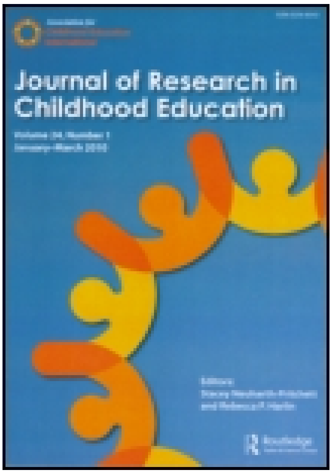

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Preschoolers' Causal Reasoning During Shared Picture Book Storytelling: A Cross-Case Comparison Descriptive Study

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This study investigates how shared picture book storytelling within a peer-group setting could stimulate causal reasoning in children aged 4 ½ to 6 years. Twenty-eight children from preschool classes of three schools were allocated to one of six groups (four to five children per group). Each group participated in six storytelling sessions over a period of 2 weeks. During these sessions, the children freely generated stories from stimuli in two picture books. Storytelling discourse was analyzed in the groups that showed the lowest and the highest pre- to postintervention improvement on a series of causal reasoning tasks. In the most-improving group, discourse was distinguished by detailed interpretations of perceptual features, causal explanations, and explicit justifications of statements. The least-improving group was distinguished by "superficial" talk (i.e., labeling perceptual features, simple inferences, uncritical acceptance of statements, and disagreements). These types of discourse could be related to time spent on storytelling. The findings generate hypotheses for future research on stimulating causal reasoning in early childhood education.

Keywords: preschoolers, causal reasoning, narratives, peer interaction, picture books

Causal reasoning can be broadly defined as the ability to understand relationships with a cause and an effect. Children's capacity for causal reasoning is fundamental to understanding the dynamic physical and social environments they confront every day (Hickling & Wellman, 2001;

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Schlottman, Allen, Linderoth, & Hesketh, 2002; Wellman & Liu, 2007). It allows them to understand past events, predict future outcomes, and influence what happens in the world (Gopnik et al., 2004). Later on, children need this capacity to be successful at school, where much of the formal thinking underlying school subjects—including mathematics, natural sciences, and reading comprehension—is causal in nature (Devlin, 2000; Kuhn & Pearsall, 2000; Van den Broek et al., 2005).

This study investigates how causal reasoning could be stimulated in preschool children (ages 4 ½ – 6 years) through shared picture book storytelling within a peer-group setting. We distinguish three types of causal reasoning. In *causal inference*, a conclusion is drawn about a connection between an antecedent and an outcome (Das Gupta & Bryant, 1989; Gopnik et al., 2004). *Causal explanations* describe mechanisms that act on antecedents to produce particular outcomes (Hickling & Wellman, 2001; Legare, Gelman, & Wellman, 2010*). Causal predictions* are made about the outcome of an event, assuming a particular causal mechanism (Bonawitz et al., 2010).

Causal Reasoning in Young Children

Causal reasoning emerges early in life, with the ability to perceive cause-and-effect relationships among physical events appearing in infancy. Leslie and Keeble (1987) showed 6-month-old infants films of so-called launching events. In the "direct launching" film, a moving object collides with a stationary object, directly setting it in motion. In the "delayed reaction" film, the second object only begins to move after a delay of a half-second. Adults and children perceive a "direct launching" event as causal but a "delayed reaction" event as noncausal. After habituation to one of these films, the same film was shown to the infants in reverse. Although spatiotemporal change was identical for both films, only the reversed "direct launching" film created a novel causal event (i.e., the second object now caused the first object to move). Infants showed more dishabituation to the reversed "direct launching" film than to the reversed "delayed reaction" film, suggesting that they were perceiving the causal events.

As children get older, they develop more sophisticated causal reasoning skills. Gopnik et al. (2004) devised a series of experiments that required children to work out which objects would activate a novel machine and how to intervene to make it stop. The machine lit up and played music when certain objects—but not others—were placed on it. By exposing children to different patterns of covariation relationships between the objects and the machine's behavior, the researchers showed that 2- to 4-year-olds can infer causal relationships from observing patterns of covariation among events in the world around them. Four-year-olds also can infer how causal agents can bring about transformations in objects. Das Gupta and Bryant (1989) showed that 4-year olds, but not 3-year-olds, can readily infer what causes a change in an object that starts out as noncanonical in one way (e.g., a broken cup) and ends up as noncanonical in two ways (e.g., a wet, broken cup) and also can infer what causes a change from a noncanonical state (e.g., wet cup) to a canonical state (e.g., dry cup).

Furthermore, young children seek and provide causal explanations for natural events, human activity, and psychological states. Hickling and Wellman (2001) found that children's everyday causal explanations during the toddler and preschool years incorporate various types of causality (e.g., physical, psychological, biological). More recently, Legare et al. (2010) found that children's causal explanations are especially triggered by events that are inconsistent with prior knowledge, suggesting that children's explanations function in the service of discovery.

Young children also make causal predictions about future events. Bonawitz et al. (2010) showed 2- and 4-year-olds two events in a predictive relation: a block was moved to contact a base following which a toy connected to the base lit up and spun. After this sequence was shown several times, a trial was presented in which the block contacted the base but the toy did not activate. Almost all children predictively looked at the toy; however, only the older children spontaneously intervened to activate it by moving the block to the base.

Although more complex (e.g., multivariable) causal reasoning abilities continue to develop up to 6 or 7 years or older (Kuhn & Pearsall, 2000; Lagattuta & Wellman, 2001), the ability to think about causal relationships appears quite robust by the time children enter early childhood education. Nonetheless, there are important preconditions for competent causal reasoning: young children use prior knowledge and experience of causal structures and mechanisms to learn new causal relationships and to make causal inferences and predictions (Gopnik et al., 2004; Goswami, 2008; Schlottman, 2001). There are, however, important individual differences in young children's causal knowledge and experience, stemming from variability in home context. Specifically, the frequency and type of talk engaged in between parents and children affects children's understanding of the causes and consequences of everyday events and human behavior (Wellman & Liu, 2007). Consequently, some young children may lack much exposure to causal reasoning, which makes it important to provide activities that can stimulate these skills in early childhood education.

Causal Reasoning in Narrative Construction

A fundamental way in which children apply causal reasoning is in constructing narratives—alone or in conversation with parents and peers—that help them derive meaning from their experiences (Bruner, 1990; Nelson, 2007). Narratives are stories that construct relationships between characters, actions, events, motivations, and emotions, based on contextual clues and prior knowledge (Paris & Paris, 2003).

Narratives typically involve several types of causality. *Physical causality* refers to interactions between physical entities (e.g., a moving object bumping into a stationary one and setting it in motion), whereas *psychological causality* refers to how the behavior of characters is related to mental states (e.g., laughing because you are happy) (Hickling & Wellman, 2001; Schlottman et al., 2002). Within the context of narratives, it is important to distinguish a third type of causality, which we refer to as *situational causality*. This reflects the view that narratives involve mental representations of depicted or described situations that include causal connections between various story elements (Van den Broek et al., 2005; Zwaan & Radvansky, 1998). Thus, behavior and mental states could be connected to particular events (e.g., someone becoming upset because they are trapped), events from different parts of the story can be connected (e.g., someone slipping and falling because they dropped a banana peel earlier on), single events can have multiple causes (e.g., a wild fire requires a long dry period and a discarded match or cigarette), and a single cause can lead to multiple events (e.g., a flood can destroy buildings, uproot trees, and wash vehicles away) (Van den Broek et al., 2005; Zwaan & Radvansky, 1998).

Through constructing narratives, children thus learn to form coherent and meaningful representations that include concepts about causal relationships between various story elements (Lever & Sénéchal, 2011; Paris & Paris, 2003). When children construct narratives that make sense of pictorial stimuli, they also make inferences, form predications, and provide explanations that enable them to form coherent accounts of causally sequenced plots (Paris & Paris, 2003). In a study by O'Neill, Pearce, and Pick (2004) that individually measured young children's narrative skills, preschoolers showed this kind of reasoning when narrating a picture book story that depicted different mental states in the context of characters interacting (e.g., seeing a frog in her salad causes a diner to react with surprise and anger). Walsh (2003) also showed that children's oral responses to picture books include cause-and-effect reasoning, as well as labeling (i.e., naming or identifying elements of pictures) and detailed observations of perceptual features.

By around age 5 years, many children are able to produce well-structured, coherent, and cohesive narratives (Schick & Melzi, 2010). Narrative abilities are also amenable to intervention. Peterson, Jesso, and McCabe (1999) helped mothers stimulate disadvantaged preschoolers' narrative skills by spending more time in narrative conversation, asking more open-ended and context-eliciting questions, and encouraging longer narratives. One year postintervention, these children showed overall improvements in narrative skill, including more descriptions of when and where events took place. Hayward and Schneider (2000) taught narrative skills to preschoolers with language impairments through a number of activities, including sorting and sequencing elements, identifying missing elements, and reformulating scrambled stories. Postintervention, children included more story information and produced more complex stories when generating narratives. In a study by Spencer and Slocum (2010), preschoolers with narrative language delays were taught narrative structure in a story-retell context using picture sequences and icons. Children made substantial gains in narrative retelling and personal story generation. Thus, interventions in which young children are encouraged to engage in narrative activities appear to stimulate their narrative abilities.

Reasoning Through Peer Interaction

A further learning perspective relevant to the present study comes from sociocultural research: children's learning and development are significantly shaped by social and communicative interactions with peers (Howe & Mercer, 2010). Under appropriate conditions, peer interaction during learning tasks can stimulate children to think aloud, share knowledge, explore and extend ideas, clarify or defend their own points of view, challenge others' ideas, and provide alternative hypotheses or interpretations (Howe & Mercer, 2010; Mercer & Howe, 2012). These types of interaction typify what is known as "exploratory talk." Importantly, appropriate conditions for facilitating this kind of talk include the absence of directive control by the teacher, whose role instead focuses on enabling participants to engage openly and equitably with each other's views (Mercer & Howe, 2012). While exploratory talk is considered a desirable and effective form of peer interaction, commonly observed types of interaction in primary school classrooms are less effective. "Disputational talk" is characterized by disagreement and short exchanges of assertions and counter-assertions. With "cumulative talk," speakers build uncritically on each other's statements by repeating, confirming, completing, or elaborating on what has gone before (Howe & Mercer, 2010).

Although previous research has largely focused on older children (≥ 8 years) and adolescents, preschoolers also justify opinions, suggest alternatives, and reach compromises during free play with siblings or peers (Ehrlich, 2011; Howe & McWilliam, 2001). When preschoolers share stories with peers, they take on different roles than when interacting with adults: engaging actively with each other, requesting clarification, providing feedback, supporting each other's storylines, and seeking to improve narrative coherence (Blum-Kulka, Huck-Taglicht, & Avni, 2004; Nicolopoulou & Richner, 2004; Schick & Melzi, 2010). These exchanges resemble the kinds of interactions characterizing exploratory talk but are less readily facilitated in preschoolers' conversations with adults (Schick & Melzi, 2010). Importantly, such interactions can help children appropriate skills that mediate performance on individual nonverbal reasoning tasks (Rojas-Drummond, Pérez, Vélez, Gómez, & Mendoza, 2003; Wegerif, Mercer, & Dawes, 1999).

This Study

Bringing these perspectives together suggests that having preschoolers interact in small groups during a shared narrative construction (i.e., storytelling) task without directive adult control could stimulate them to reason about their thinking and benefit from each other's knowledge and perspectives, which could in turn benefit their individual reasoning skills. As far as we can determine, this combination of learning components has not previously been addressed in early childhood education research. It is therefore not known how preschoolers will talk with each other under these circumstances, nor whether this bears a relationship to outcomes on causal reasoning tasks. Indeed, it is also possible that less effective types of interaction, such as those characterizing disputational and cumulative talk, could occur.

This study aims to answer these questions by investigating the kinds of discourse elicited when preschoolers take part in such a learning arrangement. Specifically, it examines whether different outcomes on causal reasoning tasks reflect differences in the types of narrative statements and peer interaction exhibited during a storytelling task. Based on the research discussed, it could be expected that outcomes would be related to the extent to which narratives contain causal reasoning (i.e., causal inferences, explanations, predictions) about story elements as well as the extent to which children interact in ways characterizing exploratory, disputational, or cumulative talk.

To this end, children's utterances during shared storytelling were investigated in terms of their *narrative* and *interactional* functions, according to the theoretical framework described above. The approach taken was to compare discourse in the groups that showed the lowest and the highest improvement on causal reasoning tasks, after a storytelling intervention in multiple groups. This "diverse-cases" approach compares cases (here: groups) representing the range of variation in outcomes (here: improvement in causal reasoning), to explore relationships between case characteristics (here: discourse functions) and the outcome variable (Gerring, 2007). The results could help generate hypotheses for future research on stimulating preschoolers' causal reasoning.

In this study, as in other studies investigating preschoolers' narrative abilities (e.g., Crawford & Hade, 2000; O'Neill et al., 2004), picture sequences from picture books were used to create an open-ended process in which children assign meaning to visual stimuli. Picture books are accessible, attractive, and authentic materials, specially made for and familiar to young children. To date, picture book research has largely focused on their potential to promote language and literacy skills and on parent–child interactions during shared reading (Fletcher & Reese, 2005; Mol, Bus, De

Jong, & Smeets, 2008). Only a few studies have used picture books to stimulate other cognitive and academic skills, such as promoting theory of mind understanding (e.g., Adrián, Clemente, & Villanueva, 2007; Symons, Peterson, Slaughter, Roche, & Doyle, 2005), understanding mathematical concepts (e.g., Anderson, Anderson, & Shapiro, 2005; Van den Heuvel-Panhuizen & Elia, 2011), and problem solving (e.g., Gosen, 2012). Furthermore, most picture book research focuses on interactions between child and adult (e.g., parent, teacher); only a few studies focus on interactions between children during picture book activities. Thus, this study also provides an original contribution to picture book research in early childhood settings.

METHOD

Design

Three mainstream primary schools in The Netherlands with preschool classes took part in the study. Dutch preschool is generally organized as separate classes within primary schools, where children aged 4 to 6 years learn through play activities and other suitable experiences prior to the commencement of formal education.

The study employed a pretest/posttest group design and cross-case (group) comparison following the "diverse-cases" approach described. Six storytelling groups (A to F) were formed (two per school), each consisting of four to five children. Within schools, groups were made as comparable as possible[1] on age, sex, preintervention estimators of general cognitive functioning and causal reasoning, home languages, parental level of education, home reading environment, and the extent of liking books and magazines (see Participants and Measurement sections). Descriptive statistics are in Table 1.

All groups participated in a 2-week storytelling intervention. Pre- to postintervention change on three causal reasoning tasks (see Measurement section) was aggregated across all individuals in a group. Kruskal-Wallis tests calculated group mean ranks for the aggregate change on each

TABLE 1
Group Descriptive Statistics Preintervention

	School 1				*School 2*				*School 3*			
	Group A $n = 5$		*Group B* $n = 5$		*Group C* $n = 5$		*Group D* $n = 5$		*Group E* $n = 4$		*Group F* $n = 4$	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age (months)	64.6	7.1	62.6	6.5	63.0	4.3	65.4	5.1	65.8	4.7	63.8	3.3
IQ estimate	79.6	20.6	72.2	11.7	112.8	5.7	115.6	13.2	99.3	19.6	101.3	11.7
Working memory	5.2	3.3	7.0	3.5	8.4	1.8	6.8	1.1	3.8	2.5	6.3	1.9
Attention	16.4	1.7	12.4	14.2	19.6	0.9	19.2	1.8	17.0	4.7	19.8	0.5
Home reading environment	4.8	1.5	4.8	2.3	7.4	2.5	8.2	1.8	5.5	2.1	6.0	2.2
Liking for books & mags	2.8	0.4	2.6	0.5	2.2	0.8	3.0	0.0	2.8	0.5	2.5	0.6
Physical causality	1.2	1.6	1.8	1.8	1.4	1.1	2.0	1.4	0.8	1.0	1.3	1.5
Psychological causality	2.6	0.5	3.0	0.0	2.6	0.5	3.0	0.0	2.0	0.8	2.5	0.6
Situational causality	4.2	0.8	4.0	0.7	4.8	0.4	3.8	0.4	4.0	0.8	4.3	1.0

TABLE 2
Pretest-to-Posttest Change on Causal Reasoning Tasks

			Physical Causality		*Psychological Causality*		*Situational Causality*		
Group	*N*	*Mean Pretest- to Posttest Duration (days)*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Kruskal-Wallis Total Rank*
A	5	45.80	0.20	1.30	0.00	0.71	−0.20	1.30	37.0
B	5	41.00	0.60	1.14	−0.40	0.89	0.60	0.89	41.8
C	5	45.00	0.60	1.14	0.20	0.45	−0.40	0.89	39.1
D	5	44.20	1.20	0.45	0.00	0.00	0.20	0.45	45.6
E	4	48.00	1.75	1.50	0.75	0.96	0.25	0.50	54.4
F	4	43.25	1.25	1.26	0.25	0.50	0.00	0.82	45.8

causal reasoning task; a total rank order for each group was then calculated (Table 2). The group with the lowest total rank order (i.e., Group A; five children) and the group with the highest total rank order (i.e., Group E; four children) were denoted as being the least-improving and the most-improving groups, respectively. These groups were the subject of the cross-case comparison.

Participants

Participating schools received information packages for parents/caregivers of all children in their preschool classes, excluding children whom teachers knew to have behavioral and/or attentional deficits. The packages contained a letter about the purpose of the study, a request to participate, an informed consent form, and a questionnaire containing demographic items (e.g., child's sex and age, home languages, parental level of education). The questionnaire also requested information about the home reading environment and the child's liking for books and magazines. Home reading environment was operationalized as the extent to which different types of books and magazines (i.e., storybooks, first picture books, picture books for preschoolers, early readers, chapter books, information books, comic books, children's magazines, other children's books) were available in the home. Liking for books and magazines was indicated on a 3-point scale as *does not like, likes a bit*, or *likes a lot*.

Twenty-eight children who were comparable with other children at their school in terms of age, background variables, and pretest scores were selected to participate in the storytelling intervention. Of these, $n = 15$ (54%) were boys. Sample mean age was 64 months ($SD = 5$ m; range 54–72 m). Within each school, children were assigned to one of two storytelling groups.

Materials

Two picture books were used: the Dutch versions of *Cave Baby* (Donaldson & Gravett, 2010) and *Tom's Elephant* (Harvey & Klaassen, 1997) (see Appendix A). Books were selected on five criteria. First, the story and illustrations were judged in children's literature reviews to be of high quality, captivating, and attractive to young children and adults. Second, a clear storyline could be derived from the illustrations. Parts of the storyline and illustrations were amenable to different interpretations, however, which is considered to be a requirement of group tasks at primary school level (Howe & Mercer, 2010). Third, the sequence of illustrations depicted situations that could be explained by constructing a causal chain of events (i.e., a given situation could be understood from information depicted in earlier situations). Fourth, the stories were fictional but situated in meaningful contexts governed by natural laws. This precluded the use of books where magical rather than causal forces could be used to explain the chain of events. Fifth, the selected books were new to all participants (as verified by teachers), to ensure that earlier experiences did not affect the results.

Procedure

Groups were supervised by three research assistants who were final-year master's students in pedagogical sciences and fully trained in using the materials and protocols. Each group completed three sessions per week for 2 weeks in a quiet room at school. In all sessions, the research assistants encouraged the children to contribute to group storytelling without explicit control of turns. Less active children were regularly given additional encouragement. Children were also encouraged to listen to each other. Importantly, the research assistants did not intervene with respect to the content of what was said. A detailed protocol covered what instructions should be given, how to display the picture book illustrations, how long to wait before turning a page, how to support participation, and so on, and fidelity of the intervention was verified from digital recordings of the storytelling sessions.

In the first two sessions (Week 1), the children were asked to generate a storyline together while looking at the illustrations of *Cave Baby*. No child was able to read the text of the book. The third session included a hand puppet as a prop. Following O'Neill et al. (2004), the children were told that the puppet loved stories and had not heard this one before. They then were asked to tell the story while looking at the illustrations. The presence of a "naïve" listener can be an extra stimulus for children to articulate their reasoning more than they would to a knowledgeable listener. This procedure was repeated in Week 2 using *Tom's Elephant*.

Importantly, children were allowed as much time as they wished to tell the stories, so that each group ultimately spent a different amount of time on the intervention. The first two sessions lasted 25 minutes on average (range 13–29), while the third session lasted 22 minutes on average (range 7–34). Storytelling sessions were digitally recorded; six recordings (17%) were lost due to technical failures.

Measurement

Pretests and Posttests

Children were individually tested on general cognitive functioning and causal reasoning (i.e., physical, psychological, and situational causality). Pretests were performed an average of 23 days (range 11–34) before the intervention and posttests an average of 11 days (range 3–33) after. Mean number of days between pretests and posttests for each group is indicated in Table 2. Children were tested by a research assistant in a quiet room. Test sessions lasted 49 minutes on average (range 30–65).

General cognitive functioning was measured using well-known, validated tests, administered following their standard protocols. To estimate intellectual abilities, the Vocabulary and Block Design subtests of the Dutch version of the Wechsler Preschool and Primary Scale of Intelligence-Third Edition (WPPSI-III-NL; Hendriksen & Hurks, 2009) were administered. Combining these subtests gives a reliable estimate of children's intelligence (Sattler & Dumont, 2004). The Vocabulary subtest comprises 25 items to be named or defined (max raw score 45). The Block Design subtest requires 20 visually presented patterns to be reproduced (max raw score 40). Raw scores for the two subtests were transformed to standard scores and a total IQ estimator calculated following the standard procedure. Working memory was assessed with a computerized visual-spatial grid task in which sequences of dots have to be remembered and reproduced (Klingberg, Forssberg, & Westerberg, 2002; max score 16). Attention was measured as accuracy on the "Cats" task of the Developmental Neuropsychological Assessment (NEPSY) visual attention subtest, which requires the subject to search for a target embedded in a random array of different pictures within a set time (Korkman, Kirk, & Kemp, 1998; max raw score 20).

Physical causality was measured with an instrument derived from Das Gupta and Bryant (1989). Pairs of picture sequences were presented, each showing an object in an initial state followed by that object in an end state. The initial state was noncanonical in one way (e.g., a wet cup or a broken cup), whereas the end state was noncanonical in two ways (e.g., a wet, broken cup). The child had to select one of two agents (e.g., faucet or hammer) that could cause the end state from the initial state. Both agents are needed to cause the end state from the canonical state of the object; however, only one is needed to cause the end state from an initial state in which one transformation has already taken place. To be correct on both sequences in a pair, children needed to make a causal inference about the change between the initial and end state of the depicted object. In the example, the hammer is the agent for the sequence "wet cup - wet, broken cup" and the faucet is the agent for the sequence "broken cup - wet, broken cup." In total, eight sequences were presented (i.e., four pairs). The two sequences of a pair were never presented consecutively. The number of pairs for which both sequences were correct was summed to give a total score (max 4).

Psychological causality was measured with an instrument developed by the research team. Children were presented with a picture of a psychological state and had to indicate which of three other pictures showed a causal antecedent. For example, an angry rabbit was shown. Possible causal antecedents showed the rabbit raking a pile of leaves together in the presence of another character who was acting in three different ways: (1) lying calmly, (2) jumping onto the pile of leaves, (3) moving out of the scene. The instrument comprised three such items.

Situational causality was measured with a similar 5-item instrument developed by the research team. Children were presented with a picture of a situation and had to indicate which of three other pictures showed a causal antecedent. For example, a character was shown covered in cake mix and throwing back his arms in surprise with an upturned mixing bowl on a table in front of him. Possible causal antecedents were: (1) a ball heading straight for the bowl, (2) a stationary ball under the table, (3) a ball knocking the table over and the contents of the bowl to the ground.

Group Discourse

Discourse in the groups showing the lowest and the highest improvement in causal reasoning postintervention (i.e., Groups A and E, respectively) was investigated through qualitative content analysis, involving systematic observation, coding, and analysis of children's verbal utterances in terms of their narrative and interactional functions.

Seven mutually exclusive narrative categories were defined: four noncausal categories (i.e., labeling, observation, elaboration, other) and three categories of causal reasoning (i.e., causal inference, prediction, explanation). Similar categories were used in previous research (e.g., Hickling & Wellman, 2001; Paris & Paris, 2003; Walsh, 2003; see Introduction); we added the category "elaboration" to designate statements related to prior knowledge and a category "other" to capture nonspecific, non-narrative, or incomprehensible statements. Definitions and examples of each category are given in Appendix B.1.

Seven mutually exclusive interactional categories were derived from previous research on children's talk in primary school classrooms described in the Introduction (Howe & Mercer, 2010). Three categories were used to capture types of interaction found in exploratory talk (i.e., extension, clarification, challenge). Two categories identified disputational and cumulative interactions, respectively. We added a category "assertion" to designate self-contained claims about story elements and a category "other" for nonspecific or incomprehensible statements. Definitions and examples of each category are given in Appendix B.2.

All video recordings for both groups were transcribed and coded. One Group A recording was missing. Transcriptions excluded utterances unrelated to the task. Utterances were segmented into speech units, defined as a single meaningful unit of information serving one or more functions of interest to the study. Each speech unit was assigned a single narrative category and a single interactional category; thus, each speech unit had exactly two functional codes. This system is illustrated in Figure 1 (translated from the original Dutch). Coding reliability was confirmed for 25% of the transcribed corpus by a colleague who was trained in using the coding protocols and who was blind to the study hypotheses and the group differences. Percentage agreement for both types of codes was 80%. Inter-rater reliability was further tested using Krippendorff's α coefficient for nominal data; coefficients of .72 for narrative codes and .76 for interactional codes indicate acceptable reliability.

Cross-Case Analysis

Discourse in the groups showing the lowest and the highest improvement in causal reasoning post intervention (i.e., Groups A and E, respectively) was analyzed. Analyses were performed in IBM SPSS Statistics 20 ($\alpha = .05$). For both groups, discourse duration was calculated as the total amount of time spent on the intervention across all storytelling sessions. Discourse participation of individual group members was calculated as a proportion of the total number of speech units per group. Spearman's rank-order correlation was calculated to establish the relationship between discourse participation and improvement in causal reasoning. Discourse development over time was analyzed for both groups by calculating the proportion of the total number of speech units coded in each category per storytelling session and comparing these proportions across sessions using the chi-squared test and Fisher's exact tests. Comparison of discourse between groups was done by aggregating the number of occurrences of each coding category across sessions per group and obtaining patterns of narrative and interactional talk from the proportions represented by each category. These patterns were compared using the chi-squared test and Fisher's exact tests.

Child	*Speech Unit*	*Nar Cat*	*Int Cat*
3, 4	Oooooooo! *[together]*	other	other
1	Oooooooo!	other	cumulative
4	He is more dangerous than with sharp…	inference	assertion
3	No	other	disputational
2	See the…these, I think he will eat these up	prediction	extension
4	Ohhoho!	other	other
1	No, because he hasn't got a big…he's got a small mouth so he can't eat these	explanation	challenge
2	But the hairs he can	elaboration	challenge
4	He does like this *[gestures]*, so he can't	explanation	challenge
1	First it'll be his trunk and then here and then here and then here	prediction	extension
4	Why not the hairs and only the meat and then he can eat the meat?	elaboration	challenge
1	And he he…	other	other
4	Because tigers eat meat	elaboration	clarification
1	And he he…it looks like he's got grass on his bottom	observation	assertion
4	But the tiger is looking like this *[gestures]* the tiger looks	observation	assertion
1	And he wants to ahhhhh *[gestures]*	inference	extension
4	No, like this *[gestures]*	elaboration	challenge

Note. Nar Cat = narrative category; Int Cat = interactional category.

FIGURE 1 Example transcription coding.

RESULTS

Discourse Duration and Participation

The groups spent notably different amounts of time on the intervention: Group A (i.e., lowest improvement) spent a total of 1 hour, 23 minutes ($M = 14$ min/session), whereas Group E (i.e., highest improvement) spent 2 hours, 38 minutes ($M = 26$ min/session).

TABLE 3
Groups A and E: Causal Reasoning Scores and Discourse Participation

	Total Causal Reasoning Score			
	Pretest	*Posttest*	*Change*	*Discourse Participation (%)*
Group A:				
Child 1	8	4	−4	1.7
Child 2	11	10	−1	25.7
Child 3	6	9	3	16.6
Child 4	9	8	−1	29.6
Child 5	6	9	3	26.2
Average	8	8	0	
Group E:				
Child 1	4	7	3	30.1
Child 2	8	12	4	18.9
Child 3	8	10	2	37.3
Child 4	7	9	2	13.7
Average	6.75	9.5	2.75	

Note. Maximum causal reasoning score = 12.

Table 3 presents scores on the causal reasoning tasks and discourse participation percentages for individual group members. There was no significant relationship between discourse participation and improvement in causal reasoning ($\rho = .18$, $p = .64$).

Narrative Talk

Group A produced mainly labeling (31.7%), inferences (24.2%), and "other" statements (21.8%). Narrative category proportions changed over time, $\chi^2(24) = 71.62$, $p < .001$; specifically, labeling decreased after the first session ($p < .05$). Group E exhibited talk that was more diverse and balanced, with substantial proportions of labeling (17.8%), observations (15.0%), inferences (17.5%), and "other" statements (26.6%). Over time, $\chi^2(30) = 80.89$, $p < .001$, inferences increased by the end of the intervention and predictions peaked in Sessions 2 and 3 (both $p < .05$).

Between groups, patterns were significantly different, $\chi^2(6) = 98.78$, $p < .001$, with a higher proportion of labeling and inferences in Group A and a higher proportion of observations, explanations, and "other" statements in Group E (all $p < .05$). Group differences were not significant for elaborations and predictions. Results summarized across all sessions are presented in Figure 2 and session statistics are available in the Supplementary Materials.

Excerpts from the transcriptions are illustrative of these differences. First, much of Group A discourse went no further than identifying perceptual features of the stimulus (i.e., labeling). By comparison, Group E discourse contained more detailed descriptions or interpretations of perceptual features (i.e., observations). The following example from *Cave Baby* concerns stimuli representing a sabre-toothed tiger and a hyena. Group A statements concerning these stimuli were typically: "I see a tiger," "A tiger and an elephant," "This is a tiger with sharp teeth," "A zebra" (i.e., the hyena), "That's not a zebra, that's a wolf," "That's a long tiger." Group E, on the other

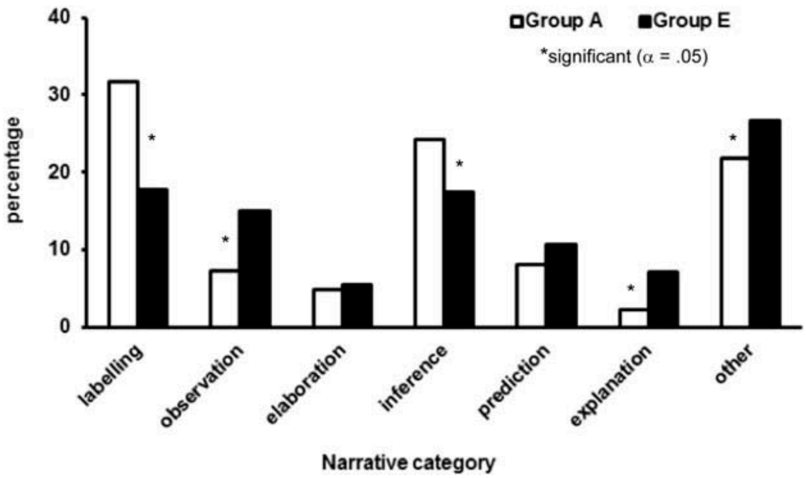

FIGURE 2 Narrative category percentage occurrence across sessions per group.

hand, made several observations focusing on the tiger's teeth: "There's a great big tiger with a sharp tooth," "He is big and the tooth is big but this is a bit smaller and his body is bigger than the tooth," "Do you know how big the teeth are? Longer than . . . ," "But this is longer than this and big, but this is even longer." Then, when they encountered the picture of the hyena and took it to represent the same tiger, the children continued to focus on its teeth: "But his big teeth are a bit broken now." This then led them to offer an explanation of why the teeth were smaller in the picture of the hyena, during which they invoked the causal mechanism that chewing grass breaks teeth. Thus, producing more detailed descriptions and interpretations of perceptual features may stimulate causal reasoning by drawing attention to situations or events that invite or need explanation.

A second difference concerns the use of inferences (i.e., connections between situations or events inferred from the stimulus) and explanations (i.e., references to causal mechanisms). In *Tom's Elephant*, the stimulus is a picture of the elephant getting free of shackles after being chained up. Group A discourse consisted of several simple inferences:

Child 1: "The elephant is free."

Child 2: "He broke everything."

Child 2: "He sucked it all up with his trunk."

Child 3: "Yes, and by stamping."

In Group E, discourse about the same stimulus went as follows:

Child 1: "Maybe he wants a strong wind, maybe he stamped really hard."

Child 2: "Look here, do you know why this opened? Look, he stamps really hard and then he goes there to that side and then he also goes again."

Child 3: "I think that he sees water there and that he. . . ."

Child 3: "And that he, no, that his legs are really strong so the cuffs around his leg break."

Child 4: "Look, the elephant has strong claws and then he goes like boom boom and breaks the locks and that iron."

These excerpts show that, while Group A's causal reasoning was limited to drawing simple inferences about the stimuli, Group E engaged in reasoning about the causal mechanisms that could underlie the depicted situation.

Interactional Talk

Almost one third of all statements in both groups was in the form of self-contained assertions. Both groups also produced a substantial proportion of extensions (Group A: 16.7%; Group E: 19.7%). Group A was further characterized by cumulative (15.5%) and disputational (12.1%) interactions, whereas Group E produced a sizeable proportion of clarifications (13.9%). In Group A, interactional category proportions did not change over time, $\chi^2(24) = 28.63$, $p = .23$. In Group E, $\chi^2(30) = 69.49$, $p < .001$, assertions increased after the first session, while there were fewer clarifications in the last session than in the first (both $p < .05$).

Between groups, patterns were significantly different, $\chi^2(6) = 58.16$, $p < .001$. There was a higher proportion of cumulative and disputational talk in Group A, while Group E produced more clarifications (all $p < .05$). Group differences were not significant for assertions, extensions, challenges, or "other" interactions. Results summarized across all sessions are presented in Figure 3 and session statistics are available in the Supplementary Materials.

To illustrate: in *Cave Baby*, the stimulus was a picture of the baby and the mammoths playing amid big splashes of color. Group A discourse was as follows:

Child 1: "They're setting off fireworks."

Child 2: "No."

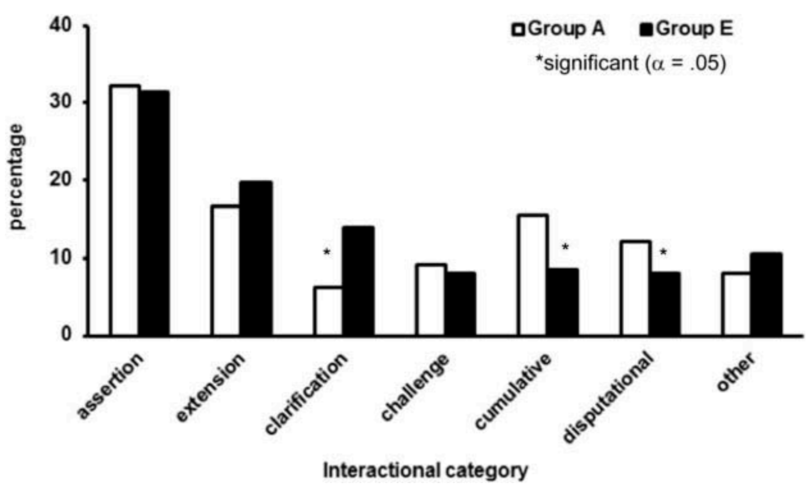

FIGURE 3 Interactional category percentage occurrence across sessions per group.

Child 1: "Yes!

Child 3: "No, they are painting."

Child 1: "No, fireworks!"

Child 4: "Painting!"

Child 1: "Fireworks!"

Child 4: "Painting!"

Child 1: "Fireworks, fireworks, fireworks!"

Child 2: "Yes, they are painting."

Child 3: "Yes."

Child 1: "No!"

Child 3: "Yes!"

Child 1: "They are painting and setting off fireworks."

Child 1: "They're setting off painted fireworks."

Child 3: "Yes, that could be."

Child 1: "I'm right!"

Clearly, little or no causal reasoning is stimulated by these interactions, which contain little more than confirmations and repetitions (i.e., cumulative talk), simple rebuttals, and reassertions (i.e., disputational talk). By comparison, an excerpt illustrating the clarifications distinguishing Group E involves a discussion about whether the mammoth is using his trunk to point with in one scene of *Cave Baby*:

Child 1: "He wants to go to the baby otherwise he'll run away."

Child 2: "Look, look, this is pointing there."

Child 1: "Yes, because he's got hands but then he'll fall on his behind."

Child 2: "No."

Child 1: "Yes, he's got hands but they're a bit flat here [gestures] and we've got hands like this [gestures]."

Child 2: "I don't know what she means."

Child 3: "Really?"

Child 3: "Look, he's pointing with his trunk."

Child 3: "Look, look, then he can't really do like this . . . so."

Child 4: "I think it's pointing to him."

This excerpt shows Group E children explicitly justifying their statements. Starting from the notion that the trunk could be pointing, Child 1 tries to justify (anatomically) why the mammoth would point with his trunk rather than with his feet (here, hands), and is stimulated to become more explicit by Child 2 not accepting her arguments. As seen here, clarifications may involve causal reasoning being made visible and may result in agreement being reached.

DISCUSSION

This study examines discourse elicited when preschoolers participate in undirected, shared picture book storytelling within a peer-group setting. As far as we can determine, this combination of learning components has not previously been investigated in early childhood education research, and the study therefore provides an original contribution to several lines of research described in the Introduction. The issue to be investigated is how preschoolers talk with each other under these circumstances and whether differences in the types of discourse elicited by the storytelling task reflect different outcomes on causal reasoning tasks. On the one hand, the learning arrangement could stimulate children to share their knowledge, experiences, and perspectives in forming coherent causally sequenced plots, which could help to improve causal reasoning skills. On the other hand, less effective types of talk could occur and this could be related to lower outcomes on causal reasoning tasks.

Twenty-eight children from three preschools were placed in six groups and asked to generate narratives together from picture book stimuli in the absence of directive adult control of the discourse. Discourse then was compared in the two groups that showed the lowest and the highest improvement on causal reasoning tasks post intervention. The main differences between these groups are presented in Figure 4.

Regarding narrative statements, relatively more labeling and simple inferences were produced by the least-improving group, whereas relatively more causal explanations were produced by the most-improving group, often in relation to detailed interpretations of perceptual features. There were no group differences in causal predictions. This suggests that engaging in explanations

Narrative statements:	Least-improving group produced more labeling and simple inferences
	Most-improving group produced more detailed observations and causal explanations
Interactional statements:	Least-improving group produced more disputational and cumulative exchanges
	Most-improving group offered or requested information justifying or clarifying previous statements
Discourse duration:	Most-improving group spent twice as long on the intervention

FIGURE 4 Group discourse differences.

invoking causal mechanisms could play a key role in improving causal reasoning, lending support to previous findings regarding the importance of children's explanations in learning and thinking. Causal explanations—particularly of surprising events or inconsistent outcomes—are thought to be especially powerful in influencing children's causal reasoning and causal learning (Legare et al., 2010; Wellman & Liu, 2007), and young children make use of causal-explanatory theories to make sense of real-life happenings (Hickling & Wellman, 2001). In addition, the most-improving group showed increased use of causal inferences and predications across sessions, while the least-improving group showed no growth in types of causal reasoning displayed during the intervention. Taken together, this strongly suggests that outcomes on causal reasoning tasks are affected by the extent to which causal reasoning is elicited when children construct narratives together.

This could be mediated by the types of peer interaction that arise during the storytelling task. Intriguingly, the groups displayed patterns of interaction that show considerable similarities to patterns found with older children; moreover, the relationship between these patterns and learning outcomes also appears similar to what is found with older children (Howe & Mercer, 2010; Rojas-Drummond et al., 2003; Wegerif et al., 1999). Children in the most-improving group engaged critically but constructively with each other's ideas and explicitly offered justifications of their statements for joint consideration. In contrast, the least-improving group was distinguished by exchanges typifying what is known as disputational and cumulative talk, both of which are associated with lower learning outcomes (Howe & Mercer, 2010). Taken together, these findings suggest that group discourse beneficial to causal reasoning in preschoolers may be characterized by the kinds of interactions known as exploratory talk, but also support the view that placing children in groups does not guarantee exchanges that are likely to enhance learning (Howe & Mercer, 2010).

The study design allowed differing amounts of time to be spent on the intervention, as determined by the children themselves. Notably, the most-improving group spent the most time on the intervention, while the least-improving group spent the least. This strongly suggests that duration of shared storytelling experiences could be influential. Specifically, more productive types of narrative thinking or peer interaction could emerge only in later stages of discourse.

Finally, it is worth noting that discourse participation was not balanced; discourse was dominated by two or three group members, whereas others contributed much less. This concurs with previous findings on unstructured discussions (Howe & Mercer, 2010). As a lack of active contribution does not preclude children from benefiting from the knowledge and perspectives made visible by others (e.g., vicarious learning, observational learning), the relationship between active participation and learning in this study is unclear, particularly as there was no significant relationship between discourse participation and improvement in causal reasoning.

Individual Differences

As noted at the start of this article, individual differences in children's causal knowledge and experience stem largely from variability in home context. Variations in narrative abilities are also associated with socio-cultural-economic background and home context (Lever & Sénéchal, 2011; Peterson et al., 1999; Schick & Melzi, 2010). Furthermore, the effectiveness of interaction processes depends on social histories and past experiences as well as individual characteristics that affect the quality of children's discussion with peers (Howe & McWilliam, 2001; Howe & Mercer, 2010). Thus, individual differences between children could affect how they participate in shared storytelling and the discourse patterns shown. For example, children's prior knowledge of and experience with books and storytelling affects how they make sense of picture book stimuli (Crawford & Hade, 2000), while the extent to which their social experiences outside school stimulate reasoned argumentation affects how they negotiate and justify their reasoning in interactions with peers (Ehrlich, 2011; Howe & McWilliam, 2001; Howe & Mercer, 2010).

In this case, it is possible that members of the two groups possessed different narrative and interactional skill levels at study commencement that affected their ability to respond to the learning arrangement and consequently the kind of discourse that arose. If members of the least-improving group did not possess sufficient skill to engage constructively with each other in the storytelling task, this could explain why they were unable to capitalize on their slight pre-intervention advantage in causal reasoning skill (see Table 3). Clearly, it is important to investigate the influence of different narrative and interactional skill levels in future studies.

RESEARCH IMPLICATIONS

As stated, this may be the first study investigating how undirected shared picture book storytelling in a peer-group setting could stimulate causal reasoning in preschoolers. Although its small-scale nature does not permit definite conclusions to be drawn about the effects of the learning arrangement, it does allow detailed, in-depth examination of the discourse that takes place. This, in turn, helps generate hypotheses that should be tested in future research on a larger scale and using a broader range of causal reasoning tasks.

First, it appears that preschoolers can interact in ways similar to exploratory talk taught to older children and that this benefits their learning. Therefore, it would be of interest to investigate the extent to which preschoolers can explicitly learn and use ground rules for exploratory talk and the effects on learning. Second, it appears that discourse involving causal explanations and detailed interpretations of perceptual features is beneficial to causal reasoning. A question to be resolved, therefore, is how to stimulate children to move past superficial reactions to deeper treatment of the material. Third, more time spent on storytelling appears to be related to better outcomes, possibly because discourse becomes more productive after some time has elapsed. Research focusing on the temporal dimension of discourse progression with preschoolers should investigate this issue (Mercer, 2008).

If these hypotheses are confirmed, it would be important to investigate how children can be engaged in the intervention for longer periods of time. The traveling lens model of attention used in literacy and television-viewing research (e.g., Linebarger, Moses, Garrity Liebeskind, & McMenamin, 2013) posits that children's interest in and attention to stimuli depends on stimulus features (e.g., novelty, complexity, recognizability) in relation to individual dispositions. This gives pointers for investigating how many sessions—as a function of picture book characteristics and individual or group dispositions—are optimal for arousing and sustaining children's interest and attention and for manipulating the complexity and novelty of stimuli. For example, picture books could be used that present multiple storylines simultaneously, so that children have to move backward and forward through the book to seek connections between story elements (Wolfenbarger & Sipe, 2007).

The study did not examine the influence of individual differences on the results. However, as noted, differences between children could affect how they participate in shared storytelling and the discourse patterns shown. It is important to untangle these influences in future studies.

Finally, future research could examine the effects of increasing the adult's role in the discourse—for example, through the kinds of strategies used in research with older children. These include the use of open questions to explore children's ideas, allowing children plenty of time to express what they are thinking, encouraging them to clarify and justify their views, and modeling these kinds of interactions so that children can learn by example (Mercer & Howe, 2012).

EDUCATIONAL IMPLICATIONS

This study contributes to a line of research that aims to provide early childhood educators with accessible and low-threshold methods and materials that stimulate young children's thinking skills (e.g., Bodrova & Leong, 2007; Diamond, Barnett, Thomas, & Munroe, 2007). This could help to improve young children's school readiness, which is an issue of major importance to educators, the public, and politicians (e.g., National School Readiness Indicators Initiative and Head Start program in the United States, Head Start in Australia, and Sure Start program in the United Kingdom).

In this regard, it is important to note that fully authentic materials, familiar and accessible to early childhood educators and young children, were used here. Picture books were selected on the basis of criteria that nonresearchers could easily learn to apply and were not shortened or adapted, as is often the case in education research. Moreover, the small-group setting increases the ecological validity of the approach, as schools rarely have sufficient resources to carry out such activities on a one-to-one basis.

The role of the adult in this study was to create conditions for active, open, and equitable group discourse, rather than to direct or control it—an approach shown to facilitate learning in peer groups (Mercer & Howe, 2012). If future research confirms that these conditions are effective for preschoolers, this would have pedagogical implications. First, early childhood educators need to become aware of the value and possibility of promoting exploratory talk with young children and of creating a climate and conditions that support this kind of talk. This study indicates that such talk during a shared storytelling task may promote important reasoning skills that are not typically stimulated by other activities in early education settings. Regarding causal reasoning specifically, conditions include providing surprising or ambiguous learning materials and giving children ample time to move past more superficial reactions (e.g., labeling of perceptual stimuli) to deeper treatment of the material. In this, educators may need to guide children toward potentially relevant cues, for example, by encouraging them to observe and explain story events (Girard, Girolametto, Weitzman, & Greenberg, 2013).

Furthermore, educators need to learn how to employ strategies for facilitating effective discourse and avoiding less effective (e.g., disputational and cumulative) types of discourse. It may be difficult for educators with more directive styles to resist the temptation to control the content of children's responses in their habitual ways, for example requiring children to produce "correct" answers (Howe & Mercer, 2010). In short, educators need to learn how to manage discourse that needs guidance in form but freedom in content.

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SUPPLEMENTAL MATERIAL

Supplemental material for this article can be accessed at www.tandfonline.com/ujrc.

NOTE

1. Given the number of groups, group size, and number of matching variables, significance testing of group differences on these variables is not meaningful.

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APPENDIX A: PICTURE BOOK MATERIALS

Cave Baby (Donaldson & Gravett, 2010) is situated in prehistoric times, where a baby lives with his parents in a cave. His mother paints animals on the walls of the cave. Cave Baby decides to join in by adding splashes of paint to the walls; this angers his parents, however. Come night, Cave Baby is kidnapped by a mammoth who takes him on a ride through a moonlit landscape populated by different animals to his own cave. There, Cave Baby happily paints and plays with the mammoths. Finally, the mammoth takes Cave Baby back home to bed. The book comprises 32 pages with color illustrations.

In *Tom's Elephant* (Harvey & Klaassen, 1997), a circus comes to Tom's town. Tom is awakened one night by a strange noise. An elephant has run away from the circus and is hiding in the garage. Tom and the elephant become friends and the elephant helps Tom to do his paper rounds and punishes the school bully by putting him up in a tree. Tom tries to hide the elephant but the police find him and lock him up in chains. A violent storm arises and the town is flooded. The elephant escapes and rescues people from the water. The townsfolk hail him as a hero and send him on a boat back home to Africa. The book comprises 25 pages with color illustrations.

APPENDIX B: EXAMPLE NARRATIVE AND INTERACTIONAL CATEGORIES

TABLE B.1
Narrative Categories

Category	*Definition*	*Examples*
Labeling	Naming or identifying perceived features of the stimulus without further information	"There is paint"; "The baby is waving"
Observation	Description or interpretation of perceptual features that goes beyond labeling	"He is big and the tooth is big but this is a bit smaller and his body is bigger than the tooth"
Elaboration	Information about the stimulus that represents prior knowledge	"Look, you can fold up these steps and then you can drive it [i.e., a caravan] with a car"; "Zebras don't have hair there"
Inference	Statement about a connection between actions, events, characters, or psychological variables that is inferred from the stimulus	"They want to kill the mouse"; "The baby's frightened of the elephant"
Prediction	Expression of an expected outcome of a depicted or inferred action or event	"The elephant's going to pull him out of there"; "The mother is going to think that the baby made those tracks"
Explanation	Reference to a causal mechanism to explain a depicted or inferred action, event, or psychological state	"Do you know why the window is open? Because the elephant stamps really hard and makes a wind that blows there"; "They're walking next to the father so that's why you can see them in the water"
Other	Nonspecific, non-narrative, or incomprehensible statement	"Wow!"; "I think the baby is cute"; "What do you mean?"; "Yes"

TABLE B.2
Interactional Categories

Category	*Definition*	*Examples*
Assertion	Self-contained claim about a story element	"That's a circus for sure"
Extension	Additional thought about or elaboration on a previous statement	Second part of the exchange: "He is looking behind him"/"He doesn't want to be seen and has to hide somewhere"
Clarification	Provides or requests information justifying or clarifying a previous statement	"It's a circus because there's a clown here"; "What do you mean?"
Challenge	Alternative interpretation of a previous statement accompanied by a justification of that interpretation	"No, it's a swimming pool [as opposed to a ditch] because there's a pool-ladder there"
Cumulative	Statement that builds positively but uncritically on an earlier statement, characterized by confirmation, repetition, or completion of an unfinished statement	"He is right"; second part of the exchange: "And then he has a fright so he lets go of his torch"/"Then he has a fright and drops his torch"; second part of the exchange: "That's a big. . ."/"Bath"
Disputational	Disagreement in the form of a simple rebuttal or reassertion without further justification or elaboration	"No it isn't"; "Yes it is"
Other	Nonspecific or incomprehensible statement	"Woh!"