77)
Word types	TD	26.79 (9.12)	28.45 (10.51)	30.50 (11.59)	29.74 (10.47)	28.87 (10.52)
	PL	19.81 (6.53)	21.15 (9.25)	22.77 (10.32)	23.21 (9.64)	21.71 (9.03)

Note. TD = typically developing; PL = pre- or perinatal unilateral brain injury.

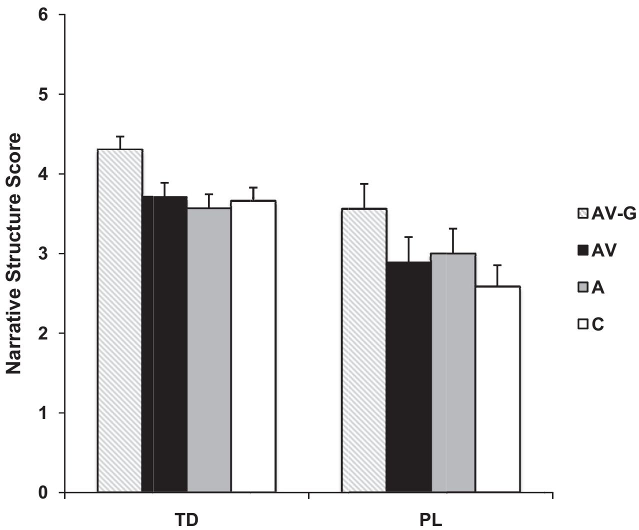

Figure 1. Narrative structure score by elicitation format (C = cartoon, A = auditory, AV = audiovisual, AV-G = audiovisual with gestures) for typically developing children (TD) and children with pre- or perinatal unilateral brain injury (PL).

of clauses and number of word types, that is, controlling for our narrative language measures. Preliminary analyses on the language measures showed a main effect of participant group (TD, PL) on both word types, Wald $\chi^2(1, N = 555) = 12.41$, $p < .01$, and clauses, Wald $\chi^2(1, N = 555) = 9.26$, $p < .01$, controlling for elicitation format, story order, and parent education. There was also a main effect of elicitation format on number of word types, Wald $\chi^2(1, N = 555) = 19.05$, $p < .01$, but not on number of clauses, Wald $\chi^2(1, N = 555) = 5.54$, $p = .14$. Follow-up analyses showed that number of word types was significantly higher in the AV and AV-G formats than in the A and C formats.

The analyses of narrative structure score showed that the two language measures were significant predictors of narrative structure score: number of clauses, Wald $\chi^2(1, N = 555) = 12.14$, $p <$ .01, and number of word types, Wald $\chi^2(1, N = 555) = 25.34$, $p <$ .01. Importantly, however, after controlling for the two language measures (number of word types and number of clauses), elicitation format remained a significant predictor of narrative structure, Wald $\chi^2(3, N = 555) = 18.91$, $p < .01$. Pairwise comparisons revealed that children produced stories with higher structure scores in response to the AV-G format than in response to any of the other formats: versus A, $p < .01$; versus AV, $p < .01$; and versus C, $p <$ .01. Moreover, the main effect of group was no longer significant when we controlled for the two language measures, Wald $\chi^2(1, N = 555) = .47$, $p > .10$, suggesting that any differences found between TD children and children with PL in narrative structure scores could be partially accounted for by differences in the language the children used in their story retellings. As in the previous analysis, there were no significant main effects of PCG education or of story order. Importantly, there was no interaction between group and elicitation format.

To summarize, thus far, our findings indicate that children—both TL children and children with early brain lesions—tell better-structured narratives after listening to a storyteller who gestures than after listening to a storyteller who does not move her hands (as she might if she held the book while talking), after listening only to a storyteller's voice (as if she were on the radio), or after watching a story unfold in a wordless cartoon form. Elicitation format had a significant impact on narrative production (indexed by narrative structure score) and not on narrative comprehension. The beneficial effect of gesture on children's narrative structure remained significant even after controlling for other aspects of the children's narratives (number of clauses, number of word types). Importantly, the effect of elicitation format did not vary by group.

The Effect of Elicitation Format on Children With PL as a Function of Lesion Characteristics

Although the effect of elicitation format did not differ for children in the TD versus PL groups, children with PL are heterogeneous in terms of lesion characteristics. We next asked whether children's narrative structure scores were related to children's lesion characteristics, and whether the effect of elicitation format varied as a function of these characteristics, perhaps showing a greater positive impact of gesture for children with lesions that are likely to impact language functions—that is, children with left hemisphere lesions, larger lesions, CIs, or a history of recurrent seizures (e.g., Feldman et al., 2002; Rowe et al., 2009; Sauer et al., 2010; Staudt et al., 2004; Weckerly et al., 2004). Because lesion type was highly correlated with lesion size in our sample, we only report analyses on lesion size (in fact, the results of analyses on lesion type parallel the findings reported on lesion size).

We used generalized estimating equations analyses to examine the effects of lesion characteristics and elicitation format on children's narrative production, using TD children as a comparison group. Given that our sample size for each lesion characteristic group was small, we ran three separate models, one for lesion size, one for lesion laterality, and one for seizure history. These analyses were conducted using only the AV and AV-G formats because our analyses on TD versus PL children showed that the AV-G led to better performance than all of the other three formats (AV, A, and C) and because the AV, A, and C formats did not differ significantly from one other; moreover, we were specifically interested in the value added by including gesture in a story, and the AV format provided the best contrast for that question. Lesion characteristic was a between-subjects variable, and elicitation format was a within-subjects variable. Child was the subject variable. Parent education and story order were not included in these analyses since they were not significant predictors of performance in the previous analyses. We provide descriptive statistics for each lesion characteristic group in Table 3.

Lesion size. The sample included 11 children with small/medium lesions and 8 with large lesions. Lesion size was significantly related to children's narrative structure score, Wald $\chi^2(2, N = 277) = 27.87$, $p < .01$. Children with large lesions had significantly lower narrative structure scores than TD children, $p < .01$, and than children with small/medium lesions, $p < .01$. Children with small/medium lesions did not differ significantly from TD children, $p > .10$. Children earned higher narrative structure scores in responding to the AV-G format than in responding to the AV format, Wald $\chi^2(1, N = 277) = 11.08$, $p < .05$, but there was also a significant interaction between lesion size and elicitation format, Wald $\chi^2(2, N = 277) = 6.88$, $p < .05$.

Table 3
Means (and Standard Deviations) for Narrative Structure Scores Produced by Children With PL as a Function of Elicitation Format and Lesion Characteristics

Lesion characteristic	Audiovisual	Audiovisual + gesture	Average
Lesion size			
Small/medium	3.81 (1.83)	4.05 (2.01)	3.63 (1.84)
Large	1.50 (0.94)	2.86 (1.35)	2.07 (1.33)
Lesion type			
CI	2.11 (1.41)	3.21 (1.51)	2.43 (1.42)
PV	3.81 (2.04)	4 (2.17)	3.67 (2.01)
Lesion laterality			
Left hemisphere	2.63 (1.54)	3.53 (1.68)	3.04 (1.70)
Right hemisphere	3.19 (2.29)	3.60 (2.10)	2.95 (1.96)
History of seizure			
No	2.88 (1.88)	3.71 (1.92)	3.29 (1.93)
Yes	2.90 (2.08)	3.20 (1.69)	3.05 (1.85)

Note. PL = pre- or perinatal unilateral brain injury; CI = cerebrovascular infarct; PV = periventricular.

Follow-up pairwise comparisons revealed that, in response to the AV format, children with large lesions received significantly lower narrative structure scores than children with small/medium lesions, $p < .01$. Although the same pattern was found for the AV-G format, the difference did not reach significance, $p > .10$. For both formats, children with large lesions received significantly lower scores than TD children (AV, $p < .01$; AV-G, $p < .01$), whereas children with small/medium lesions did not differ from their TD peers for either format (AV, $p > .10$; AV-G, $p > .10$). Children with larger lesions (all 8 of whom had CIs) received significantly higher scores in responding to the AV-G format than in responding to the AV format, $p < .01$. In contrast, although children with small/medium lesions (8 of whom had PV lesions) and TD children also received higher scores in response to the AV-G than to the AV format, the difference did not reach significance (both ps $>$ .10; see Table 3 and Figure 2).

We next examine whether the benefit of gesture depended on group (TD, PL with small/medium lesions, PL with large lesions) or narrative skill level. That is, did the children with large lesions benefit more from gesture than TD children and children with small/medium lesions, not because of their lesions per se but because of their lower narrative skill level overall? To answer this question, we examined the effect of lesion size versus overall narrative skill level (as measured by performance in response to the AV format) on improvement when gesture was included in a story (i.e., on the difference between narrative structure scores for the AV-G and AV formats; AV-G minus AV). For these analyses, each child's scores for the two stories told in the AV format and the two stories told in the AV-G format were averaged (except for those few children who were missing a retelling in one or more of the formats). A difference score was created for each child by subtracting their average AV score from their average AV-G score. Children who received an average score of 6 in response to the AV format were excluded from this analysis (8 TD children and 1 child in the small/medium lesion group) because it was not possible for them to improve in the AV-G format as they were already at ceiling in the AV format. We then ran a one-way ANOVA on the remaining 63 children with the difference score (AV-G minus AV) as the dependent variable, group (TD, PL with small/medium lesion, PL with large lesion) as a between-subjects variable, and AV narrative structure score as a covariate (our measure of overall narrative skill level). Results revealed a main effect of narrative structure score in the AV format, $F(1, 59) = 20.59$, $p < .01$, partial $\eta^2 = 0.26$. In particular, the lower a child's scores in the AV format, the larger the difference between the child's narrative structure scores for the AV-G and AV formats. Lesion size did not have a significant effect on the difference between narrative structure scores for the AV-G and AV formats once narrative structure score for the AV format was covaried out, $F(1, 59) = 0.86$, $p > .10$, partial $\eta^2 = 0.03$.

Figure 3 shows the relation between children's narrative structure scores for the AV format (x-axis) and the difference between narrative structure scores for the AV-G and AV formats (y-axis) for the three groups. For the TD children (top graph) and the PL children with small/medium lesions (middle graph), it is clear that the benefit of gesture systematically decreased as a function of performance in response to the AV format—the worse the child's performance in response to the AV format, the more gesture helped. For the PL children with large lesions (bottom graph), the benefit of gesture was uniformly large, but note that all of the children with large lesions performed poorly in response to the AV format. Importantly, the boost these children got from gesture was no larger than the boost TD children and children with small/medium lesions received when performance in response to the AV format was controlled.

It is possible that the relation between performance in response to the AV format and benefit accrued from gesture can be explained by a ceiling effect. Children who do not benefit from gesture might be those who already produce well-structured, goal-based stories in response to the AV format, and thus have no further room to grow with additional gesture input. However, our findings suggest otherwise. In order to examine whether a ceiling effect exists, we looked at the baseline scores (i.e., scores for the

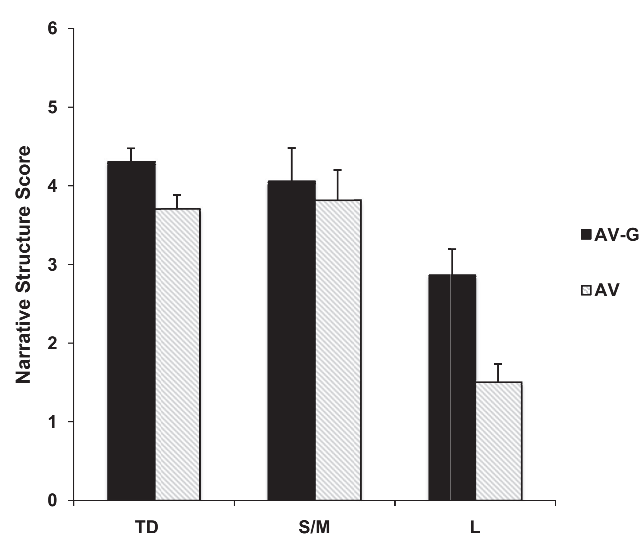

Figure 2. Narrative structure score by elicitation format (AV = audiovisual, AV-G = audiovisual with gestures) for typically developing children (TD) and for children with pre- or perinatal unilateral brain injury (PL) with small/medium (S/M) lesions and with large (L) lesions.

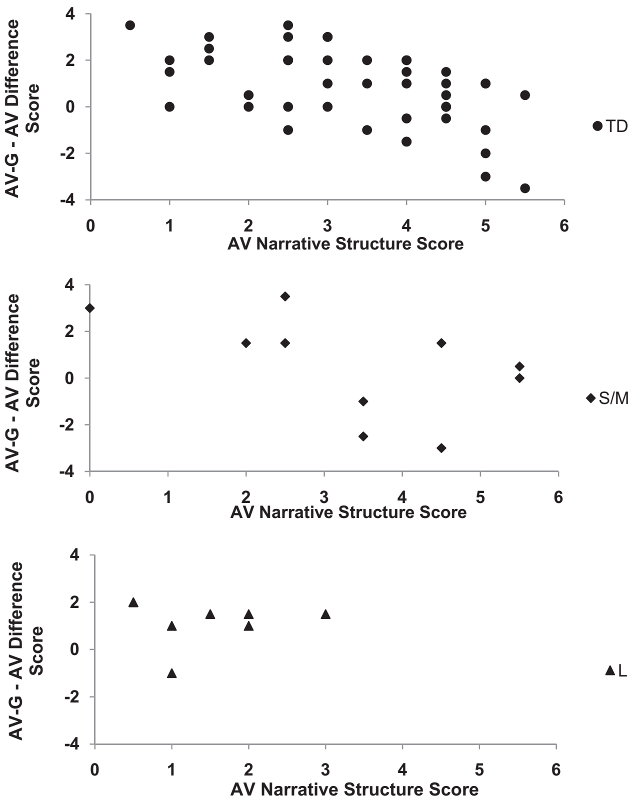

Figure 3. The added value of gesture (as measured by performance in response to the AV-G format minus performance in response to the AV format; *y* axis) in relation to overall narrative level (as measured by the AV narrative structure score; *x* axis) for typically developing children (TD, top graph), children with pre- or perinatal unilateral brain injury (PL) with small/medium lesions (S/M, middle graph), and PL children with large lesions (L, bottom graph). AV = audiovisual; AV-G = audiovisual with gestures.

AV format) for children who did not show a gesture benefit (i.e., children who received the same or lower scores in response to the AV-G format as to the AV format). On average, TD children who did not benefit from gesture received a score of 3.78 ($SD = 1.26$) with the AV format, and children with PL received a score of 3.6 ($SD = 1.67$), out of a maximum score of 6. Thus, these children did have room for growth, suggesting that a ceiling effect does not fully account for the negative relation between performance in response to the AV format and gesture benefit.

Lesion laterality. Our sample included 10 children with left hemisphere (LH) lesions and 9 with right hemisphere (RH) lesions. The generalized estimating equations analyses revealed a main effect of lesion laterality, Wald $\chi^2(2, N = 277) = 6.14$, $p = .05$. However, none of the pairwise comparisons reached significance (RH vs. LH, $p = .10$; RH vs. TD, $p > .10$; LH vs. TD, $p = .06$). Children received significantly higher narrative structure scores in response to the AV-G format than in response to the AV format, Wald $\chi^2(1, N = 277) = 6.12$, $p < .05$, and this difference did not significantly interact with lesion laterality, Wald $\chi^2(2, N = 277) = 0.31$, $p > .10$ (see Table 3).

Seizure status. Our sample included only 5 children who had experienced recurrent seizures, which were controlled by medication. The generalized estimating equations analyses did not reveal a significant main effect of seizure history, Wald $\chi^2(2, N = 277) = 4.80$, $p = .09$. Again, children received significantly higher narrative structure scores in responding to the AV-G format than to the AV format, Wald $\chi^2(1, N = 277) = 3.69$, $p = .05$, and the difference did not significantly interact with seizure history, Wald $\chi^2(2, N = 277) = 0.53$, $p > .10$ (see Table 3).

Discussion

Our goal was to examine whether the narrative retellings of typically developing (TD) children and children with pre- or perinatal unilateral brain injury (PL) vary as a function of the way the narratives are elicited. We found that both TD children and children with PL were particularly likely to produce well-structured stories when provided with rich multimodal input that included gesture. Children were significantly more likely to produce well-structured narratives when retelling stories presented with co-speech gestures than when retelling audiovisual stories presented without co-speech gestures, stories presented only auditorily, or stories presented visually via a wordless cartoon. This gesture advantage remained significant even after controlling for differences in narrative length (number of clauses) and diversity of word types in the narratives. These findings build on research in the language development literature showing that adding gesture to the speech that toddlers hear improves their ability to understand that speech in the early stages of language learning (McNeil, Alibali, & Evans, 2000; Morford & Goldin-Meadow, 1992). The current study shows that adding gesture to the stories that kindergarten children hear improves their skill in constructing a well-organized, goal-based narrative, a much later-developing language skill. Gesture thus continues to play an important role in language processing at later stages of language learning, as measured by children's narrative structure scores on a narrative retelling task.

Including gesture in a story might lead to a better retelling in a number of ways. First, the presence of multimodal information throughout the story may have made it easier for the children to pay attention to the storyteller, thereby increasing the amount of information they encoded, which, in turn, may have enhanced their higher order representation of the story structure. Second, the presence of multimodal information may reduce children's cognitive load (Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001; Ping & Goldin-Meadow, 2008; Wagner, Nusbaum, & Goldin-Meadow, 2004). That is, the gestures that occur during story presentation may make it easier for children to process the linguistic information in those stories and to extract the underlying structure of the stories. Supporting this view, neuroimaging studies on language comprehension using functional magnetic resonance imaging (fMRI) have shown that when speech is accompanied by congruent gestures, connections between Broca's area and other language-relevant cortical areas are weaker than when speech is accompanied by irrelevant movements. The weaker connections between brain regions are hypothesized to reflect gesture's role in reducing the need for lexical selection/retrieval by conveying relevant semantic information (Skipper et al., 2007). Third, stories that included gesture provided both auditory and visual information, and the type of the visual information provided was richer than that in the AV format. Thus, the different format and the quantity of the information provided in the stories that included gesture might have led to better structured stories. Finally, the gestures that accompanied the stories may have specifically drawn children's attention to the story's goal. In all four stories in the AV-G format, the storyteller produced a beat gesture just before, or coincident with, the clause that indicated the protagonist's goal. The storyteller's beat gestures may have provided a cue that the protagonist's goal was an important point in the story. Indeed, children who produced stories that were less well-structured overall were the ones who benefited most from gesture. Importantly, this effect was not because there was no room to improve among the children who produced well-structured stories in response to the AV format. Future work is needed to determine the mechanisms by which seeing gesture leads to producing better-structured stories and whether this benefit depends on the placement of the gestures within the story (e.g., placement of gestures near story goal information). In the current study, the storyteller's gestures were not scripted and, as a result, gesture type and spoken content were confounded. Different gesture types (iconic vs. beat gestures) have been shown to have differential effects on children's recall (So, Chen-Hui, & Wei-Shan, 2012), and future work needs to explore whether the type of gesture also influences children's recall of information in the context of narrative retellings. Elicitation format had an impact on narrative production but not on narrative comprehension, as indexed by scores on our comprehension questions. However, given children's high performance on the comprehension questions, our comprehension measure may not have been sufficiently sensitive to pick up elicitation format differences on narrative comprehension.

In line with previous work (e.g., Demir et al., 2010; Feldman, 2005; Levine, Kraus, et al, 2005; Reilly et al., 2004; Stiles et al., 2005), our findings provide evidence that plasticity in kindergarten children with PL may be limited when they are called upon to tackle a more complex language task such as narrative production. We found that a child's production of relatively complex goal-based stories depended on the size of the child's lesion—children with large lesions were significantly less likely to produce goal-based stories than were children with smaller lesions and TD children. Children with large lesions (and cerebrovascular lesions) may have particular difficulty with narrative production tasks, which require the ability to organize information hierarchically (Chapman et al., 2004), because these tasks call upon large neural networks (Nichelli et al., 1995). In the current study, all of the children who had larger lesions also had CIs, thus making it impossible to disentangle the effects of lesion size and lesion type. In addition, children in our sample with left versus right hemisphere lesions did not differ significantly from each other, a finding that is consistent with previous work. For example, Demir et al. (2010) found that lesion laterality did not influence narrative production on a story stem task, and Reilly et al. (1998) found that lesion laterality had an impact on language development only prior to age 5. Finally, seizure history was not a significant factor in children's narrative productions, perhaps because of the small number of children with a positive seizure history in our sample or because the children's seizures were well controlled.

Importantly, when retelling stories presented without gesture, including gesture in the narrative input helped both groups, and the degree to which gesture helped did not significantly differ by group. This finding indicates that the role of co-speech gesture in language processing is robust, even in the face of early brain injury that impinges on brain networks typically involved in language functions (cf. Özçalışkan et al., 2013; Sauer et al., 2010). Children with larger lesions (all of whom had CIs) did show more improvement when stories were presented with co-speech gestures than did children with smaller lesions and TD children, but our analyses showed that this difference was attributable to their lower narrative structure scores in the absence of co-speech gesture (see Figures 2 and 3). These findings hint at the possibility that gesture may be particularly helpful in scaffolding narrative structure scores from a low level to a medium level, rather than from a medium level to a fully goal-based story. This finding is consistent with previous research showing that gesture is most helpful when language skill is low, as in children with language difficulties (Botting et al., 2010; Kirk et al., 2011) or younger TD children who have lower language skills (McNeil et al., 2000). It is also possible that the smaller impact that gesture had on children whose narrative skills were more highly developed was due to the lack of sensitivity of our coding system to gains at higher levels or to ceiling effects. However, ceiling effects cannot fully explain our findings given that children who did not benefit from gesture input had room for growth in their narrative structure scores.

Our findings have both theoretical and practical implications. From a theoretical point of view, our findings underscore the importance of considering how stories are elicited in studies of narrative skill development. We have shown that presenting a story in different formats can result in different mental representations of the events in the story and significantly different story retellings. The format in which a story is presented is thus an important factor that needs to be considered in studies of narrative development. From a practical point of view, our findings suggest that multimodal input may be a good way to scaffold the storytelling abilities of young children at risk for delayed narrative skill. Eventually, of course, children need to learn to process story information that is decontextualized—notably, story information presented in books without supporting audiovisual information. But it may be important to get children's narrative skills off the ground by initially presenting stories that are accompanied by gesture. In fact, our findings raise the possibility that presenting stories in a multimodal format could be helpful even to older children and adults, particularly when the material is complex (see, e.g., Cutica & Bucciarelli, 2008). Indeed, even after language has been mastered, learning a new concept is often facilitated when instruction is accompanied by gesture (Church, Ayman-Nolley, & Alibali, 2001; Flevares & Perry, 2001; Goldin-Meadow, Kim, & Singer, 1999; Neill & Caswell, 1993; Núñez, 2004; Singer & Goldin-Meadow, 2005; Wang, Bernas, & Eberhard, 2012; Zukow-Goldring, Romo, & Duncan, 1994).

In summary, we have shown that the conditions used to elicit a narrative can have a substantial effect on the structure of that narrative. Being exposed to rich multimodal information that includes gesture enables both typically developing children and children with early brain injury to produce better structured stories than they would have produced without gesture. Moreover, adding gesture to a story has a particularly large impact on narratives created by children with lower narrative production skills, and thus has the potential to narrow the gap between children with stronger and weaker narrative skills.

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Appendix A

Examples of Stories Produced by the Storyteller in Auditory (A), Audiovisual (AV), and Audiovisual With Gestures (AV-G) Formats Describing the Cartoons in the Cartoon (C) Format

Telephone (A, AV, C)

After school, Ellie likes to take a little nap. Maus comes in, looking for the phone, and calls a friend. He listens, but there is no dial tone and no sound. Maus hangs up and dials again, but still nothing. He bangs on the phone and wakes Ellie up. Maus looks at the cord and sees that it's broken. He sticks his tail between the two ends of the cord. Maus dials again, and this time the call goes through. Ellie claps for Maus and his crazy ideas. Now Ellie can go back to taking her nap.

Socks (A, AV, AV-G)

It's laundry day, and Maus has a pile of wet clothes. He hangs some worn out socks on the clothesline. The wind whirls by and blows the socks off the line. Maus hangs them up again, but the wind is too strong. The socks blow off again and again. Maus wonders how to keep the socks from blowing away. Maybe the holes in the socks can do the trick. Maus strings the clothesline through the hole in each sock. A strong wind whirls by and the socks stay put. No wind can blow these socks away.

Hole (A, AV-G, C)

Maus goes for a walk and is enjoying the day. Before long, he stands at the edge of a cliff. Maus looks, sniffs the air, and then he backs up. Maus wants to jump to the other side. He flies half way across but stops in the air. Then Maus belly flops down into the hole. He scratches at the walls, trying to climb out. Maus doesn't want to spend his day in a hole. His tail spins like a helicopter and lifts him up. That's how you get yourself out of a deep hole.

Appendix B

Examples From Each Narrative Structure Category for Typically Developing Children (TD) and Children With Pre- or Perinatal Unilateral Brain Injury (PL)

(0) Narrative With No Structure

TD, Hole: none

PL, Hole: *I think tail flying.*

(1) Descriptive Sequence Narrative

TD, Telescope: *She was going to wake up Ellie. There was a high telescope.*

PL, Telephone: *Mouse answers the phone, and the cord is broken.*

(2) Action Sequence Narrative

TD, Hole: *He was stuck in a hole, and his tail was spinning, and he got where—he was walking on the other side.*

PL, Snore: *They were sleeping. Then somebody woke up and put a—.*

(3) Reactive Sequence Narrative

TD, Snore: *After the mouse was sleeping. Then the elephant was sleeping. Then they were snoring. Then the mouse can't sleep. He sleeps again. Then the elephant just snored, and he put the top on. And the elephant can't sleep because he sneezed. Then the mouse—the top hits the mouse in the face. He never saw nobody.*

PL, Snore: *The elephant was snoring. The mouse put the beer cap on his trunk, and the elephant woke up, and he was like—, and it hit the mouse, and woke him up.*

(4) Incomplete Goal-Based Narrative

TD, Teapot: *The mouse—he wanted to keep the tea warm, and he kept going from hat to hat to hat to hat, and then he found the elephant Ellie.*

PL, Telescope: *He tried to see the telescope. He was bouncing on a trampoline, and he was trying to look out the telescope again.*

(5) Complete Goal-Based Narrative With One Episode

TD, Hole: *Mouse was taking a walk and enjoying the day, but he fell in the hole, and he tried to get up and his tail spinned like a helicopter, and it took him up, and he said that's how you get out of a deep dark hole.*

PL, Hole: *Mouse wanted to jump over, but then he found a hole, and he used his tail to get out.*

(*Appendices continue*)

(6) Complete Goal-Based Narrative With Multiple Episodes

TD, Socks: *And that he—it was a nice day for laundry, and then he hanged up some socks. They—the wind was so strong. It blew them away. He tried again. They blew them away. Then he thought the holes would do it. He—he threaded the—the socks and holes. He put it on. The wind blew at it, but it didn't go away. The end.*

PL, Telephone: *After school Ellie likes to take a nap. Mouse was looking for a phone. He wanted to call the friend, but there was no answer. So Mouse tried again but—but first he can't get the phone number, and then tried again and then again, but then Ellie—then he saw Ellie, but then he saw that the cord was broken. So he put the tail in there, and it worked. The end.*

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