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Gesture like a kitten and you won't forget your tale: Drama-based, embodied story time supports preschoolers' narrative skills

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ABSTRACT

Oral narrative comprehension is an important precursor to reading comprehension. Supporting preschool students in building strong oral narrative comprehension skills prepares them to be successful once they enter formal schooling. Gesture and body movement have been shown to support children's oral narrative comprehension and recall skills. This study examines whether drama-based instruction (DBI)—an organic, inherently gesture- and movement-based approach to teaching—during storytime fosters preschool children's narrative comprehension and recall. In this paper, we compare story retells by preschool students who participated in a DBI storybook reading ($n = 90$) with retells by preschool students who heard the same book during a business-as-usual (BAU) storytime ($n = 106$). Results show that using embodied behaviors (i.e., gesture, facial expression, body movement, vocal change) during story retelling was associated with recalling more story elements during a free retell task (when children are asked to retell the story without additional prompts), although not during a prompted retell task (when children retell the story by responding to questions). Students who participated in the DBI storytime used twice as many story-relevant embodied behaviors during retell tasks compared to their BAU peers. Additionally, embodied behavior significantly mediated the relation between treatment status and free retell scores. This study offers promising evidence as to the efficacy of using drama-based storytime in preschool classrooms to support listening comprehension and recall of oral narratives. Findings support a theory of embodied language learning and suggest potential benefits of drama to enhance literacy learning.

1. Introduction

Instructional approaches that encourage students to engage in gesture and body movement can be powerful tools for supporting learning. From calculating the answers to complex math problems to learning vocabulary in a foreign language, the benefits of gesture and body movement for the acquisition of new skills and knowledge have been have documented across disciplines (Cook & Goldin-Meadow, 2006; Marley & Carbonneau, 2015; Schmidt et al., 2019; Stam & Tellier, 2022). Gesture- and movement-based instruction have also been shown to be beneficial for children's comprehension and recall of oral narratives (Guilbert et al., 2021; Ionescu & Ilie, 2018). Oral narratives are, across cultures, cognitive and social tools used for organizing experiences, making sense of the world, relaying events, and building relationships (Lyle, 2000; Ochs & Capps, 2001). Understanding and producing oral narratives are thus critical for participating in society and for acquiring and sharing knowledge. For preschool age children, oral narrative skills are also key predictors of later literacy achievement, as they, along with the ability to decode text, are essential components of reading comprehension (August et al., 2009; Dickinson & Porche, 2011, Griffen et al., 2004). Reading comprehension, in turn, is a skill on which all subsequent academic success rests, as children move from learning to read in early elementary school to reading in order to learn in later grades (Dickinson & McCabe, 2001, Miller et al., 2006; Roth et al.,

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2002).

This study examined whether drama-based instruction (DBI) during storytime—an organic, inherently movement-based way to support embodied literacy learning—fosters preschool children's narrative comprehension and recall. DBI is an instructional approach that provides students with opportunities to learn curricular objectives through collaborative and imaginative physical engagement with narratives (Dawson & Lee, 2018). DBI has demonstrated numerous benefits for preschoolers, including dual language learners and those with disabilities, on language skills, motivation, engagement, creativity, critical thinking, and empathy toward others (Kilinc et al., 2017; Lee et al., 2015; Murray & Weltsek, 2018). Drama-based storytimes incorporate creative drama techniques, such as pantomime, into shared book reading to provide students with the opportunity to see and engage in story-relevant, first-person action (Deshmukh et al., 2019; Flack et al., 2018). During a DBI storytime, teachers and students step into the role of story characters, carrying out key story events, experiencing characters' emotions, and solving story problems (Kilinc et al., 2023). As they act out the story, they may engage in gestures (moving hands and arms to represent a concept, object, or action), full body movements, facial expressions, or vocal changes (see Appendix A for definitions and examples of each). We view all of these types of action as falling under the broader category of *embodied behavior*, defined here as the use of one's face, voice, head, shoulders, arms, hands, torso, legs, and feet in story-relevant action.

In this study, we sought to understand the effects of DBI storytime participation on students' narrative retell performance, as well as the role played by their embodied behavior during story retelling. We compared students who participated in DBI storytimes to a control group of students, examining: a) condition-related differences in students' retell task performance, b) condition-related differences in students' embodied behavior during their retells; and c) whether embodied behavior during retells explained condition-related differences in retell performance.

2. Theoretical framework: Embodied cognition

Our hypotheses that gesture and body movement will benefit preschoolers' comprehension and recall of narratives are rooted in theories of embodied cognition. As described by Glenberg (1997), a core notion of embodied cognition is that "the world is perceived in terms of its potential for interaction with an individual's body" (p. 4). An individual's perceptions, actions, and thoughts, along with the environment, thus all play roles in cognition (Barsalou, 2008; Foglia & Wilson, 2013; Lakoff, 2012; Wilson, 2002). In contrast to information processing theories of cognition—which posit that cognition consists of the manipulation of abstract, amodal, and arbitrary symbols (e.g., words and numbers) without the body and environment playing a role—theories of embodied cognition hold that not only do humans encounter the physical world with their senses, they recall, reflect on, and make predictions about the world with their senses as well. Thus, cognition consists of mental simulations that activate all relevant senses. For instance, studies using fMRIs have shown that when participants say words like "lick," "pick," or "jasmine," in addition to the brain's language centers, the motor cortex controlling the mouth, the motor cortex controlling the hand, and the olfactory cortex, are activated as well (Hauk et al., 2004). In embodied theories of cognition, language comprehension is thus akin to re-experiencing those initial, physical experiences through which language was learned (Adams et al., 2018; Glenberg & Gallese, 2012).

Accordingly, language researchers have found that gesture and body movement can help children learn language (Iverson & Goldin-Meadow, 2005; Porter, 2012; Schmidt et al., 2019). Gesture also supports oral language processes such as lexical retrieval. In one experiment, when 6- to 8-year-old children were prohibited from gesturing—by wearing mittens that fastened their hands to a table with Velcro—they found it more difficult to think of the names of pictures of uncommon objects, like a stethoscope or camel (Pine et al., 2007). If embodied cognitive theory predictions are correct, providing learners with opportunities to see and participate in enactments of story events during narrative encoding should result in greater memory for story events than providing only verbal and visual codes (i.e., reading the text; showing the book's pictures). Additionally, children who enact story events during retell should recall and recount more story events, as students recall stories using the same modalities through which they initially experienced them (e.g., Glenberg, 2011; but also as far back as Morris et al., 1977; Tulving & Thomas, 1973).

3. Gesture supports narrative comprehension and recall

Prior research provides additional support for our hypotheses, demonstrating the conditions in which gesture and body movement benefit narrative comprehension and recall (Bharadwaj et al., 2022; Dargue & Sweller, 2020a, 2020b; Kartalkanat & Goksun, 2020). Specifically, gesture has been found to to support children's narrative comprehension and recall in three ways: a) seeing others perform gestures when listening to a story; b) performing story-relevant gestures when listening to a story; and c) performing story-relevant gestures when recalling a previously-heard story. The following sections review the existing literature in these three areas.

3.1. Seeing gesture/movement at time of narrative encoding

Studies examining the effects of seeing and/or engaging in gesture at narrative encoding have found that, for young children, observing a storyteller make narrative-relevant gestures supports comprehension and recall. In one lab-based experiment (Dargue & Sweller, 2018), preschool students (ages 3-5) watched a video-recorded narrative with an instructor either telling a story while making narrative-relevant gestures, telling a story while making contradictory/irrelevant gestures, or telling a story without gesturing at all. Children who saw the video with story-related gestures scored higher on a free retell task (i.e., remembered more story elements) than children in the contradictory and non-gesture conditions. There were no condition-related differences between any of the three conditions on prompted recall (answering story questions). In another lab-based experiment, Guilbert and colleagues (2021) found that 4- and 5-year-old children who saw and heard a narrative accompanied by gestures recalled more story elements, in both free and prompted recall, than children who just heard the same story.

Kartalkanat and Goksun (2020) conducted a similar experiment with 4.5- to 6-year-olds, comparing a no-gesture condition to two gesture conditions: narrative accompanied by iconic gestures (gestures that visually represent physical properties of an object or action, like raising a hand up for "tall") and narrative accompanied by beat gestures (gestures that simply mark the rhythm of speech). They found that children who saw and heard narratives accompanied by iconic gestures scored better on free retells than those who experienced narratives with beat gestures or no gestures. There were no differences on prompted recall. Austin and Sweller (2017) and Macoun and Sweller (2016) found similar patterns. In their studies, children who saw iconic gestures (gestures representing object or actions) or deictic gestures (gestures that point to a location or path) had benefits for both free and prompted retell, while children who saw beat gestures had no advantage over participants who saw no gestures at all. It is worth noting that while most gesture studies are lab-based, these last three studies (Austin & Sweller, 2017; Kartalkanat & Goksun, 2020; Macoun & Sweller, 2016) all took place in schools. However participants were taken one at a time to a quiet room to both hear the narratives and perform the recall tasks.

3.2. Performing gesture/movement at time of narrative encoding

While the above studies examined effects of *seeing* gestures at narrative encoding, other studies provide support for *participating* in gesture at encoding. In Murachver and colleagues' (1996) study, 5- to 6-year-old children were taken to a separate room at their school where they either acted out a pirate narrative from the character's perspective using props, watched another child act it out with props, or passively listened. Children who acted out the story recalled twice as many narrative details in free recall as children who either listened to the story or who watched another child perform the actions. However, in a prompted recall task in which children were given props to act out the story, the children who watched a peer act out the story (a condition more similar to the lab-based studies above where students watched a gestured narrative) scored just as highly as children who acted out the story themselves when compared to children who just listened. Finally, in what may be the only classroom-based experiment of gesture and narrative (Ionescu & Ilie, 2018), preschool classes of 4-year-olds either listened to a picture book or were instructed to act out events in the book as they listened and to gesture in ways that matched the story (e.g., acting out "robber" by pretending to steal from another child). Students whose classes acted out the story were better able to both freely retell the story as well as correctly order pictures of key story events (a type of prompted retell tasks) when compared to students whose classes just listened to the story. Students in the acting condition also retained more key vocabulary.

Together, these studies point to benefits for young children of seeing or engaging in gesture—particularly iconic or deictic gestures, which reflect concrete objects or actions—during stories to support their narrative recall. These studies also provide evidence that gesture and movement are most consistently beneficial on free retell tasks, which are more cognitively demanding for preschool children than prompted recall. During free recall, children must remember story characters and events and structure those characters and events in a coherent way (e.g., introducing characters before relating events in which they feature; using devices like "next" and "so"; Silva et al., 2014). In prompted retell tasks, by contrast, the questions prompt which elements children must recall and they provide the structure for the recall (Silva et al., 2014). The mixed results as to the benefits of gesture for prompted recall underline the importance of asking students to engage in different types of tasks, in order to better understand how gesture supports comprehension skills. Murachver and colleagues' (1996) work additionally suggests that on difficult tasks, such as free retell, engaging in gesture is more beneficial than just observing it, a finding which is supported by theories of embodied learning.

3.3. *Performing gesture/movement at the time of narrative retell*

While most studies of gesture and narrative in young children focus on seeing or participating in gesture at the time of encoding (and its impact on story retell), a smaller number of studies focus on children's performance of gestures during the retell task. In a lab-based experiment, Laurent et al. (2020) showed 3- to 5-year-old children a wordless Pink Panther cartoon and then asked them to retell it, allowing some children to gesture and impeding other children from gesturing by asking them to hold a sign as they retold the story. Children who gestured told longer and more creative stories than children who were prevented from gesturing or children who were free to gesture but did not. Similarly, in Cameron and Xu's (2011) lab-based experiment with preschoolers, children who used gestures or body movement in retelling a narrative remembered significantly more details than children who did not gesture (either because they were prevented from gesturing or chose not to). Stevanoni and Salmon (2003), borrowing from Murachver and colleagues (1996), led children through an experiential narrative of a pirate event. Although this study took place in a school setting, children were pulled one by one from class to go to a room where they experienced the narrative one on one with a researcher. All participating children acted out the pirate narrative using props, then had their recall tested two weeks later in one of four conditions: (1) taught to gesture and instructed to use gestures; (2) taught to gesture and permitted to gesture spontaneously; (3) not taught to gesture and permitted to gesture spontaneously; or (4) prohibited from gesturing. Children who were taught to gesture/instructed to gesture during recall remembered twice as much information during a free retell as the children in the other three conditions. Taken together, these studies provide evidence for the beneficial effects of story-relevant gesture and body movement at the time of story retell.

Additionally, several studies examined gesture types at retell and found that taking a first-person perspective may enhance the effectiveness of using gestures while retelling a story. Parrill and colleagues (2018) trained kindergarten students to retell the plot of a wordless cartoon with gestures using three different approaches. In the first approach, students were taught to use character viewpoint gestures, or gestures in which the student becomes the character (e.g., pantomiming grabbing each rung while climbing a ladder). In the second condition, children were taught to make observer-viewpoint gestures, or gestures in which the student's hand represents the character's action, like sweeping a finger upward to show climbing a ladder. Both groups were compared with a third group of control students who simply watched the cartoon and retold the plot with no gesture instruction. Parrill and colleagues found that children who used character-viewpoint gestures had significantly higher narrative structure scores than those who used observer-viewpoint gestures or no gestures at all. Demir et al. (2015) examined the types of gestures children used spontaneously during a narrative production task at age 5 and asked whether those predicted later narrative skills. Children who produced more character viewpoint gestures had higher narrative scores at ages 6, 7, and 8. These studies suggest additional benefits of engaging in first person gesture and body movement during story retell.

The studies reviewed in the three sections above contribute to our work in three additional ways. First, these studies provide models for the measures we use in the present study: nearly all use free retell followed by prompted retell as outcome measures. In free retell, children are simply asked to retell the story and scored on the number of correct story elements they recount. In prompted retell, children are asked specific questions about the story or given prompts to scaffold their narrative (Silva et al., 2014). The two tasks, which put different cognitive demands on children, have often shown different results (Kendeou et al., 2007). Second, these studies, with few exceptions, are lab-based or create lab-like conditions in schools, contributing to our understanding of why DBI during shared book reading is expected to improve preschool student comprehension, but also paving the way for a study such as ours that provides comparable experimental evidence from in a naturalistic, classroom setting. Finally, in each of these studies, researchers examined benefits of gesture and movement at the time of encoding (i.e., as children heard a story for the first time) OR at the time of recall (i.e., when they are asked to retell the story or answer questions about the story), but rarely both.

4. The present study

This study extends current knowledge by replicating findings from lab-based studies, examining the role of gesture in narrative comprehension in a naturalistic setting. Additionally, we examine gesture during both encoding and recall concurrently to identify a pathway of influence from DBI storytime to narrative recall through embodiment during story retelling. Specifically, we examined free and prompted story retells of preschool students, half of whose classrooms were randomly assigned to DBI storybook reading intervention (i.e., embodied instruction at narrative encoding) and half of whose classrooms were randomly assigned to a control condition in which children heard the same books during a business-as-usual (BAU) storytime. We asked:

RQ1. Do preschool children instructed with DBI recall more story events on free and prompted retells relative to BAU children?

RQ2. Do preschool children taught with DBI during storytime use more embodied behaviors (i.e., gesture, facial expression, full body movement, vocal change) during story retells than BAU children?

RQ3. Is students' embodied behavior during their retells related to their retell scores?

RQ4. Does student embodied behavior during story retells mediate the relation between instructional condition and free and prompted retell scores?

Based on theories of embodied cognition, we hypothesized that children in the DBI group would recall more story events compared to their control group peers and engage in more embodied behaviors during their story retells because of the story-relevant embodied activity encouraged during storytime. We also hypothesized that the level of children's embodied behavior during testing would positively correlate with performance on free and prompted story retells. Finally, we predicted that embodied behavior during story retelling would mediate the relationship between instructional condition and free and prompted retell performance, as students in the DBI condition retold stories using the same modalities through which they initially experienced them. Studying these effects in an authentic classroom setting—in which drama-based literacy lessons provide an organic, inherently movement-based way to support embodied learning—gave us the opportunity to examine "in the wild" the benefits of embodied action during narrative encoding and retell.

5. Method

5.1. Study overview

This study is part of a larger, randomized control trial of a professional development (PD) program in which preschool teachers learn to incorporate DBI into their storytimes using trade picture books and drama techniques. The PD program, called Early Years Educators at Play (EYEPlay), was developed by Childsplay, a professional children's theater company in Tempe, Arizona, with input from university researchers from ArArizona State University (see Kilinc et al., 2016 for more information). The program aims to develop teachers' capacity for using drama to enhance young children's literacy and language development. During the year-long program, teachers attend six out-of-class PD sessions to learn various drama facilitation skills. The teachers then implement those skills in their own classrooms, through a classroom-embedded apprenticeship model, in which each classroom teacher is partnered for the duration of the school year with a professional teaching artist, an educator with expertise in both early education and theatre education. In the partnership, the classroom teacher is understood to be an expert on their students and in early childhood education, and the teaching artist is understood to be an expert in theatre education and DBI. The expectation is that, across the year, both partners grow to become equally expert in planning and delivering DBI storytimes to that particular class of students.

As part of EYEPlay's apprenticeship model, the teaching artist and classroom teacher engage in six cycles of "I do, you do, we do" teaching. In the first week of each cycle, the teaching artist teaches a DBI storytime to the students ("I do"), with the classroom teacher observing and providing comments and feedback. The following week, the teaching artist and classroom teacher co-plan and co-teach a DBI storytime ("We do"). Finally, the third week, the classroom teacher plans and teaches a DBI storytime on their own, as the teaching artist observes and provides feedback ("You do"). Across the year, through the six teaching cycles, children experience at least 18 DBI storytimes, with each DBI storytime allowing students to participate in a story by embodying characters.

As part of the larger study, students participated in pre- and post-measurements of language skill (syntactic and semantic) and emotion knowledge. Students were also assessed four times across the year on narrative retell ability on short, simple, researcher-constructed oral narratives. Finally, they were assessed twice during the spring on their narrative retell skills after hearing actual trade story books as part of DBI lessons; these are the measures we use in this article (see Measures below). The larger study also included classroom observations, recordings of DBI lessons and teachers' business-as-usual book readings, as well as several teacher-level measures to assess knowledge of child development, teaching self-efficacy, and use of drama in the classroom. Teachers also participated in focus groups at the end of each semester. Finally, parents completed surveys about their child and the home literacy environment.

5.2. Participants

The final sample of students for this study included 196 children (43% girls), aged 31.74 to 68.63 months ($M = 50.71$, $SD = 6.44$). The majority of students were Hispanic/Latino (69%). The rest were White (10%), Biracial (9%), Black (8%), Native American (4%), and Asian American (1%). Twenty eight percent of students were bilingual (English/Spanish), and 10% of students were identified as having special needs or disabilities. The students were recruited from 28 classrooms participating in the larger RCT. All classrooms were in Title I schools, indicating that at least 40% of enrolled students in the school were from low-income families.

At the start of the school year, half of the classrooms (and their teachers and students) were randomly assigned to participate in DBI ($N = 14$ classes) and the other half were randomly assigned to the BAU control group ($N = 14$ classes). In control classrooms, teachers received the same books and props but did not participate in the PD program. Up to eight students were randomly selected from each classroom for student-level assessments. In this study sample, 90 students (46%) were in intervention classrooms and 106 (54%) were from control classrooms.

5.3. Procedures

At two time points during the year-long RCT, intervention students and control students heard the same trade picture books, but in two different conditions. In control classrooms, classroom teachers read the books in a BAU storytime. They were provided with the books in advance so they could prepare but were asked not to read the books to students until the appointed day. They were otherwise provided with no special guidance or instruction; just told to read however they would normally read a book to their class. Recordings show teachers in the BAU readings engaging in shared book reading strategies that are typical to preschool classrooms, such as discussing the cover of the book, referencing the pictures and print, asking comprehension and prediction questions, and using vocal variety. While BAU teachers occasionally gestured, particularly using deictic gestures to refer to the book's pictures or iconic gestures to support vocabulary, they did not engage in drama-based strategies (i.e., becoming or directly students to become characters) and did not direct students to engage in gesture or movement (Schmidt et al., 2023). These behaviors align with findings in other studies of teacher behavior during shared book reading (Barnes et al., 2023).

In intervention classrooms, teaching artists delivered a DBI storytime using the same book. Given the autonomy teacher teams had in planning the co-led ("We do") and classroom-teacher-led ("You do") DBI lessons, in this study, we used the teaching-artist led lessons ("I do") to minimize variability within the DBI condition and to maximize treatment strength in this first analysis of DBI effects. In January (Time 1), the book that was used was *Lost and Found* (Jeffers, 2005), in which a boy finds a sad penguin on his doorstep. Thinking the penguin must be lonely because he is lost from his family, the boy attempts to return the penguin to the

South Pole before realizing that the penguin was simply sad because he wanted a friend. The story ends as the penguin and boy joyfully reunite. In February (Time 2), the lesson used *Kitten's First Full Moon* (Henkes, 2004), a book in which a kitten sees the full moon, thinks it is a bowl of milk, and engages in various attempts to reach it, before giving up and returning home to find milk waiting for her on the porch.

5.3.1. Drama-based storytimes

In DBI storytimes, the teaching artist and/or teacher begins with an "anticipatory set," eliciting background knowledge from students, asking them questions about the book cover, and introducing a key vocabulary word and social phrase (a phrase that students repeat several times throughout the storytime). Many of these practices are typical to preschool book readings (looking at the cover; eliciting background knowledge). The reading of the book itself in the DBI lessons also always begins like a typical book reading, with the teacher reading the text, showing students the pictures, pointing out specific elements in the pictures, and engaging in short dialogue with students. However, at an appointed place in the story, DBI book readings diverge sharply. The teacher closes the book and invites the students to become the main character.

For example, in a book used in this study, *Kitten's First Full Moon* (Henkes, 2004), the teacher invites students to become the kitten and leads the students in generating ideas for everything they need to be kittens. They pantomime donning imaginary ears, fur, whiskers, tails, and claws. Once they have fully become kittens, testing out their claws, moving their tails, and taking a few practice leaps, the teacher continues reading. As the teacher reads the text, they also coach students through pantomiming key actions and events in the book. In *Kitten*, for instance, the students are encouraged to act out seeing the moon, thinking it is a bowl of milk, and trying multiple ways to reach it. They are coached through climbing an imaginary tree, branch by branch, to try to get the "milk" in the sky. They act out leaping into a pond to try to taste the "milk" reflected there. They are also coached to show with their faces and bodies how they feel as they get higher and higher in the tree or sit in the cold wet pond. The teacher then labels the feelings they see children exhibiting (e.g., "Ooh, Amari looks so scared!" or "Jessie looks really cold and sad") as well as the embodied behaviors that point to those feelings (e.g.. "Amari is holding the branch super tight and his eyes are really really wide" or "Jessie's shoulders are hunched over, her lower lip is out, and she is shivering"). Eventually, the children experience the resolution of the book (i.e., coming home to find milk waiting on the porch), then become humans again. The lesson concludes with a group reflection about the story, in which students are given the opportunity to respond verbally as well as physically to reflection questions (e.g., "Show me how you felt when you came home to find that warm milk just waiting for you"). Lesson plans for both DBI lessons discussed in this article can be found in the online supplementary materials or at https://www.literacyatplay.org.

5.3.2. Retell tasks

For this study, after each storytime—whether a BAU reading or a DBI lesson—participating students in each classroom were asked to individually participate in a free and prompted retell task. This assessment—as with all the assessments in the larger study—was conducted by a student research assistant who had experience working with young children and who had undergone extensive training and practice in administering assessments with fidelity. All assessments were video or audio recorded, and these recordings also provide evidence as to adherence to assessment protocols. For the story retell task, students were assessed in a randomly assigned order at each time point to account for order effects. One at a time, the experimenter took each student to a quiet place in the classroom—necessary for audio recording and to preclude other students from chiming in—to gain the student's assent and conduct the assessment. The experimenter began with the free retell portion assessment, saying, "I missed the story you heard today! Could you tell it to me?" In the free retell portion, experimenters used generic prompts to engage the student including, "Tell me more", "Then what happened?", "What happened next?" or "Just tell the parts you remember." There was no time restriction for the retell. Once the experimenter suspected the student was finished with their free retell of the story, the experimenter confirmed by asking, "Are you finished?". If the student had finished, the experimenter asked six story questions as part of the prompted recall (See Appendix A for questions). This portion was completed regardless of whether the child produced a free retell. Experimenters did not give feedback on the accuracy of answers; all answers were praised and if students did not know an answer, the experimenter said, "That's ok" and moved onto the next question. Depending on the length of the student's responses, each assessment took approximately three to five minutes. Each assessment was video and audio recorded for coding as part of two measures.

5.4. Measures

5.4.1. Free and prompted recall

Our first outcome measure, which we call The Story Recall Measure (SRM), consists of free and prompted verbal retell tasks, scored by the presence of key story elements in each retell (e.g., characters, setting, problem). The questions we used in the prompted retell portion task (in Appendix A) are modeled on those asked in the Narrative Language Measure-Preschool (NLM:P), a validated story retell measure for preschoolers (Petersen & Spencer, 2016), but are written specifically to capture the plots of the trade picture books read to the class during DBI or BAU storytime.

We also modeled our scoring of the SRM after the NLM. The *Listening Retell* score captures children's free retell of the story and includes points for story elements (e.g., characters; 7 items, maximum score of 14), linguistic complexity (i.e., number of times student uses words like "then" or "because"; maximum score of 10), and children's ability to combine story elements into cohesive episodes (e.g., what the character felt and why they felt that way; 4 items, maximum score of 5). Story elements were scored using a 3-point scale (0 = *no credit*; 1 = *partial*, 2 = *full*). All items were summed to create a composite Listening Retell score (maximum score of 29). Internal consistency for this subscale was good (Time 1 $\alpha = .83$; Time 2 $\alpha = .74$). The *Story Questions* score evaluated students' prompted retell, or their ability to answer questions about the story. Responses were scored using the same 3-point scale as the Listening Retell. In order to generate results that are comparable with other studies of gesture and story recall, only verbal responses received credit. This approach to scoring was also necessary to analyze the relationship between gesture and verbal retell scores. Internal consistency for this subscale was good (Time 1 $\alpha = .89$; Time 2 $\alpha = .82$).

Twenty five percent of scored SRMs were randomly selected for double scoring. Intraclass correlations (ICCs) were calculated using a one-way random model, consistency type. Rater agreement for both Listening Retell (Time 1 ICC = .93; Time 2 ICC = 1.00) and Story Questions (Time 1 ICC = .96; Time 2 ICC = 1.00) were excellent (> .90; Koo & Li, 2016). The SRM also demonstrated good convergent validity, with SRM *Listening Retell* and *Story Questions* scores significantly correlated with NLM *Listening Retell* and *Story Questions* scores at Time 2, $r(110) = .30$, $p = .002$ and $r(107) = .68$, $p < .001$, respectively.

5.4.2. Embodied behavior

Our second measure, which we call the Embodiment Coding System (ECS), also reflects a typical approach to coding for participants' gestures and other embodied behavior in studies of gesture at retell. Drawing on a review of theoretical and empirical research on gesture (e.g., McNeill, 1992), we developed a code book for coding video recordings of the story recall task (see Appendix B for codebook with examples). Videos were coded for gesture, body movement, facial expression, and vocal change using Vosaic (www.vosaic.com), a web-based video coding software. *Gesture* was coded when students use their hands and arms to represent a concept, object, or action (e.g., pointing up to indicate the moon; cupping hands to show a bowl of milk). *Body movement* was defined as students' use of their whole body (beyond hands and arms) or part of their body (other than hands and arms) to act out character actions (e.g., leaping into the pond). *Facial expression* captured children using their faces to show character emotions or represent action (e.g., smiling for happy; closing eyes for sleeping). *Vocal changes* included changes in voice with a clear rhetorical purpose (e.g., mimicking a character; providing emphasis ["Really REALLY HUGE"]). Each behavior received a frequency score, and scores were summed to create a total embodiment score for each student.

Two researchers independently coded each video for embodiment and then discussed the differences and reached consensus during coding calibration meetings. Another researcher in the team served as the master coder and coded 20% of all videos in the dataset to check the accuracy and consistency of coding. The research team met regularly to discuss any questions throughout the coding process. Interrater reliability was good for both Time 1 (Cohen's $\kappa = .75$) and Time 2 ($\kappa = .74$; Altman, 1991).

5.5. Analysis

Means, standard deviations, skewness, kurtosis, and bivariate correlations were examined for all study variables using SPSS version 27. Independent samples *t*-tests were calculated to compare means of story retell scores and embodied behaviors between intervention and control group students. Attrition analysis was performed to examine systematic missingness in study variables based on student race/ethnicity, sex, disability status, treatment status, and age.

A path model was estimated in Mplus version 8.2 (Muthén & Muthén, 1998-2017), with student story retell scores regressed on frequency of embodied behavior at Time 2, controlling for story retell and embodied behavior, respectively, at Time 1. Embodiment was regressed on treatment status. Missing data were handled using full information maximum likelihood (FIML; Allison, 2003). Models were evaluated using multiple fit indices, including the chi-square statistic (χ^2), comparative fit index (CFI), and root mean square error of approximation (RMSEA). A nonsignificant chi-square statistic, CFI greater than .95, RMSEA less than .05, and SRMR less than .08 suggest good model fit (Hu & Bentler, 1999). Unstandardized and standardized parameter estimates were examined for magnitude and direction as well as significance by evaluating individual Wald tests. The mediated effect of treatment status to story retell scores through embodiment was tested using the MODEL INDIRECT command. Significance of the mediated effect was determined by examining confidence intervals based on bootstrap (BOOTSTRAP=1000) estimation, in which the indirect effect is significant if the confidence intervals do not include 0.

6. Results

6.1. Preliminary analyses

Table 1 contains descriptive statistics for all study variables. Data did not significantly differ in missingness based on demographic variables save for one. Black students were significantly more likely to have missing SRM data, $t(77) = -2.04$, $p = .045$, although it should be noted that only six students identified as Black in the current study sample.

Table 2 shows bivariate correlations for all study variables. Embodied behavior at Time 2 was significantly and positively correlated with Time 2 free retell ($r[112] = .23$, $p = .01$) but not Time 2 prompted retell ($r[112] = .15$, $p = .15$). Embodied behavior at Time 1 was unrelated to retell scores. Student age was significantly associated with free retell ($r[116] = .21$, $p = .02$) and prompted retell ($r[116] = .21$, $p = .02$) at Time 2 but not Time 1. Assessment order was also significantly related with free retell ($r[123] = -.26$, $p = .003$) and prompted retell ($r[123] = -.19$, $p = .03$) at Time 1, such that students assessed later scored lower on story retell, indicating some order-related memory decay. No correlations emerged between assessment order and story retell scores at Time 2.

Table 1
Descriptive statistics for all study variables (N = 156)

	n	Min	Max	Mean	*SD*	%
Bilingual Status						
English	141					71.9
Bilingual Spanish	55					28.1
Assessment Order T1						
1	37					30.1
2	36					29.3
3	30					24.4
4	19					15.4
5	1					.8
Student Age (in months) T1		37.06	88.64	56.68	7.48	
Free Retell T1	124	0	17	2.69	3.88	
Prompted Retell T1	124	0	12	3.32	2.90	
Embodied Behaviors (Frequency) T1	94	0	27	2.16	4.25	
Assessment Order T2						
1	40					33.3
2	34					28.3
3	25					20.8
4	21					17.5
Student Age (in months) T2	114	38.08	89.56	57.52	7.18	
Free Retell T2	122	0	20	5.27	5.88	
Prompted Retell T2	122	0	12	5.35	3.94	
Embodied Behaviors (Frequency) T2	112	0	30	4.59	6.44	

Note. T1 = Time 1; T2 = Time 2.

6.2. Primary analyses

6.2.1. RQ 1: Student story retell by treatment status

Results of independent samples t-tests did not yield significant differences in free or prompted retell scores between intervention and control students. See Table 3 for a summary of condition-related differences.

6.2.2. RQ 2: Embodied behavior during retell by treatment status

Intervention students used significantly more embodied behaviors at Time 2 ($M = 6.34$, $SD = 7.48$) compared to their control group peers ($M = 3.32$, $SD = 5.27$; $t[110] = -2.51$, $p = .01$, $d = 0.48$). See Table 3.

6.2.3. RQ 3: Associations between embodiment and story retell scores

At Time 1, embodied behavior during story retelling was associated with free ($r[94] = .24$, $p = .02$) but not prompted retell ($r[94] = .14$, $p = .17$). Similarly, embodied behavior at Time 2 was related to free ($r[113] = .24$, $p = .01$) but not prompted retell ($r[113] = .14$, $p = .15$). Embodied behavior was significantly correlated at Time 1 and 2 ($r[87] = .41$, $p < .001$), with more embodied behavior at Time 1 associated with more embodied behavior used during story retelling at Time 2. Free and prompted recall were significantly and positively correlated at Time 1 ($r[124] = .63$, $p < .001$) and Time 2 ($r[122] = .58$, $p < .001$).

6.2.4. RQ 4: The role of embodiment during retell in explaining the relation between treatment status and story retelling

A path model was estimated with story retell regressed on embodiment regressed on treatment status. The fit of the final model (see Fig. 1) was excellent, $\chi^2(N = 196;\ df = 19) = 18.45$, $p = .62$; CFI = 1.00; RMSEA = .00, 90% CI[.00, .06]; SRMR = .04. Student age and assessment order were entered as covariates in the model. Embodied behavior and story retell at Time 1 significantly predicted embodied behavior and story retell scores at Time 2, respectively. Treatment status was unrelated to free and prompted recall at Time 2. Treatment status did, however, significantly predict embodied behavior at Time 2 ($b = 3.35$, 95% CI[1.58, 5.39]), such that intervention students used on average

Table 2
Bivariate Correlations among Student Story Recall Measure (SRM) Assessment Scores and Embodied Behavior Observed during Story Recall (N = 112)

	1	2	3	4	5	6	7	8	9	10
1. Student age (months) T1	-									
2. Assessment order T1	-.02	-								
3. Free Retell T1	.17	-.26**	-							
4. Prompted Retell T1	.17	-.19*	.63**	-						
5. Embodied Behavior T1	-.04	-.27**	.24*	.14	-					
6. Student age (months) T2	.98**	.09	.19	.15	-.04	-				
7. Assessment order T2	-.04	-.26**	.07	.02	-.13	-.02	-			
8. Free Retell T2	.22*	-.22*	.55**	.54**	.03	.21*	-.07	-		
9. Prompted Retell T2	.17	-.12	.42**	.65**	.04	.21*	-.04	.58**	-	
10. Embodied Behavior T2	-.10	-.19	.17	.10	.41**	-.13	-.03	.23*	.14	-

Note. * $p < .05$. ** $p < .01$.

Table 3
Independent Samples t-Tests Comparing Intervention and Control Students on Embodiment and Story Recall

		Control		Intervention		Independent samples *t*-test			Cohen's *d*
		M	*SD*	*M*	*SD*	*t*	*df*	*p*-value	
Free Retell	T1	2.59	3.60	2.80	4.16	-0.31	122	.38	0.06
	T2	5.39	5.82	5.04	5.98	0.33	120	.37	0.06
Prompted Retell	T1	3.32	2.97	3.32	2.83	0.004	122	.50	0.001
	T2	5.10	4.03	5.68	3.84	-0.80	120	.21	0.15
Total Embodiment	T1	2.56	4.85	1.67	3.35	1.01	92	.16	0.21
	T2	3.41	5.23	6.38	7.61	-2.46	111	.01	0.40
Gesture	T1	1.40	2.91	1.12	2.34	0.52	92	.30	0.11
	T2	1.67	2.75	3.19	3.77	-2.49	111	.01	0.48
Facial Expression	T1	0.31	0.78	0.14	0.52	1.17	92	.12	0.24
	T2	0.53	1.17	0.77	1.37	-0.98	111	.16	0.21
Full Body Movement	T1	0.44	1.56	0.10	0.37	1.41	92	.08	0.29
	T2	0.52	1.37	0.77	1.55	-0.91	111	.18	0.01
Vocal Change	T1	0.19	0.53	0.21	0.68	-0.18	92	.43	0.12
	T2	0.64	1.57	1.11	1.71	-1.51	111	.07	0.12

Note. T1 = Time 1. T2 = Time 2.

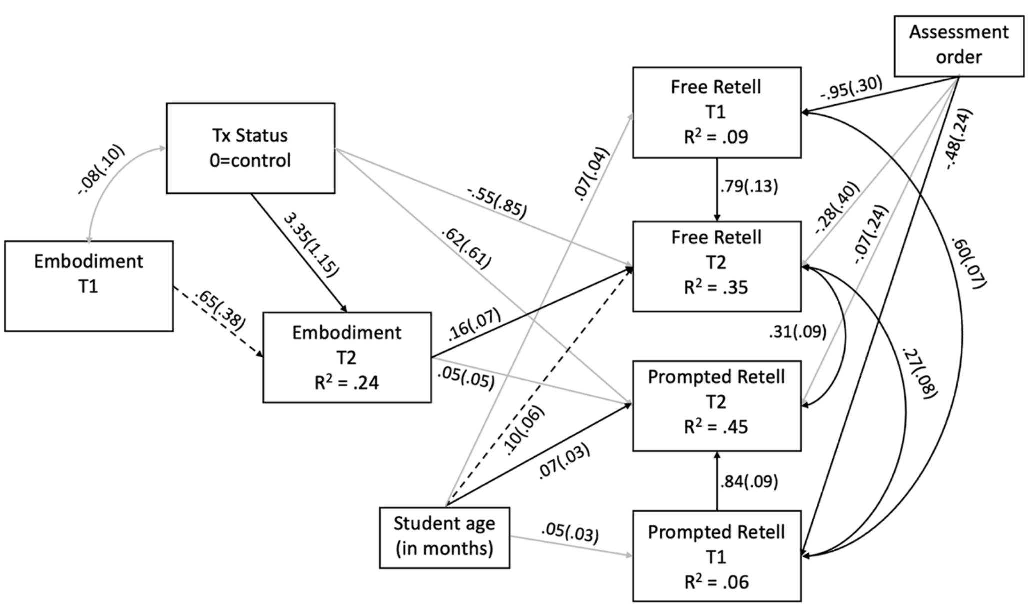

Fig. 1. Drama-Based Story Time Supports Free and Prompted Story Retell through Embodiment.
Note. Bolded paths are significant (i.e., CI did not include 0), and dashed paths are trending at $p < .10$. Unstandardized beta coefficients are reported for all direct paths with standard errors in the parentheses. Covariances are reported as standardized beta coefficients for interpretability.

three more embodied behaviors during their retells compared to their control group peers. Embodied behavior in turn was significantly associated with better free retell scores ($b = 0.16$, 95% CI[0.06, 0.31]), but was unrelated to prompted retell scores ($b = 0.05$, 95% CI[-0.02, 0.13]).

A significant direct path (i.e., from treatment status to story retell) is not necessary to test for indirect effects, as a mediating variable transmits the effect of an independent variable on a dependent variable (O'Rourke & MacKinnon, 2015), so we proceeded with the test for mediation. The standardized mediated effect (which can be interpreted like Cohen's *d*) from treatment status to free retell through embodiment was significant ($b = 0.05$, 95% CI[0.02, 0.10]), in which intervention students used more embodied behaviors during their story retell and in turn had better free retell scores compared to control students. In contrast, embodiment did not mediate the relation between treatment status and prompted retell ($b = 0.02$, 95% CI[-0.004, 0.07]). See Fig. 1.

7. Discussion

Narrative comprehension skills during preschool are an important predictor of later reading comprehension and overall school success. This study examined the effectiveness of incorporating drama into storytime to support preschool students' story comprehension and retelling. Specifically, we examined relations among preschool students' DBI storytime participation, their embodied behavior during a story retell task, and their story retell scores. Findings show that students who participated in DBI storytime produced more embodied behaviors during story retell compared to their control group peers and that embodied behavior during retelling in turn supported students' free recall of story elements.

7.1. RQ 1: Condition-related differences on story retell

In response to our first research question, we found no significant condition-related differences on free and prompted retell scores. In other words, children in the intervention group who participated in DBI lessons did not perform significantly better on either portion of the retell task at either time point. This finding was surprising, given the robust work showing that viewing or participating in gesture at encoding supports retell (e.g., Austin & Sweller, 2017; Kartalkanat & Goksun, 2020; Macoun & Sweller, 2016). One possible explanation is that many of the studies of gesture at encoding use videos for stimuli. In these studies, the gesture condition typically shows someone gesturing while telling an oral story, and the control condition just shows a person standing still telling the same story. This differs from our study in which the control condition included not only oral storytelling, but visual images from the book, teachers pointing to those images, teacher questions, and teachers talking about the story. These elements are known to be supportive for comprehension and learning (e.g., Hargrave & Sénéchal, 2000) and may have provided additional support, reducing differences in comprehension and recall outcomes between conditions.

Another explanation may be the less controlled nature of classroom research, in which students who are part of the same condition might have different experiences within that condition. This variability could stem from teacher behavior: Although we reduced this variability as much as possible by using "I do," or model, lessons for the DBI stories, teaching artists may still have varied in their own embodied action during the lessons, and these differences likely contribute to students' retell outcomes. In a recent study in this journal, for instance, Barnes and colleagues (2023) noted variation in preschool teachers' use of gestures during shared book reading and found a relationship between the quantity of meaning-focused teacher gestures and students' end-of-year vocabulary scores. Variability within DBI conditions in our study could also stem from student behavior: Two students in the same classroom may have attended to the teacher to different degrees, attended to peers to different degrees, or even performed embodied actions themselves to different degrees. A next step in our research is to observationally code both teacher and student behavior during storytime to test whether those might be possible, additional explanatory mechanisms.

7.2. RQ 2: Condition-related differences on embodiment

Our second finding, however, in response to RQ 2, was that intervention students did show significantly more embodied behaviors (twice as many at Time 2) during their story retells compared to control students. This is a relatively novel finding, as the majority of studies of gesture and narrative in young children either studied the relationship between gesture at narrative encoding and retell scores or the relationship between the gestures children produce during retell and their retell scores, but not whether seeing or participating in gesture at encoding results in producing more gestures at retell. In one exception, Stefanovi and Salmon (2003) found that children who were explicitly taught to gesture during encoding and then instructed to use gestures in their retells used significantly more gestures in their retells than children in other conditions (who saw gestures modeled during encoding but were not taught to gesture, who did not see gesture modeled, but were permitted to gesture, or who were prohibited from gesturing). These findings align with what we would predict based on theories of embodied cognition: that knowledge acquired through embodied experiences "lives" not just in the brain, but in the body, so drawing upon that knowledge means re-experiencing it in those same, embodied ways.

Our findings also expand the literature on embodied learning and narratives by moving beyond gesture to include other types of embodied actions. To date, the literature on embodiment and learning has primarily focused on gesture, possibly because gesture is easier to execute consistently in experiments or because gestures are easier to capture on video when someone is seated at a table (where most experimenters and students sit for retells) than full body movement. In this study, however, in order to capture the effects of an existing DBI intervention in which students were invited to use multiple types of embodiment, we needed to examine all of those types of embodied action in our retell task. It is therefore noteworthy that our findings for RQ 2—that condition predicted embodied behavior at retell—parallel those of studies in which gesture was the only type of embodiment under examination.

7.3. RQ 3: Associations among embodiment and story retell

Our third research question examined the relationship between students' embodied behavior during their retells and their retell scores. We found that students who exhibited more embodied behaviors during retelling at Time 2 indeed also recalled more story elements during Time 2 free retell. This finding, like the findings to RQ 2, is also consistent with theories of embodied cognition: recalling an embodied story experience means recalling more pieces of the narrative itself. This finding also aligns with prior research: others who have examined gesture during retell have found that children who gesture during story retell recall and recount more story events than children who do not gesture or who are prevented from gesturing (Cameron & Xu, 2011; Laurent et al.; 2020; Stefanovi & Salmon, 2003).

It may seem surprising that embodied behavior predicted free retell scores but not prompted retell scores. Yet, this is a pattern found in other studies (Dargue & Sweller, 2018; Kartalkanat & Goksun, 2020). One explanation may be that prompted recall is a less cognitively demanding task: in prompted retell, children are asked specific questions about the story or given prompts to scaffold their narrative, rather than having to recall and structure the narrative on their own (Silva et al., 2014). Perhaps in prompted retell, embodied learning simply does not make a difference. Indeed, there is evidence that gesture benefits learners primarily with cognitively challenging tasks (Kendeou et al., 2007). For instance, Guilbert and colleagues (2021) examined the benefits of gesture on free retells, comparing 4- and 5-year-old children with undergraduates. While gesture supported higher retell scores for the children, they found no benefit for adults, for whom recall of simple stories is less cognitively demanding. In Berenhaus and colleagues' (2015) work with slightly older children, they examined the effects of playset manipulation on narrative recall for 7- and 8-year-olds. They found that manipulating the toys benefitted poor comprehenders, but good comprehenders showed no condition-related differences. Additionally, in work with adults, McKern and colleagues (2021) examined whether gesture type, task difficulty, and participants' cognitive ability moderate the benefits of gesture in narrative comprehension. They found—similar to others—that typical, iconic gestures were more beneficial than atypical or no gestures for all participants, and they also found that participants with average or below average delayed non-verbal memory benefited most. Importantly, however, these patterns were significant only when the task was difficult (sound interference during the encoding task), not when it was simple. Lin (2021), too, found benefits for adolescents of seeing deictic and iconic gestures at encoding over seeing beat gestures or no gestures, but these differences were only significant in a complex narrative condition, not a simple one. In our work, we suspect that while free recall was a difficult enough task to make condition-related differences visible, prompted recall was less difficult for our participants, and the benefits of embodied learning were therefore less noticeable between groups on the prompted recall task.

7.4. RQ 4: Embodiment explains story retell

Finally, in response to RQ 4, we found that embodied behaviors during story retell explain condition-related differences in children's free retell scores, even where condition alone cannot provide an explanation. This finding—that student embodied behavior during story retells mediate the relation between instructional condition and free retell scores—is a novel one. It suggests that researchers examining the relationship between seeing gestures at encoding and students' retell scores may want to capture and count students' own gestures during retell. In one study that examined gesture at both encoding and retelling (Stefanovi & Salmon, 2003), although they did not test for mediation, the authors found that students who were taught and instructed to gesture produced more gestures during retelling and recalled twice as much information as children in any other condition. Importantly, they found no differences between children who saw gestures modeled, were permitted to gesture, or were prohibited from gesturing. This suggests that simply having gestures modeled is not as powerful as being instructed in gesturing and actively participating in gestures, and it points to a possible explanation for the lack of a direct path from DBI to story retell scores in our study. In our study, there was likely variability in students' participation during DBI storytime, with some students actively participating and participating a lot, others participating some, and still others simply observing teachers and peers. One of the challenges of doing classroom-based rather than lab-based research is that it is more difficult to monitor and control individual children's behavior in a group setting. Yet, given past findings showing that actively engaging in embodied learning is more effective for supporting difficult tasks like free retell than simply seeing others engage in embodied learning (Stefanovi & Salmon, 2003; Murachver et al., 1996), it would be worth coding for students' actual embodied behavior during DBI lessons—rather than just using treatment condition as the explanatory variable—to capture variability in student participation. Accounting for children's own embodied behavior would contribute to explaining the link between student embodied behavior at encoding, embodied behavior during story retelling, and retell performance.

8. Strengths and limitations

As with all studies, the present study has strengths and limitations to consider. There are several strengths to the present study. First, the study is a true experiment that began with random assignment to experimental and control conditions. This study characteristic improves our ability to make a causal claim regarding the effectiveness of DBI in promoting embodied behavior at retell and subsequent free retell performance. Second, our study's classroom-based results converge with similar findings from lab-based studies (e.g., Laurent et al., 2020; Stevanoni & Salmon, 2003), providing evidence that theories of embodied literacy learning may hold up in authentic educational contexts. Specifically, in this study, we: 1) used trade picture books—more similar to what teachers would read with students—rather than researcher-constructed narratives, and 2) implemented the intervention in actual preschools as part of everyday teaching and learning. Importantly, these were group settings, with all of the surprise contributions and distractions that peers can provide, and real classrooms, full of additional distractions: shelves full of toys; announcements over the loudspeaker; adults coming in and out; children with a range of behaviors being redirected by classroom aides, and so on. All of these things have the potential to reduce the effects of any type of intervention (although in this study, there may also have been benefits to seeing peers engaging in gesture and movement as well).

In terms of study limitations, the primary limitation is that we did not code for teaching artist or student embodied behavior during storytime. As we wrote in the discussion of RQ 1, it is possible that there was variability in teaching artist and/or student behavior in both DBI and BAU lessons that is not captured by the dichotomous treatment status variable and that could serve as an additional explanatory mechanism for retell outcomes. As a next step, we will code for these behaviors. Additionally, because we did not instruct BAU teachers in what to do or not to do during book readings, the design of the study does not allow us to make statements regarding DBI shared book reading in contrast to other specific approaches to share book reading (e.g., dialogic shared book reading [Flack et al., 2018]).

A limitation inherent in using trade picture books is that story plots vary in complexity. The plot of the Time 1 book (*Lost and Found*; Jeffers, 2005) was more complex than the plot of the Time 2 book (*Kitten's First Full Moon*; Henkes, 2004). In contrast to *Kitten*—with only one character and one problem, which is resolved after a few attempts—*Lost and Found* has two characters, a sad penguin and a boy who tries to help him. Additionally, the boy thinks that the problem is that the penguin is lost and needs to get home to the South Pole, but learns at the end that the penguin is actually sad because he is lonely and needs a friend. Additionally, using trade books can mean that some students may have prior experience with the book. Students may also vary in the amount of background knowledge they come with about the topic of the book. Future studies will account for plot complexity in study design (i.e., in the selection of books to use in the intervention) and will assess students' background knowledge in order to be able to account for it in analysis.

Finally, a limit to this study's ecological validity is that the DBI lessons in this study were delivered by teaching artists rather than classroom teachers. While students experienced an equal number of teaching-artist-led and teacher-led DBI lessons across the year, the lessons on which our current analyses were based were teaching-artist led.

9. Educational implications

Our study shows that opportunities to engage in gesture and body movement during storytimes in the preschool classroom result in students using more gesture and body movement during retells, and that this in turn, supports better free retells. The majority of research showing benefits of gesture for story recall are lab-based, not classroom based. Our results provide some evidence that trends shown in lab-based, one-on-one research may hold up in "in the wild," in classrooms in the context of DBI instruction. These results are promising, and they suggest a need for more classroom-based research in this area, particularly on teacher-led lessons.

Additionally, this study took place in classrooms serving low-income students, students with disabilities including language delay, and students from diverse racial, ethnic, cultural, and linguistic backgrounds. In the US, low-income children, children of color, and children with disabilities are more likely than their higher-income and White peers to be taught through direct instruction of basic skills (Early et al., 2010; Stipek, 2004). In early literacy, this can mean instruction in discrete components, such as letter knowledge and letter-sound relationships, in lieu of "richer and more stimulating experiences" (Early et al., 2010, p. 177). Yet, oral storytelling can be a critical entry point to literacy for children from diverse backgrounds, connecting to the funds of knowledge that Black students and Latino students in particular bring to school (e.g., Gardner-Neblett & Iruka, 2015; Kinnally, 2019). Additionally, gesture and physical movement may be most beneficial to non-verbal students or students for whom it is challenging to sit quietly and listen for extended periods of time . In our work, teachers have anecdotally, yet consistently, reported that students who remain disengaged during traditional storytimes—particularly, non-verbal students and students with behavior challenges—regularly participate in drama-based storytimes through physical modalities. Our findings—that arts-based, playful, embodied learning through drama can support crucial early literacy skills—provide experimental evidence for including DBI and opportunities for embodied participation in storytimes in *all* classrooms, including in Title 1 schools serving diverse populations of students, with and without disabilities.

10. Future directions

One future direction for our work is to specifically examine effects of DBI for non-verbal students, students with language impairments, and students with other disabilities, who may experience difficulty in language-intensive learning situations such as storytime. While such students have always been included in classrooms receiving DBI as part of our research, our measures (e.g., oral retell) have not been able to capture all students' learning, and students with impairments have not been centered in our work. A new study beginning at the time of writing (September 2023), "EYEPlay ADAPT: All Different Abilities Participate and Thrive", seeks to develop observational measures to capture that learning and to use outcomes to adapt DBI instruction to better meet the needs of all learners.

Another future direction is to quantify teacher gestures during storytime to examine correlations between teacher behavior at encoding and student behavior at both encoding and retell. Similarly, a third future direction is to measure children's embodied behavior during storytime. Measuring embodied behavior during learning, in addition to during retell, will allow the direct examination of relations among embodied behaviors at encoding and retell, rather than just comparing embodied behavior at retell by condition. Additionally, the specific picture books used during the story may be associated with the efficacy of DBI. Future investigation should attempt to generalize the observed effects by varying the picture books and capturing variables, such as story complexity and familiarity to students. Future work should also examine benefits of drama for specific sub-groups of students: students with disabilities, emergent bilingual students, students with behavioral challenges, and students from various cultural backgrounds.

Finally, past studies of embodied learning that have tracked student enjoyment and engagement indicate that learners preferred embodied learning. Schmidt et al. (2019), for example, found that children learning French vocabulary both by doing random physical activity or by acting out the actual word (the embodied condition) all reported more enjoyment in learning than children passively learning French vocabulary. As Ionescu and Ilie (2018) put it, "children in the experimental group might have liked the task more and thus retained more words because they were also grounded in positive emotions" (p. 11). Future studies could track participation, engagement, and enjoyment—along with embodied behavior—as potential mediators between DBI and story retell outcomes.

11. Conclusion

This study provides classroom-based, experimental support for the ideas that: 1) preschool students who participate in a drama-based storytime use more embodiment during story retells compared to their control group peers, and 2) embodiment positively aids story comprehension as measured by a story retell task. In times of heightened focus on literacy achievement, these findings may be used to advocate for inclusion of drama-based instruction in early childhood literacy learning.

CRedit authorship contribution statement

Katie A. Bernstein: Securing Funding, Carrying out Intervention, Collecting Data, Conceptualizing Paper, Literature Review, Coding, Writing, Revising. **Lauren van Huisstede:** Securing Funding, Carrying out Intervention, Collecting Data, Conceptualizing Paper, Analysis, Writing, Revising. **Scott C. Marley:** Securing Funding, Analysis, Writing, Revising. **Yuchan (Blanche) Gao:** Collecting Data, Conceptualizing Paper, Literature Review, Coding. **Melissa Pierce-Rivera:** Collecting Data, Conceptualizing Paper, Literature Review, Coding. **Evan Ippolito:** Collecting Data, Conceptualizing Paper, Literature Review, Coding. **M. Adelaida Restrepo:** Securing Funding, Writing, Revising. **Jenny Millinger:** Securing Funding, Carrying Out Intervention, Collecting Data. **Kathryn Brantley:** Carrying Out Intervention, Collecting Data. **Jen Gantwerker:** Carrying Out Intervention, Collecting Data.

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Data availability

The authors do not have permission to share data.

Supplementary materials

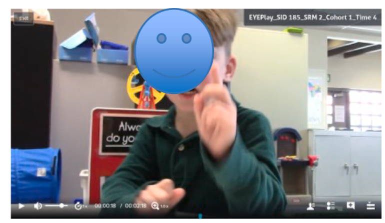
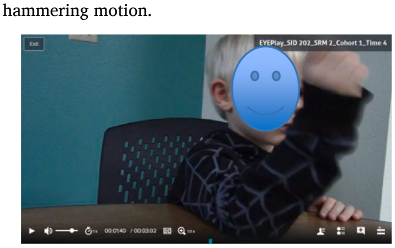
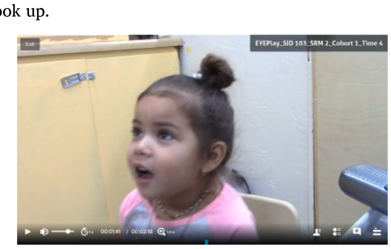
Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ecresq.2023.10.004.

Appendix A. Story questions

1 Who was this story about? (Can rephrase to: "Who was in this story?")
2 What did the kitten want?
3 But what was the problem?
4 How was the kitten feeling?
5 What did the kitten try to do to get the milk?
6 What happened when she did that?
7 How did the story end?

Appendix B. Embodied behavior codebook and examples

Note: We have parental permission to publish these images. However, we have covered or partially covered children's faces when they are not necessary to understand the code.

Code	Subcode	Description	Example
Gesture		Students' use of **hands and arms** to represent a concept, object, or action	
	Iconic gesture	Use hand movements to depict the physical properties of an object, action, or event	1) "he got claws" 2) Child brings his hands to his face and curls in his fingers to make the shape of claws. 
	Beat gesture	Formless quick hand movement(s) matching rhythm of speech	1) "But!" 2) Child raised finger when he said "but!". 
	Point/Deictic gesture	Use a whole hand or index finger to point to an object or a location	1) "down" 2) child points down at the table with his finger. 
	Metaphoric gesture	Use gesture to present an image of an abstract concept	1) "let's keep trying"! 2) fist in hammering motion. 
Facial Expression		Use face to show emotions and/or expressions	1) "up" 2) eyes look up. 

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Code	Subcode	Description	Example
Full Body Movement		Students use part or whole body (*other than or in addition to hands and arms*) to act out the story (e.g., character actions)	1) "He's running like this" 2) Child rocks in his seat back and forth while making galloping motions with his hands and body. 
Vocal Change		Change in voice for rhetorical effect (e.g., emotion, character voice, story emphasis)	1) "she SAW something" 2) child uses a higher pitch on "saw"

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