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Bethany M. Williams March 15, 2023

The role of embedded questions and caregiver-child extratextual talk during book reading for children's integration of science facts

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Abstract

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Integrating separate but related facts to self-derive new information is vital in building a semantic knowledge base. This research asks how young children learn from science books by evaluating the relation between embedded questions in children's books, integration in extratextual talk during caregiver-child STEM book reading, and child integration of paired science facts. By connecting the literatures of shared book reading and integration, this research sheds light on how children derive new knowledge from shared book reading. We observed as caregiver read a book containing six integratable fact pairs to their 5- to 7-year-old children. One book condition contained embedded questions, or questions included in the text of the book on the content being presented, while another did not. Extratextual talk, or any conversation between parties during shared book reading outside of the text of the book, was recorded throughout shared book reading. The children were then tested on their ability to remember the integrated facts. The findings revealed that Quality of Integration in Extratextual Talk is significantly higher when the book contains embedded questions than when it does not. They also revealed that Quality of Integration was significantly positively correlated with integration testing performance, so that higher Quality of Integration in shared book reading predicted better integration testing performance. There was no significant relationship between embedded questions and integration performance. These findings connect the literatures of integration and shared book reading and hold educational significance for science learning in young children.

Keywords: Shared book reading, embedded questions, extratextual talk, integration, science learning, young children

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Introduction

With an increased focus on science learning and education in recent years, investigating the methods through which young children learn science information is critical. One major form of science learning in children is integration, the combination of separately presented but substantively related facts which allows self-derivation of new knowledge. Because information is presented in separate episodes over time, it must be integrated to accumulate knowledge. Thus, integration is a vital part of building a knowledge base, including science knowledge (Bauer, 2021). In particular, it is important to investigate integration in the context of book reading, a major form of pre-formal education for young children. What types of books and methods of book reading are most effective for children's science learning? Past research found that caregiver's extratextual talk while reading (talk beyond the text of the book) relates to young children's learning of science facts (Miller-Goldwater et al, 2023). However, there is limited understanding of how books and caregiver-child book reading supports knowledge integration early in development. In the current study, we evaluate whether content-related embedded questions in science books and caregiver-child extratextual talk during shared book reading relate to children's integration of science facts. In doing so, this work will provide insight into whether and how book reading is a source of supporting science knowledge integration early in childhood.

Integration

Integration is the combination of information learned across separate episodes. The new, combined representation permits self-derivation of new information not contained in either episode. For example, an individual might learn "otters communicate by squealing" on one day, and that "the animal that communicates by squealing lives in groups called rafts" the next. These

individual facts are referred to as “stem facts.” To self-derive that “otters live in groups called rafts,” the individual must have integrated the two, separately taught, stem facts together. Integration is crucial for building a semantic knowledge base because information is often presented in separate episodes and thus must be integrated to have a coherent representation (Bauer, 2021). Research has shown that integration takes place for both general knowledge and science-specific information (Bauer et al, 2020b). Knowledge derived from integration is not temporary. Such knowledge is retained for at least one-week (Bauer et al, 2020b; Varga & Bauer, 2017), even amongst children as young as 4 years of age (Varga et al, 2016). Integration can take place in the classroom, and performance is related to math and reading outcomes (Esposito & Bauer, 2017) and longitudinal academic success (Varga et al, 2019) in elementary school children. Verbal comprehension also accounts for variation in integration performance (Esposito & Bauer, 2018; Varga et al, 2019).

There are both age-related changes and individual variability in integration and self-derivation (Bauer & San Souci, 2010; Esposito & Bauer, 2017; Bauer et al, 2020a; Bauer & Larkina, 2017; Miller-Goldwater et al, 2021; Wilson & Bauer, 2021). Adults perform better on integration tasks than children (Miller-Goldwater et al, 2021; Wilson & Bauer, 2021). Bauer and San Souci (2010) found that amongst children, 4-year-old children tend to only recognize integrated facts when asked forced-choice questions, whereas 6-year-olds can provide their own integrated statements when asked open-ended questions. Studies also have demonstrated individual differences, ranging from near zero to near perfect, in integration performance for both young adults and children (Miller-Goldwater et al, 2021; Varga & Bauer, 2017).

In 2017, Bauer and Varga proposed the ERISS model to explain the processes underlying self-derivation of new knowledge through integration. The model is made of five steps:

encoding, encoding and reactivation, integration of knowledge into memory, selection upon demand, and *self-derivation of new knowledg*e. *Encoding* entails the initial learning of a stem fact, in our example "otters communicate by squealing." The next step, *encoding and reactivation*, involves the encoding of a new but related stem fact, like "the animal that communicates by squealing lives in groups called rafts," which also reactivates the first stem fact. Using indirect tests of reactivation, Miller-Goldwater et al (2021) found that both adults and 7- to 9-year-old children reactivate knowledge to integrate, and in adults, where integration performance is better, there is stronger evidence of reactivation. *Integration of knowledge into memory* entails integrating the separate yet related facts and incorporating both facts into an individual's knowledge base on otters. Evidence shows that integration improves with additional exposure to stem facts (Bauer & San Souci, 2010). *Upon demand*, like the question "what is the name of the group that otters live in?", an individual then *selects* the relevant information from their knowledge base. As children get older, they get better at identifying which information is relevant for integration (Bauer & Larkina, 2017). Finally, according to the ERISS model, an individual uses this selected information to *self-derive new knowledge*, in this case the statement "otters live in groups called rafts" (Bauer & Varga, 2017). Additionally, integration is not necessarily automatic: 7- to 9-year-old children rely on cues to prompt integration, whereas adults are less cue dependent (Bauer et al, 2020a).

Integration is an important skill that develops during childhood. It is supported by verbal comprehension, stem fact repetition, reactivation, and selection of relevant information (Esposito & Bauer, 2018; Varga et al, 2019; Bauer & Varga, 2017; Miller-Goldwater et al, 2021; Bauer & San Souci, 2010). As elaborated in the next section, many of these processes involved in

integration are present in caregiver-child book reading, a common form of teaching with young children.

Shared Book Reading

Book reading is a common form of instruction in preschools (Dickinson, 2001; Hindman & Morrison, 2011) and homes (Bus et al, 1995). The impact of shared book reading is well demonstrated in the literature, with correlations between book reading and language skills (Beals et al, 1994; Bus et al, 1995; Saracho & Spodek, 2010b; Sénéchal et al, 1996; Sénéchal et al, 1998).

Recently, there has been an emphasis on increasing the use of informational books, or nonfiction books, as teaching tools because of their predominate focus on clear presentation of information (Harris, 2008; Hoffman et al, 2015) and potential to enhance literacy skills (Wixson, 2011). Through informational books, readers can learn about a variety of scientific topics including nutrition (Gripshover & Markman, 2013), balance (Larsen et al, 2020), and life sciences (Mantzicopoulos & Patrick, 2010). Informational books read to young children focus overwhelmingly on topics of animals and life sciences (Pentimonti et al, 2010; Yopp & Yopp, 2012). As noted next, methods and aspects of shared informational book reading have the potential to support integration performance.

Extratextual talk is an aspect of shared book reading that includes conversation between parties during book reading, outside the text of the book. As young as 4 years old, children draw on knowledge of other texts and personal experiences to reflect during book reading (Torr, 2007). In extratextual talk, parents and children can ask questions about book content or vocabulary, discuss print and book conventions, evaluate book content, and make connections to

the child's life (Blewitt et al, 2009; Boland et al, 2003; Miller-Goldwater et al, 2023; Van Kleeck et al, 1997).

Higher levels of extratextual involvement in reading are related to print knowledge (Gettinger & Stoiber, 2014; Mol et al, 2009), vocabulary learning (Blewitt & Langan, 2016; Blewitt et al, 2009; Mol et al, 2008; Zucker et al, 2013), oral language skills (Mol et al, 2009; Whitehurst et al, 1988), and literacy skills (Zevenbergen & Whitehurst, 2003) in young children. Additionally, teachers exhibit more extratextual talk (Price et al, 2012), as well as longer utterances, greater diversity of vocabulary, and higher levels of cognitive demand (Price et al, 2009), while reading informational books than while reading storybooks.

A second device often present in shared book reading is embedded questions. Within a book, embedded questions are questions included in the text of the book on the content being presented. Research has demonstrated that reading books with more embedded questions is related to higher reading skills, including cognitive capacity (Britton et al, 1978), literal and inferential language ability (van Kleeck, 2008; van Kleeck et al, 2006;), and vocabulary acquisition (Ard & Beverly, 2004). The presence of embedded questions is also related to content learning from books, including learning from prose (Hamaker, 1986; Callender & McDaniel, 2007) and science learning from informational texts (Heisey & Kucan, 2010; Smith et al, 2010).

Embedded questions and extratextual talk are also related to one another. In 2020, Troseth et al. tested the impact of embedded questions on extratextual talk by observing caregivers and children ages 2 to 5 read an experimental e-book that either contained or omitted embedded questions. The researchers revealed that embedded questions increased extratextual talk for both parents and children, with parent talk including three times more utterances and

words in the embedded questions condition. By the end of the embedded questions condition, parents even began asking unprompted questions to their children. This suggests that embedded questions can help to increase extratextual talk.

Miller-Goldwater et al. explored the impact of extratextual talk on the efficacy of embedded questions (2023). In this study, caregivers read books high and low in embedded questions with their children and were tested on recall of facts immediately after. This study found that children learn more from books with embedded questions when more extratextual talk is present. So, not only do embedded questions increase extratextual talk, but extratextual talk plays a vital role in embedded questions' impact on learning. These two studies on the relations between embedded questions and extratextual talk suggest that they could work together to support child learning, as in integration of information in shared book reading.

Integration and Shared Book Reading

There is abundant research on the topics of both integration and shared book reading. However, no studies to date have evaluated the relations between shared book reading and integration. Specifically, few studies have evaluated the relations between two important aspects of shared book reading and their impact on integration: extratextual talk and embedded questions. Both variables have the potential to increase integration performance. Multiple factors contribute to how individuals might increase integration performance through extratextual talk during book reading. When parents and children speak during book reading, the talk often centers around the content of the book. In cases of integratable book content, extratextual talk often includes a review of stem facts. Because integration relies on the reactivation of stem facts (Miller-Goldwater et al, 2021) and integration performance improves with additional exposure to stem facts (Bauer & San Souci, 2010), additional extratextual talk might serve to increase

integration performance. Additionally, the presence of extratextual talk provides the opportunity for dyads to identify relevant information for integration, which can also improve integration performance (Bauer & Larkina, 2017). Extratextual talk might include integration of the stem facts before testing, allowing children to complete parts of the ERISS model with a caregiver.

Like extratextual talk, the presence of embedded questions is also a potential factor related to increased integration performance. Embedded questions often increase exposure to stem facts, and additional exposure to stem facts increases integration performance (Bauer & San Souci, 2010; Miller-Goldwater et al, 2021). In children, where integration tends to be cue dependent (Bauer et al, 2020a; Wilson & Bauer, 2021), the presence of embedded questions might also serve as a cue or prompt to integrate separate information across a book.

Present Research

The current research addressed the gaps in the literature by evaluating how the presence of embedded questions in children's science books and the qualities of caregiver-child extratextual talk during shared book reading impact 5- to-7-year-old children's integration of science knowledge. This research examined 5- to 7-year-olds because it is at that age when there are developmental changes in integration performance (Bauer & San Souci, 2010). We presented caregiver-child dyads with an informational book in which the protagonist learns facts about animals across seven days, with six opportunities to integrate stem facts. Half of the participants were randomly assigned to an embedded questions condition and half to a no embedded questions condition. In the embedded questions condition, the informational book included 12 questions on the stem facts, whereas the no embedded questions condition included the same content with no questions. After reading the book, children were presented with open-ended and forced-choice questions to assess integration performance.

We hypothesized a positive relation between embedded questions, extratextual talk, and integration performance, which is depicted in Figure 1. Our research questions, and therefore hypotheses, center around the relations between these three variables, which are henceforth represented by A, B, and C. Hypothesis A is that embedded questions will increase integration performance. Hypothesis B is that embedded questions will lead to increased integration in extratextual talk during shared book reading. Hypothesis C is that more integration in extratextual talk will be associated with higher performance on integration testing. Overall, we suggest a model whereby embedded questions increase integration in extratextual talk, which increases integration performance. If the evidence supports this model, we will conduct a mediation analysis.

Research on the relation between integration and aspects of shared book reading is vital to understanding young children's building of semantic knowledge because shared book reading is a key form of early education. Studies on book reading, and specifically extratextual talk, often center around their impact on language and reading ability but ignore how children learn the content of informational books, which is especially valuable in explorations of science learning in young children. This research helped to illuminate the relations between shared book reading and knowledge building in young children. It specifically addressed embedded questions and extratextual talk, key aspects of shared book reading, and their impact on integration performance.

Method

Participants

The sample included 83 children and their caregivers. The child sample ranged in age from 5.46 to 6.97 years (*M*age = 6.11, *SD* =0.43) and included 48 females and 35 males. Of the 76 caregivers who reported their demographics, their ages ranged from 31.69 to 48.13 years (*M*age = 39.19, *SD* = 3.69), and there were 75 females and 1 male. Caregiver-child dyads were recruited through a pool of families interested in research participation through the Emory University Psychology Department's Child Study Center. All testing was done online. An additional eight participants were tested but excluded prior to coding and data analysis due to the following factors: child wanted to stop (3), child read book on her/his own (thus affording no opportunity to observe caregiver behavior) (2), sibling interference (1), internet issues (1), and child unable to understand (1). One participant from the embedded questions condition had only their book reading data excluded due to a missing video from the session. Based on caregiver self-report, the child sample was 1.20% Native Hawaiian or Pacific Islander, 15.66% Black or African American, 13.25% Asian, 65.06% White or Caucasian, 1.20% Middle Eastern or Arab, 3.61% mixed race, and 10.84% unreported. 6.02% of children identified as Hispanic or Latinx. Based on self-report, the caregiver sample was 1.20% Native Hawaiian or Pacific Islander, 10.84% Black or African American, 12.05% Asian, 59.04% White or Caucasian, 1.20% Middle Eastern or Arab, and 9.64% unreported. 2.41% of caregivers identified as Latinx. 96.10% of children had at least one caregiver with a 4-year college degree or higher, and 77.92% of children had at least one caregiver with a post-graduate level of education. Caregivers gave informed consent for themselves and their child to participate using RedCap. Children verbally assented. Participants were compensated for their participation with a goody bag containing stickers and pencils for the children and a $10 gift card for the family. Families were also

permitted to keep the book used in the research. The protocol was reviewed and approved by Emory University's Institutional Review Board.

Stimuli and Design

Materials included lab-developed books and open-ended and forced choice science fact knowledge integration tests.

Book. A book on animals titled "Rosie's Adventures at School" was developed for this research. The book followed a protagonist, Rosie, through six days of school with six different animal themes: animal movement, animal groups, how animals stay cool, meanings of animal names, big animals, and animal communication. Each day included three animal facts related to the theme: two integratable stem facts, each about a different animal, and one filler fact. The book presented 18 facts in total: 12 integratable stem facts and six distractor facts. The 12 stem facts made up six stem fact pairs, offering six opportunities for integration throughout the book. Paired stem facts were never presented on the same day. Each pair of integratable stem-facts contained one "name" fact, with an animal's name and a characteristic about it (e.g. "Otters squeal to communicate"), and one "characteristic" fact, with a different characteristic along with the characteristic presented in the name fact, but without the explicit name (e.g. "The animal that squeals to communicate lives in a group called rafts"). All integration facts have an AB, BC structure where the "name" fact references the name and characteristic about the animal (AB) and the "characteristic" fact pairs the characteristic from before and a new characteristic (BC). Three unpaired name facts and three unpaired characteristic facts were also included as fillers. An example day from the embedded questions condition is presented in Appendix A.

There were two book conditions: embedded questions and no embedded questions. The embedded questions condition offered two embedded questions tests on each day: a pre-test and a post-test. The pre-test included questions on the name of the animals in that day, before they were presented (e.g., “Do you know which animal communicates by honking, which communicates by scratching, and which communicates by squealing? Take a guess!”), and the post-test included questions on the characteristic of the animal just presented (e.g., “Rosie thinks about how animals communicate differently to express their needs just like her friends talk to each other. How do the animals communicate to express their needs? Try to remember!”). No-embedded questions books offered the same information without questions for pre-test (e.g., “We will learn about animals who communicate by honking, scratching, and squealing.”) and post-test (e.g., “Rosie thinks about how animals communicate differently to express their needs just like her friends talk to each other”). Embedded questions only included content from stem facts directly taught in the book and never called for integration. Each book condition also encompassed 10 different book orders, each of which presented the days/story themes in a different order, so the stem facts were presented in a different order. This resulted in variation of whether the name fact or characteristic fact was presented first in a stem fact pair. In total across the conditions and orders, there were 20 books.

Tests. The science fact memory test included open-ended and forced choice integration questions. Through the integration questions, we asked about information that could only be ascertained by combining elements of the two stem facts (e.g. “What is the name of the group that otters live in?”). Forced choice questions were the same integration questions asked in open-ended integration testing, but with 3 response options to choose from (e.g., “What is the name of the group that otters live in? Raft, loveliness, or blue”). The incorrect answer choices were

derived from the filler facts provided in the book. See Table 1 for examples and Appendix B for full list of questions and forced choice answers.

Procedure

Children and their caregivers were tested through online video conference (Zoom) due to the onset of the COVID-19 pandemic. All sessions were recorded. When possible, participants were instructed to use a computer, laptop, or tablet to join the session. Due to the demands of the research, experimenters instructed participants not to use a smartphone if possible. Caregivers and children were instructed to sit at a table or on a couch with an armrest when possible. This facilitated filming caregivers' and children's points/gestures at images in the book. Participants were tested by 1 of 5 female experimenters. Dyads were instructed that they were permitted to eat snacks and take short breaks during the session, if necessary. Recording began after parental consent and continued for the duration of the session. Child assent took place directly after the recording began and was recorded for each participant. There were 2 phases.

Phase 1: Shared Book Reading. Approximately equal numbers of children were pseudo-randomly assigned (constrained to balance age and gender) to book conditions with embedded questions (n = 42) and no-embedded questions (n = 41). The embedded questions condition asked participants to answer pre-test and post-test questions on the animals of each day (see above for examples). The no embedded questions condition contained the same information with no questions (see above for examples).

A physical copy of the assigned book condition and order was mailed to caregivers before the session took place. Caregivers were instructed at the onset of shared book reading to act as the primary reader, reading the book to their child as they normally would at home. The

experimenter turned off their video and audio during shared book reading to increase participant comfort, though recording continued. Then Caregivers read the book to their child. The shared book reading portion lasted approximately 20-30 minutes.

Phase 2: Testing. After book reading, caregivers were instructed that they could stay or leave during the testing portion, but that all questions were to be answered by the child. Testing began with an icebreaker task where children attempted to guess which animal image was hidden behind colored boxes on the screen. The icebreaker was used to help the child feel comfortable interacting with the experimenter. Children were then presented with a map of a cartoon bear which guided them through the "games," or testing activities. During all science fact memory tests, children saw on the Zoom screen the cover of the book with the cartoon bear on the side. The bear changed positions for each test. The first test was a free-recall task in which children were asked to describe what they learned from the book. Analyses of this task are beyond the scope of this paper. Participants then moved on to the open-ended integration questions. They were instructed to try their best to answer the questions and to take their best guess if they did not know the answer. Experimenters also informed the child it was acceptable to say "I do not know" if they had no guesses. In cases when children answered the integration question with a stem fact answer or if the child gave a vague/incomplete answer, the child was queried to give another answer (e.g., "Do you have another answer for what group otters live in?"). The child then participated in open-ended stem fact questions, which asked questions on the stem facts presented in the book. The analyses of performance on the stem fact questions are beyond the scope of this paper. Afterwards, children participated in forced-choice testing. Forced choice questions were only presented if the child answered the open-ended question on the topic incorrectly. At the onset of forced choice testing, the experimenter instructed the child to choose

the answer option which best answers the question. Experimenters read the question and three answer choices and marked the child's response. For the open-ended questions, the researcher marked if the child was correct or incorrect as well as if they were queried. For the forced-choice questions, experimenters chose the child's response from the three options they were read. All responses were marked by the experimenter in Qualtrics. This study analyzed the open-ended and forced choice integration questions presented during testing.

Data Reduction and Analysis

Transcription. We transcribed all speech during shared book reading. The transcribers used a template for each of the possible 20 book conditions/orders. The transcribers listened to video recordings of shared book reading and transcribed all extratextual talk, defined as talk outside of the text of the book. Extratextual talk was marked based on the line the dyad was reading in the book at the time of talk. Sentences were divided into phrases. Each phrase was preceded by who spoke it and which number phrase it was for that participant in the conversation (e.g. P/1: "What do you think of the book so far?; C/1: I really like it; P/2: Me too!; C/2: Yay!"). Unclear speech due to mumbling or technical video issues was checked to see if it could be deciphered, and if not, was noted as unclear speech. Each session was transcribed by one research assistant and checked by two others.

Coding. Caregiver-child extratextual talk was coded using a novel scheme developed for this research. Integration in extratextual talk served as a dependent variable for the independent variable of embedded questions. Caregiver-child extratextual talk also served as a predictor variable for test performance. This relation is presented in Figure 1. Talk was coded for each integratable stem fact, with coders evaluating all talk related to integration. Specifically, coders coded each integrable stem fact for Quality of Integration and Accuracy of Integration.

The three coders first identified whether there was evidence of integration. Integration during extratextual talk occurs in reference to the fact not mentioned on the current page of the book (i.e., it referenced a fact previously presented, on an earlier page). Using the AB/BC model, to integrate on an AB fact (e.g., “Otters squeal to communicate”), the participants must reference C (e.g., “live in rafts”). When evidence of integration was present, the coder rated the Quality of Integration. The Quality of Integration scoring scale and examples are provided in Table 2. The lowest quality score was Vague (1), which referred to the dyad mentioning that they had learned a related fact earlier in the book but did not provide any information on what the earlier learned fact was. The next quality score was Brief (2), which referred to dyads mentioning the missing element (C) but not making connections that C is also related to both A and B. The next quality score was Complete (3), which referred to dyads mentioning all three elements (A, B, and C) in the two integrable stem facts, but not explicitly explaining the relations between the two facts/three elements. The highest quality score was Elaborative (4), which referred to dyads mentioning all three elements in the two integrable stem facts (A, B, and C) and explicitly explaining how the two integrable facts are related or implicitly demonstrating the relation by flipping back to earlier pages of the book. Accuracy of Integration was the veracity of integration (correct or incorrect).

Two of the three research assistants coded each shared book reading transcript. Coding was checked and disagreements on coding were resolved through discussion at weekly coding meetings. Two examples of complete coding are provided in Table 3. Interrater reliability was assessed using Cohen’s Kappa. The agree for Quality of Integration was $\kappa = 0.89$ and Accuracy of Integration was $\kappa = 0.95$.

Scoring Extratextual Talk. Participant scores for Quality of Integration were derived as an average of the highest integration score for each of the six pair of stem facts, including stem fact pairs with no integration. This is designed to best represent changes in Quality of Integration across fact presentation. Typically, the highest integration occurs on the presentation of the second fact. We recoded Quality of Integration to 0 for all instances where Accuracy of Integration scored 1 (Incorrect) to prevent random guesses from impacting Quality of Integration Scores.

Test Scoring. Performance on integration and stem-fact recall testing served as a dependent variable. The open-ended and forced choice questions were scored during the session by the experimenter. For the integration questions, 2 scores were calculated. An Open-Ended Integration Score represented the proportion of integration questions (out of 6) that the child answered correctly. A Total Integration Score represented the proportion of integration topics (out of 6) that a child answered correctly in either open-ended or forced choice testing. Because children were only presented with forced-choice questions if they answered the open-ended integration questions incorrectly, this represents the total proportion of integration questions (open-ended and forced choice) that the child answered correctly. For the majority of data analysis, we used the SPSS version 28.0.0.0 (190). For multilevel modeling, we used the lme4 package of R version 3.6.2.

Results

This study explored the relations between embedded questions, extratextual talk, and integration performance with three questions: how does the presence of embedded questions in a book relate to child integration performance in testing; how does the presence of embedded questions in a book influence caregiver-child integration in extratextual talk; and how does the

quality of caregiver-child extratextual talk relate to child integration performance in testing? We also conducted an additional exploratory analysis of variation in integration in extratextual talk by fact type and order.

Embedded Questions and Integration Testing Performance

In testing, child participants answered an average of two out of six questions correctly for open-ended integration questions for both the embedded questions and no embedded questions condition. They answered an average of four to five out of six questions correctly in both conditions for Total Integration, which included forced choice questions. We examined the relations between the presence of embedded questions in a book and testing performance using independent samples *t*-tests. The tests revealed no significant difference between the embedded questions (M = 0.37, SD = 0.23) and no embedded questions conditions (M = 0.35, SD = 0.24) for Open-Ended Integration, d = .108, $t(81) = 0.47$, p = .640. There also was no significant difference between the embedded questions (M = 0.76, SD = 0.18) and no embedded questions condition (M = 0.77, SD = 0.21) for Total Integration, d = .016, $t(81) = 0.07$, p = .944. Thus, children's self-derivation performance did not differ as a function of the presence of embedded questions. This finding is contrary to our predictions.

Embedded Questions and Integration in Extratextual Talk

To characterize extratextual talk, in Figure 2 we present the Quality of Integration for the number of instances of each score (1- vague, 2- brief, 3- complete, 4- elaborative) by condition. As shown, the dyads tended to integrate more frequently in the embedded questions condition than the no embedded questions condition for every score except 1, in which the mentions of

integration were vague. The codes of brief and elaborative were most common for both conditions.

Although children's test performance did not differ as a function of embedded-questions condition, extratextual talk did differ. We statistically assessed the impact of embedded questions in a book on Quality of Integration using independent-samples *t*-tests. Caregiver-child dyads who read the book with embedded questions had higher Quality of Integration in Extratextual Talk than dyads who read the book with no embedded questions, $d = 0.45$, $t(80) = 2.05$, $p = .044$. Quality of integration was significantly higher in the embedded questions condition ($M = 1.56$, $SD = 0.98$) compared to the no embedded questions condition ($M = 1.09$, $SD = 1.07$). These findings suggest that embedded questions in children's science books, which support dyads' engagement with stem facts, increased integration in extratextual talk between caregivers and children.

Integration in Extratextual Talk and Integration Testing Performance

We next assessed the relation between extratextual talk during caregiver-child book reading and integration testing performance using correlations. The results showed that Quality of Integration was positively correlated with Open-Ended Integration, $r(80) = .51$, $p < .001$, and Total Integration, $r(80) = .37$, $p < .001$. The analyses revealed that as higher Quality of Integration was present during book reading, children performed better on integration tasks.

We also analyzed performance at the trial-level (i.e., performance on the specific stem fact pair such as otters in testing based on Quality of Integration in Extratextual Talk). Specifically, we conducted a logistic mixed effects model predicting the probability of correct integration, with the predictors of Quality of Integration in Extratextual Talk, condition

(embedded questions or no embedded questions), and the interaction between the two. We modeled the random intercepts of participant and trial, which accounted for the fact that the data are nested and that performance within-participant and/or trial would be more similar than across participants and/or trials. The model for Open-Ended Integration in testing by Quality of Integration is presented in Figure 3, and the model for Total Integration in testing by Quality of Integration is presented in Figure 4. For the effect of Quality of Integration on Open-Ended Testing, we found a significant effect of Quality of Integration such that the higher the integration quality on the specific trial, the higher the probability that the participant would get the open-ended trial correct, $b = .42$, $\chi^2(1) = 36.17$, $p < .001$. We found the same pattern for the effect of Quality of Integration on Total Integration, $b = .39$, $\chi^2(1) = 23.56$, $p < .001$. The effects of condition and the interaction between Quality of Integration and condition did not reach significance for either the open-ended or total model ($p > .263$).

These findings suggest that when caregiver-child dyads exhibited higher integration quality in extratextual talk for a specific fact pair (e.g. otters), the child performed better in integration testing for that fact pair compared to those fact pairs with lower Quality of Integration scores in extratextual talk.

Exploratory Analysis of Integration in Extratextual Talk by Fact Type and Order

We also examined the frequency of integration in extratextual talk by fact type and order (i.e. whether it was a name or characteristic stem fact, presented first or second). As presented in Table 4, there was large variability in frequency and accuracy of integration in extratextual talk. There was almost no integration when the name fact was presented first, likely representing that the presentation of name fact does not call for any second fact to explain its presence. When a characteristic fact was presented first, participants made integration statements on 39.84% of

opportunities, but 44.90% of these statements were incorrect. This is representative of the dyads guessing when presented a characteristic fact with no information about the animal's name (e.g., a dyad might first read "the animal that communicates by squealing lives in a group called rafts" and guess that the animal is a beaver). Instances and Accuracy of Integration in Extratextual Talk increased when the characteristic fact was presented second. This data reveals the impact of order of presentation and fact type on integration accuracy. The variability across order and type reveals the importance of prompting, either by presenting all necessary facts for integration or presenting what is clearly missing information, in the process of integration in extratextual talk. While the presentation of facts was counterbalanced so that each participant received 3 fact pairs with the characteristic fact first and 3 fact pairs with the name fact first, the differing presentation still resulted in variability at the level of fact pair. Table 5 shows the count of highest Quality of Integration score for each pair by fact type and order.

Discussion

The goal of this study was to examine how 5- to 6-year-old children learn from reading science books with their caregivers. Specifically, we evaluated the relation between three major variables: embedded questions in children's science books, integration in extratextual talk during caregiver-child book reading, and integration performance in testing. We hypothesized a positive relation between the three variables, as depicted in Figure 1.

Hypothesis A, that children will perform better during integration testing performance if they read a book with embedded questions, was not supported. There was no evidence that children performed better in integration testing based solely on the presence of embedded questions. This is surprising because prior research has shown that children rely on a cue, like a question, to prompt integration (Bauer et al, 2020a). Yet, the presence of embedded questions in

the test book seemed not to serve as a sufficient cue to improve integration performance. Prior research also showed that embedded questions have the most impact when caregivers engage in extratextual talk alongside the questions (Miller-Goldwater et al., 2023). To date, we have only investigated integration in extratextual talk. It will be important in future research to also examine the extent to which dyads answered the books' embedded questions, as effects of embedded questions may be driven by participation with such questions.

Hypothesis B was that if embedded questions were present in the book, then there would be more evidence of integration in extratextual talk during shared book reading. This hypothesis was supported: there was a significantly higher average Quality of Integration for dyads in the embedded questions condition than the no embedded questions condition. Caregivers and children integrated more during book reading when embedded questions were present. The finding that embedded questions increase extratextual talk is not novel (see Troseth et al, 2020). However, the findings that embedded questions on stem facts increased integration in extratextual talk is novel. Prior research has shown that increased exposure to stem facts improves integration performance (Bauer & San Souci, 2010). In this case, the embedded questions likely increased exposure to the stem facts, explaining the increase in integration quality. In terms of the ERISS model (Bauer and Varga, 2017), by including questions on stem facts, the embedded questions conditions maximized opportunities for encoding of the individual stem fact and reactivation of the paired stem fact, therefore facilitating integration during extratextual talk.

Hypothesis C, that children would perform better in integration testing if the dyad demonstrated more integration during caregiver-child extratextual talk, was also supported. This result was demonstrated through both correlations and multilevel modeling. For the correlation,

increased Quality of Integration in Extratextual Talk was positively correlated with Integration Performance for both open-ended and total integration testing. Children performed better on Integration Testing when the dyad exhibited more Integration in Extratextual Talk during book reading. For the multilevel model, Quality of Integration in Extratextual Talk had a significant effect on Integration Testing Performance. If a dyad integrated during extratextual talk for the otter fact pair but not cheetahs, for example, the model would predict that the child would perform better on, for example, the otter fact pair than the cheetah fact pair during Integration Testing. So, not only does more Integration in Extratextual Talk overall predict better Integration Testing Performance, but more Integration in Extratextual Talk on a specific stem fact pair predicted increased Integration Performance for that pair. These findings can also be interpreted considering the ERISS model (Bauer and Varga, 2017). Without integration during extratextual talk, children must complete the processes of *integration of knowledge into memory, selection upon demand,* and *self-derivation of new knowledg*e on their own to correctly answer during the integration task. By demonstrating integration during extratextual talk with a caregiver, the process of *integration of knowledge into memory* is facilitated by the caregiver and perhaps bypassed during testing. Instead, children are able to simply *select* the relevant information upon demand and *self-derive* the appropriate new knowledge to answer the integration questions. The assistance of the caregiver in the process of *integration of knowledge into memory* might therefore explain the increased Integration Performance, both in dyads who demonstrated more Integration during Extratextual Talk overall and on trials where the dyads demonstrated more Integration in Extratextual Talk.

Our predicted model where Embedded Questions increase Integration in Extratextual Talk, and Integration in Extratextual Talk increases Integration Performance, was supported.

However, there was not sufficient evidence that Embedded Questions influenced Integration Performance. Thus, our data did not support our hypothesized mediation.

Novel Contributions

This study provided multiple novel contributions to the literature on integration and shared book reading. First, the successful use of a coding scale to measure integration quality and presence in talk is a novel contribution. Generally, integration performance is measured using question-based tasks. The ability to identify integration in talk is an important contribution to the study of the processes facilitating integration because it allows researchers to pinpoint integration in everyday conversation. The fact that this scale is not simply a measure of presence of integration, but of quality, is also valuable. Most tasks used to measure integration detect only whether it is present. The development of a scale which measures degrees of integration, from vague to elaborative, is a valuable tool in detecting which type of integration in talk is most beneficial to performance. The high reliability and multiple significant results found using this scale have revealed that it is a viable, and potentially more informative, measure of integration.

This study provided evidence for the relation between embedded questions and integration in extratextual talk. While studies have shown that embedded questions are related to an increase in extratextual talk (Troseth et al, 2020; Miller Goldwater et al, 2022), no study has provided evidence that embedded questions on stem facts can lead to an increase in integration during extratextual talk. Further, no study to date has paired extratextual talk and integration performance.

These findings analyze integration in a naturalistic setting of book reading, unlike much research using integration tasks. Because shared book reading is a primary form of education in

young children, these findings reveal variables with the ability to regularly impact integration, whether in extratextual talk or testing, in 5- and 6-year-old children. In terms of shared book reading, this study investigates a new aspect of learning: integration. Most studies on book reading focus on language and reading ability or direct fact recall. By studying integration in book reading, this research sheds light on a vital mechanism of knowledge building in young children.

This research also has educational implications. It reveals that including embedded questions in children's science books can assist the process of integration during extratextual talk, allowing children to learn and discuss science information to build their knowledge base. Further, it reveals that encouraging caregiver-child integration in extratextual talk can improve integration performance and therefore the building of a semantic knowledge base in young children.

Remaining Questions

These novel findings shed light on the processes by which Integration Performance can be improved in young children. However, some questions remain. Most obviously, why was there no significant relation between Embedded Questions and Integration Performance? The literature provides evidence that Embedded Questions have the potential to increase Integration Performance. In this study, Embedded Questions increased exposure to stem facts, and increased exposure to stem facts is related to improved Integration Performance (Bauer & San Souci, 2010). Further, Embedded Questions increased Integration in Extratextual Talk, which led to improved Integration Performance. As mentioned previously, this finding may be a result of a lack of engagement from all participants in the embedded questions. The impact of embedded

questions on integration performance when all participants are engaged is a question that remains.

There are also remaining questions about the impact of caregiver versus child involvement in Integration during Extratextual Talk. Do children perform better in Integration Testing if they demonstrated the Integration in Extratextual Talk? Who initiates and solves integration more often, and what impact does that have on Integration Testing Performance? An investigation of these questions could bring light to the processes within Integration during Extratextual Talk that increase child Integration Performance.

Another remaining question centers on the generalizability of our findings. Would the impact of Embedded Questions and Integration in Extratextual Talk hold true in a regular children's STEM book, not designed to maximize opportunities to integrate? Other children's books often contain more name facts than our study contained, as opposed to delineated stem fact pairs of a characteristic and name fact. Would children integrate two name facts on the same topic as readily as the integrate a name fact and a characteristic fact? Our exploratory analysis revealed that children never integrated correctly when the name fact was presented first, and that they were most likely to integrate when a characteristic fact was presented second (see Table 4 and Table 5). Answering these remaining questions would further enhance our understanding of this study's results as well as expand the literature on qualities of shared book reading and integration performance in young children.

Limitations and Future Directions

While this study presents many valuable findings on shared book reading and integration, it is not without limitations. Our study suffered from a few practical limitations. Because of the

COVID-19 pandemic, our data collection was forced to take place completely over online video conference (Zoom). While this has become normal for psychology research in recent years, it still deviates from the regular routine of caregiver-child book reading and likely had at least some impact on the book reading atmosphere. Future in-person testing on topics of shared book reading and integration might allow for further engagement. Conversely, collecting data via video conference offered the advantage of engaging with caregivers and children in their homes, where they are likely to be comfortable reading.

This research was also limited in the composition of its sample. Most caregivers were female, yet it is unreasonable to assume that only mothers participated because only mothers read to their children. Therefore, the sample is not completely representative of caregivers who read to their children. Conducting a study of extratextual talk in father-child shared book reading could address the gender gap. Further, our sample was extremely highly educated. Almost all children had at least one parent with a bachelor's level education, and 77.92% of children had at least one parent with a post-graduate level of education. This level of education in caregivers makes it more likely for the parents to read to their children regularly, increasing their experience with shared book reading. Future research should also take place with lower SES participants, especially where caregiver child book reading might be less common due to outside constraints (e.g. parental literacy, needing to work multiple jobs, etc), as well as in children with below average language comprehension.

The use of an experimental test book also provides some limitations. The book "Rosie's Adventures at School" was designed for this experiment in order to present multiple opportunities to integrate stem fact pairs throughout shared book reading. This was ideal for our experiment because we sought to look at integration. It does, however, pose a limitation: it is not

a regular published book. Actual science books for children are not necessarily structured around separately presenting fact pairs, and each fact pair is not composed of a name and characteristic fact. So, the extent to which integration is similar in a real-world book is not guaranteed. In additional research, it will be important to test integration in the context of regular children's science books, to determine how similar the results are with varying book structures and fact types. Further, researchers should analyze the content of children's science books for opportunities to integrate, as our test book provided.

In future research, it would be useful to further investigate the order effects in "Rosie's Adventure at School." The exploratory analysis revealed that both fact type and order impacted frequency and accuracy of integration (see Table 4). Notably, when the characteristic fact was presented first, dyads integrated on 39.84% of opportunities. However, 44.90% of these integration attempts were incorrect. While the Quality of Integration score for these incorrect answers was recoded to zero, these incorrect answers had the potential to hinder children's learning. Therefore, future research should evaluate how to reduce these errors or whether presenting a characteristic fact first in an actual children's book would be harmful.

The impact of an experimental book like "Rosie's Adventures at School" can be further explored for its potential as a tool for teaching the process of integration. Does experience with high integration opportunity books, like our test book, facilitate higher integration outside of the book? This research could shed light on whether simply practicing the process of integration, through book-reading or integration tasks, improves integration performance. Such research could have important educational implications. The variables impacting Integration Performance in this experiment could also be examined in different contexts, like classroom learning. The use

of embedded questions in lessons and discussion groups to increase integration in students could be explored.

Lastly, the present data from extratextual talk during book reading could be further explored in future research. The conversations during extratextual talk varied on many aspects that could be relevant to integration performance, including who (of the caregiver and child) initiated integration, who (of the caregiver and child) reached the highest level of integration, and the types of interactions that caregivers and children have (simply answers to questions versus longer back-and-forth conversations). The level of involvement from children in the process of integrating in extratextual talk has the potential to impact children's integration performance. Future research on more detailed elements of this caregiver-child extratextual talk could shed light on if and how caregivers are assisting their children in the processes of self-derivation through integration.

Conclusion

In this experiment, we studied how 5- to 6-year-old children learn from reading books with their caregivers by analyzing the relation between Embedded Questions in children's science books, Integration in Caregiver-Child Extratextual Talk during shared book reading, and Child Integration Performance in Testing. Overall, we found that the Presence of Embedded Questions in a children's book had no significant impact on Integration Testing Performance, but it did lead to increased Quality of Integration in Extratextual Talk between caregivers and their children. Further, increased Quality of Integration in Extratextual Talk predicted higher Integration Performance for both Open-Ended and Total Integration Testing. This work makes novel contributions by introducing a scale for Quality of Integration and revealing evidence for

the positive relation between Embedded Questions and Integration in Extratextual Talk as well as Integration in Extratextual Talk and Child Integration Performance.

References

Aram, D., Fine, Y., & Ziv, M. (2013). Enhancing parent–child shared book reading interactions: Promoting references to the book's plot and socio-cognitive themes. *Early Childhood Research Quarterly*, *28*(1), 111–122. https://doi.org/10.1016/j.ecresq.2012.03.005

Ard, L. M., & Beverly, B. L. (2004). Preschool word learning during joint book reading: Effect of adult questions and comments. *Communication Disorders Quarterly*, *26*(1), 17–28. https://doi.org/10.1177/15257401040260010101

Arnold, K. M., & McDermott, K. B. (2013). Test-potentiated learning: Distinguishing between direct and indirect effects of tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(3), 940–945. https://doi.org/10.1037/a0029199

Bauer, P. J. (2021). We know more than we ever learned: Processes involved in accumulation of world knowledge. *Child Development Perspectives*, *15*, 220–227. https://doi.org/10.1111/cdep.12430

Bauer, Cronin-Golomb, L. M., Porter, B. M., Jaganjac, A., & Miller, H. E. (2020a). Integration of memory content in adults and children: Developmental differences in task conditions and functional consequences. *Journal of Experimental Psychology, 150*(7), 1259–1278. https://doi.org/10.1037/xge0000996

Bauer, P. J., Esposito, A. G., & Daly, J. J. (2020b). Self-derivation through memory integration: A model for accumulation of semantic knowledge. *Learning and Instruction, 66*(April), 101271. https://doi.org/10.1016/j.learninstruc.2019.101271

Bauer, P. J., & Larkina, M. (2017). Realizing relevance: The influence of domain-specific information on generation of new knowledge through integration in 4- to 8-year-old children. *Child Development*, *88*(1), 247–262. https://doi.org/10.1111/cdev.12584

Bauer, P. J., & San Souci, P. (2010). Going beyond the facts: Young children extend knowledge by integrating episodes. *Journal of Experimental Child Psychology*, *107*(4), 452–465. https://doi.org/10.1016/j.jecp.2010.05.012

Bauer, P. J., & Varga, N. L. (2017). Similarity and deviation in event segmentation and memory integration: Commentary on Richmond, Gold, & Zacks. *Journal of Applied Research in Memory and Cognition*, *6*(2), 124–128. https://doi.org/10.1016/j.jarmac.2017.01.006

Beals, D. E., De Temple, J. M., & Dickinson, D. K. (1994). Talking and listening that support early literacy development of children from low-income families. In D. K. Dickinson (Ed.), *Bridges to literacy: Children, families, and schools* (pp. 19–40). Blackwell Publishing.

Blewitt, P. & Langan, R. (2016). Learning words during shared book reading: The role of extratextual talk designed to increase child engagement. *Journal of Experimental Child Psychology, 150,* 404-410. https://doi.org/10.1016/j.jecp.2016.06.009

Blewitt, P., Rump, K. M., Shealy, S. E., & Cook, S. A. (2009). Shared book reading: When and how questions affect young children's word learning. *Journal of Educational Psychology, 101*(2), 294–304. https://doi.org/10.1037/a0013844

Bojczyk, K. E., Davis, A. E., & Rana, V. (2016). Mother–child interaction quality in shared book reading: Relation to child vocabulary and readiness to read. *Early Childhood Research Quarterly, 36*(3), 404–414. https://doi.org/10.1016/j.ecresq.2016.01.006

Boland, A. M., Haden, C. A., & Ornstein, P. A. (2003). Boosting Children's Memory by Training Mothers in the Use of an Elaborative Conversational Style as an Event Unfolds. *Journal of Cognition & Development*, *4*(1), 39–65. https://doi.org/10.1080/15248372.2003.9669682

Britton, B.K., Piha, A., Davis, J. et al. (1978). Reading and cognitive capacity usage: Adjunct question effects. *Memory & Cognition*, *6*, 266–273. https://doi.org/10.3758/BF03197455

Bus, A. G., van Ijzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning to read: A meta-analysis on intergenerational transmission of literacy. *Review of Educational Research*, *65*(1), 1–21. https://doi.org/10.3102/00346543065001001

Callender, A. A., & McDaniel, M. A. (2007). The benefits of embedded question adjuncts for low and high structure builders. *Journal of Educational Psychology*, *99*(2), 339–348. https://doi.org/10.1037/0022-0663.99.2.339

Dickinson, D. K. (2001). Book reading in preschool classrooms: Is recommended practice common? In D. K. Dickinson & P. O. Tabors (Eds.), *Beginning literacy with language: Young children learning at home and school* (pp. 175–203). Paul H Brookes Publishing.

Esposito, A. G., & Bauer, P. J. (2017). Going beyond the lesson: Self-generating new factual knowledge in the classroom. *Journal of Experimental Child Psychology*, *153*(January), 110–125. https://doi.org/10.1016/j.jecp.2016.09.003

Esposito, A. G., & Bauer, P. J. (2018). Building a knowledge base: Predicting self-derivation through integration in 6- to 10-year-olds. *Journal of Experimental Child Psychology*, *176*(December), 55–72. https://doi.org/10.1016/j.jecp.2018.07.011

Gettinger, M., & Stoiber, K. C. (2014). Increasing opportunities to respond to print during storybook reading: Effects of evocative print-referencing techniques. *Early Childhood Research Quarterly*, *29*(3), 283–297. https://doi.org/10.1016/j.ecresq.2014.03.001

Gripshover, S. J., & Markman, E. M. (2013). Teaching Young Children a Theory of Nutrition: Conceptual Change and the Potential for Increased Vegetable Consumption. *Psychological Science*, *24*(8), 1541–1553. https://doi.org/10.1177/0956797612474827

Hamaker, C. (1986). The Effects of Adjunct Questions on Prose Learning. *Review of Educational Research*, *56*(2), 212–242. https://doi.org/10.3102/00346543056002212

Hammett, L. A., van Kleeck, A., & Huberty, C. J. (2003). Patterns of parents' extratextual interactions during book sharing with preschool children: A cluster analysis study. *Reading Research Quarterly*, *38*(4), 442–468. https://doi.org/10.1598/RRQ.38.4.2

Han, J., & Neuharth-Pritchett, S. (2014). Parents' interactions with preschoolers during shared book reading: Three strategies for promoting quality interactions. *Childhood Education*, *90*(1), 54–60. https://doi.org/10.1080/00094056.2014.872516

Harris, V. J. (2008). Selecting books that children will want to read. *The Reading Teacher*, *61*(5), 426–430. https://doi.org/10.1598/RT.61.5.8

Heisey, N., & Kucan, L. (2010). Introducing Science Concepts to Primary Students Through Read-Alouds: Interactions and Multiple Texts Make the Difference. *The Reading Teacher*, *63*(8), 666–676. https://doi.org/10.1598/RT.63.8.5

Hindman, Annemarie & Morrison, Frederick. (2011). Family Involvement and Educator Outreach in Head Start: Nature, Extent, and Contributions to Early Literacy Skills. *The Elementary School Journal, 111*(3), 359–386. https://doi.org/10.1086/657651

Hoffman, J. L., Collins, M. F., & Schickedanz, J. A. (2015). Instructional challenges in developing young children's science concepts. *The Reading Teacher, 68*(5), 363–372. https://doi.org/10.1002/trtr.1325

Kiefer, B. Z. (2004). Children's literature and children's literacy: Preparing early literacy teachers to understand the aesthetic values of children's literature. In O. N. Saracho, & B. Spodek (Eds.), *Contemporary perspectives on language policy and literacy instruction in early childhood education* (Vol. V, pp. 161–180). Information Age.

Larsen, N. E., Venkadasalam, V. P., & Ganea, P. A. (2020). Prompting children's belief revision about balance through primary and secondary sources of evidence. *Frontiers in Psychology, 11,* 1503. https://doi.org/10.3389/fpsyg.2020.01503

Mantzicopoulos, P., & Patrick, H. (2010). "The Seesaw Is a Machine That Goes Up and Down": Young Children's Narrative Responses to Science-Related Informational Text. *Early Education & Development, 21*(3), 412–444. https://doi.org/10.1080/10409281003701994

Miller-Goldwater, Cronin-Golomb, L. M., Hanft, M. H., & Bauer, P. J. (2023). The influence of books' textual features and caregivers' extratextual talk on children's science learning in the context of shared book reading. *Developmental Psychology, 59*(2), 390–411. https://doi.org/10.1037/dev0001480

Miller-Goldwater, H. E., Cronin-Golomb, L. M., Porter, B. M., & Bauer, P. J. (2021). Developmental differences in reactivation underlying self-derivation of new knowledge through memory integration. *Cognitive Psychology, 129*, 101413.

Mol, S. E., Bus, A. G., & de Jong, M. T. (2009). Interactive book reading in early education: A tool to stimulate print knowledge as well as oral language. *Review of Educational Research*, *79*(2), 979–1007. https://doi.org/10.3102/0034654309332561

Mol, S. E., Bus, A. G., De Jong, M. T., & Smeets, D. J. H. (2008). Added value of dialogic parent–child book readings: A metaanalysis. *Early Education and Development*, *19*(1), 7–26. https://doi.org/10.1080/10409280701838603

Olson, M. W. (1985). Text type and reader ability: The effects of paraphrase and text-based inference questions. *Journal of Reading Behavior*, *17*, 199–214. https://doi.org/10.1080/10862968509547540

Pappas, C. (1991). Fostering full access to literacy by including information books. *Language Arts*, *68*, 449–462.

Pentimonti, J. M., Zucker, T. A., Justice, L. M., & Kaderavek, J. N. (2010). Informational text use in preschool classroom readalouds. *The Reading Teacher*, *63*(8), 656–665. https://doi.org/10.1598/RT.63.8.4

Price, L. H., Bradley, B. A., & Smith, J. A. (2012). A comparison of preschool teachers' talk during storybook and information book read-alouds. *Early Childhood Research Quarterly*, *27*(3), 426–440. https://doi.org/10.1016/j.ecresq.2012.02.003

Price, L. H., van Kleeck, A., & Huberty, C. J. (2009). Talk during book sharing between parents and preschool children: A comparison between storybook and expository book conditions. *Reading Research Quarterly, 44*(2), 171–194. https://doi.org/10.1598/RRQ.44.2.4

Saracho, O. N., & Spodek, B. (2010a). Families' selection of children's literature books. *Early Childhood Education Journal*, *37*(5), 401–409. https://doi.org/10.1007/s10643-009-0365-5

Saracho, O. N., & Spodek, B. (2010b). Parents and children engaging in storybook reading. *Early Child Development and Care*, *180*(10), 1379–1389. https://doi.org/10.1080/03004430903135605

Saracho, O.N. (2017). Parents' shared storybook reading – learning to read. *Early Child Development and Care*, *187*(3-4), 554-567. https://doi.org/10.1080/03004430.2016.1261514

Sénéchal, M., Cornell, E. H., & Broda, L. S. (1995). Age-related differences in the organization of parent-infant interactions during picture-book reading. *Early Childhood Research Quarterly*, *10*, 317–337. https://doi.org/10.1016/0885-2006(95)90010-1

Sénéchal, M., LeFevre, J.-A., Hudson, E., & Lawson, E. P. (1996). Knowledge of storybooks as a predictor of young children's vocabulary. *Journal of Educational Psychology*, *88*(3), 520–536. https://doi.org/10.1037/0022-0663.88.3.520

Sénéchal, M., LeFevre, J., Thomas, E. M., & Daley, K. E. (1998). Differential effects of home literacy experiences on the development of oral and written language. *Reading Research Quarterly*, 33(1), 96–116. https://doi.org/10.1598/RRQ.33.1.5

Smith, B. L., Holliday, W. G., & Austin, H. W. (2010). Students' comprehension of science textbooks using a question-based reading strategy. *Journal of Research in Science Teaching*, *47*(4), 363–379. https://doi.org/10.1002/tea.20378

Torr, J. (2007). The pleasure of recognition: Intertextuality in the talk of preschoolers during shared reading with mothers and teachers. *Early Years*, *27* (1), 77–91. https://doi.org/10.1080/09575140601135163

Troseth, G. L., Strouse, G. A., Flores, I., Stuckelman, Z. D., & Johnson, C. R. (2020). An enhanced eBook facilitates parent–child talk during shared reading by families of low socioeconomic status. *Early Childhood Research Quarterly*, *50*, 45–58. https://doi.org/10.1016/j.ecresq.2019.02.009

van Kleeck, A. (2008), Providing preschool foundations for later reading comprehension: The importance of and ideas for targeting inferencing in storybook-sharing interventions. *Psychology in the Schools*, *45*, 627-643. https://doi.org/10.1002/pits.20314

van Kleeck, A., Gillam, R. B., Hamilton, L., & McGrath, C. (1997). The relationship between middle-class parents' book-sharing discussion and their preschoolers' abstract language development. *Journal of Speech, Language, and Hearing Research*, *40*(6), 1261-71. https://doi.org/10.1044/jslhr.4006.1261

van Kleeck, A., Judith, V. W., & Hammett, L. (2006). Fostering literal and inferential language skills in head start preschoolers with language impairment using scripted book-sharing discussions. *American Journal of Speech-Language Pathology*, *15*(1), 85-95. https://doi.org/10.1044/1058-0360(2006/009)

Varga, N. L., & Bauer, P. J. (2017). Young adults self-derive and retain new factual knowledge through memory integration. *Memory & Cognition*, *45*, 1014–1027. https://doi.org/10.3758/s13421-017-0711-6

Varga, N. L., Esposito, A. G., & Bauer, P. J. (2019). Cognitive correlates of memory integration across development: Explaining variability in an educationally relevant phenomenon. *Journal of Experimental Psychology*, *148*(4), 739–762. https://doi.org/10.1037/xge0000581

Varga, N. L., Stewart, R., & Bauer, P. J. (2016). Integrating across episodes: Investigating the long-term accessibility of self-derived knowledge in 4-year-old children. *Journal of Experimental Child Psychology*, *145*(May), 48–63. https://doi.org/10.1016/j.jecp.2015.11.015 link

Wilson, J. T., & Bauer, P. J. (2021). Prompt-facilitated learning: The development of unprompted memory integration and subsequent self-derivation. *Memory & Cognition*, *49*, 1473-1487. https://doi.org/10.3758/s13421-021-01155-4

Wixson, K. K. (2011). Reading informational texts in the early grades. Research into practice reading. *Research Into Practice*, 1-7.

Whitehurst, G. J., Falco, F. L., Lonigan, C. J., Fischel, J. E., DeBaryshe, B. D., Valdez Menchaca, M. C., Caulfield, M. (1988). Accelerating language development through picture book reading. *Developmental Psychology*, *24*(4), 552–559. https://doi.org/10.1037/0012-1649.24.4.552

Yopp, R. H., & Yopp, H. K. (2006). Informational texts as read-alouds at school and home. *Journal of Literacy Research*, *38*(1), 37–51. https://doi.org/10.1207/s15548430jlr3801_2

Yopp, R. H., & Yopp, H. K. (2012). Young children's limited and narrow exposure to informational text. *The Reading Teacher*, *65*(7), 480–490. https://doi.org/10.1002/TRTR.01072

Zevenbergen, A. A., & Whitehurst, G. J. (2003). Dialogic reading. A shared picture book intervention for preschoolers. In A. Kleeck, S. Stahl, & E. Bauer (Eds.), *On reading books to children: Parents and teachers* (pp. 302–320). Erlbaum.

Zucker, T. A., Cabell, S. Q., Justice, L. M., Pentimonti, J. M., & Kaderavek, J. N. (2013). The role of frequent, interactive prekindergarten shared reading in the longitudinal development of language and literacy skills. *Developmental Psychology*, *49*(8), 1425–1439. https://doi.org/10.1037/a0030347

Table 1

Integratable Stem Fact Pair Examples and Testing Examples

Animal Topic	**Name Fact (AB)**	**Characteristic Fact (BC)**	**Integration Question**
Otters	Otters squeal to communicate.	The animal that squeals to communicate lives in a group called rafts.	What is the name of the group that otters live in?
Cheetahs	Cheetah is the fastest animal.	The animal that runs the fastest's name means "spotted one."	What does the name Cheetah mean?

Table 2

Quality of Integration Scoring Scale and Examples

Score	Name	Definition	Example
1	Vague	Reference to fact that topic was mentioned without content of paired fact	"Didn't we hear something about that?"
2	Brief	Integrates with reference to 1 or 2 of 3 key facts	*Reads: This is the fastest animal…* "Cheetah!"
3	Complete	Integrates 3 of 3 key facts (of name fact, characteristic fact, and name)	"Cheetah is the fastest animal and its name means 'spotted one.'"
4	Elaborative	Meets all requirements for complete and explains relation between paired facts either explicitly or by flipping back pages in book	*Reads: The animals that squeals to communicate lives in rafts.* "Hmm, let's see what animal that was again (*flips back in book*). Otters squeal to communicate. The animal who squeals lives in rafts. So, otters must live in rafts."

Table 3

Coding Examples

Example 1		
Reads: The animal that lives in groups called blooms is different from other animals because it is the longest. C/1: Blooms?; P/1: That's what it says; P/1: Do we know what animal that is?; C/1: Yeah; P/2: Which one?; C/2: Sun Jellyfish; P/3: The Sun jellyfish; P/3: So now we know two things about the sun jellyfish *Reads: This animal that lives in groups called blooms is as long as 35 people lined up.* C/1: 35?; P/1: 35; P/1: How many people are in your class?; C/2: 9; P/2: So if you took everybody in your class and lined them all up; P/2: I think like laying down right?; P/2: All lined up head to toe all the way; P/2: Sun jellyfish are almost twice as long as that would be; P/2: It's super long; C/3:Sun jellyfish?; P/3: Okay		
Example 2		
Reads: Animals living in groups called rafts sometimes wrap themselves in seaweed, so they stay together. C/1: I think that's otter; P/1: Otters yeah		
	Quality of Integration	**Accuracy of Integration**
Example 1	Complete (3)	Correct (2)
Example 2	Brief (2)	Correct (2)

Note. Each phrase was preceded by who spoke it and which number phrase it was for them in the conversation, followed by a colon. Phrases were separated using a semicolon.

Table 4

Quality of Integration and Accuracy Scores by Fact Type and Order

Fact Type and Order	N	Percent of Integration Opportunities	Percent Incorrect	Percent Correct
Name 1	1	.4	100.00	0
Name 2	31	12.60	0	100.00
Characteristic 1	98	39.84	44.90	55.10
Characteristic 2	154	62.60	6.49	93.51

Table 5

Highest Quality of Integration Score by Fact Type and Order

Fact Type and Order	N	Percent of Integration Opportunities
Name 1	0	0
Name 2	31	12.60
Characteristic 1	43	17.48
Characteristic 2	144	58.54

Figure 1

Proposed Mediation Model

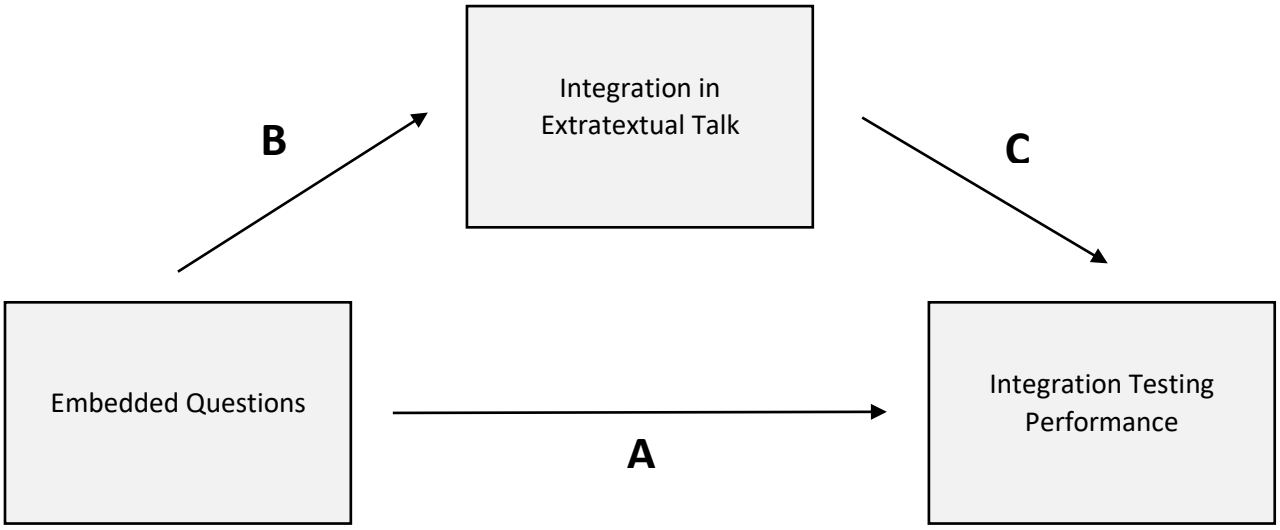
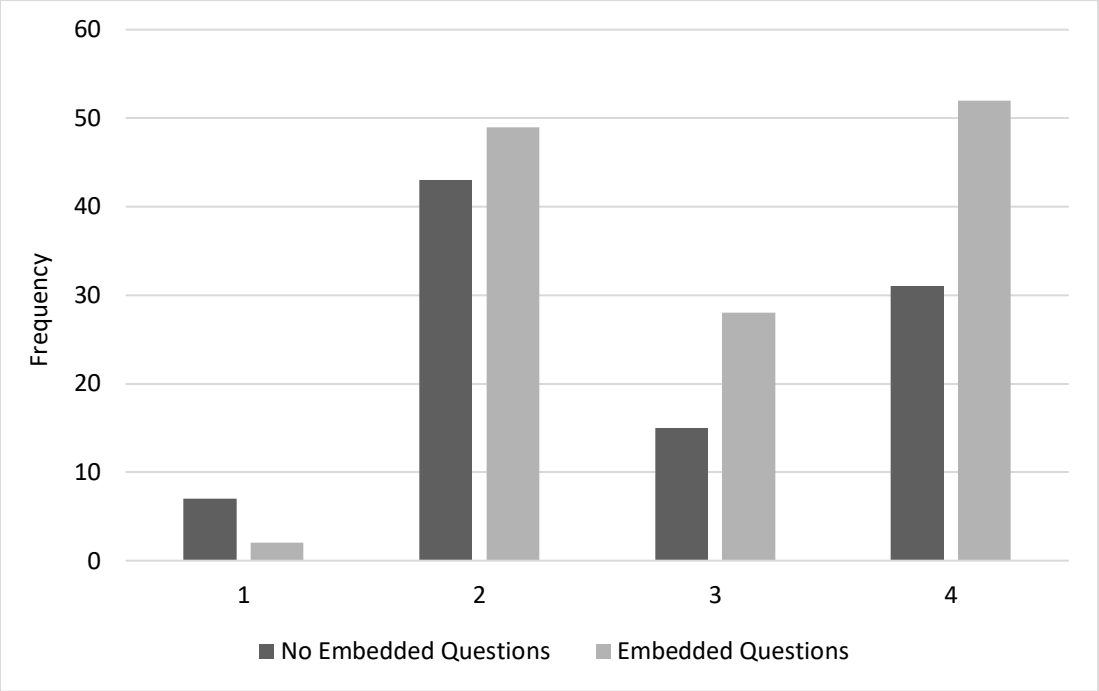


Figure 2

Frequency of Quality of Integration Scores by Condition



Note. For Quality of Integration, a score of 1 is vague, 2 is brief, 3 is complete, 4 is elaborative. Codes are explained further in Table 2.

Figure 3

Multilevel Model of Quality of Integration in Extratextual Talk by Open-Ended Integration

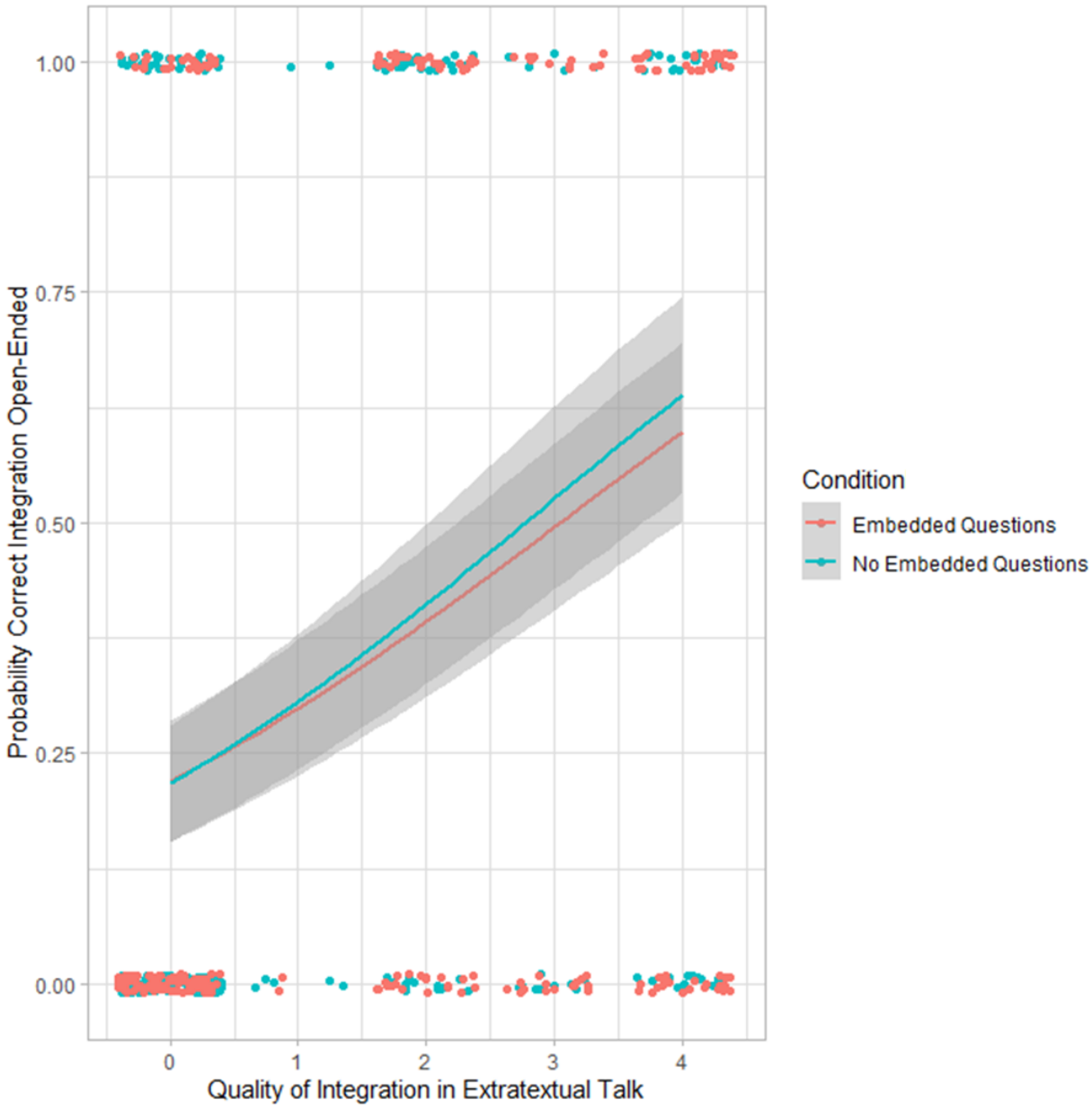
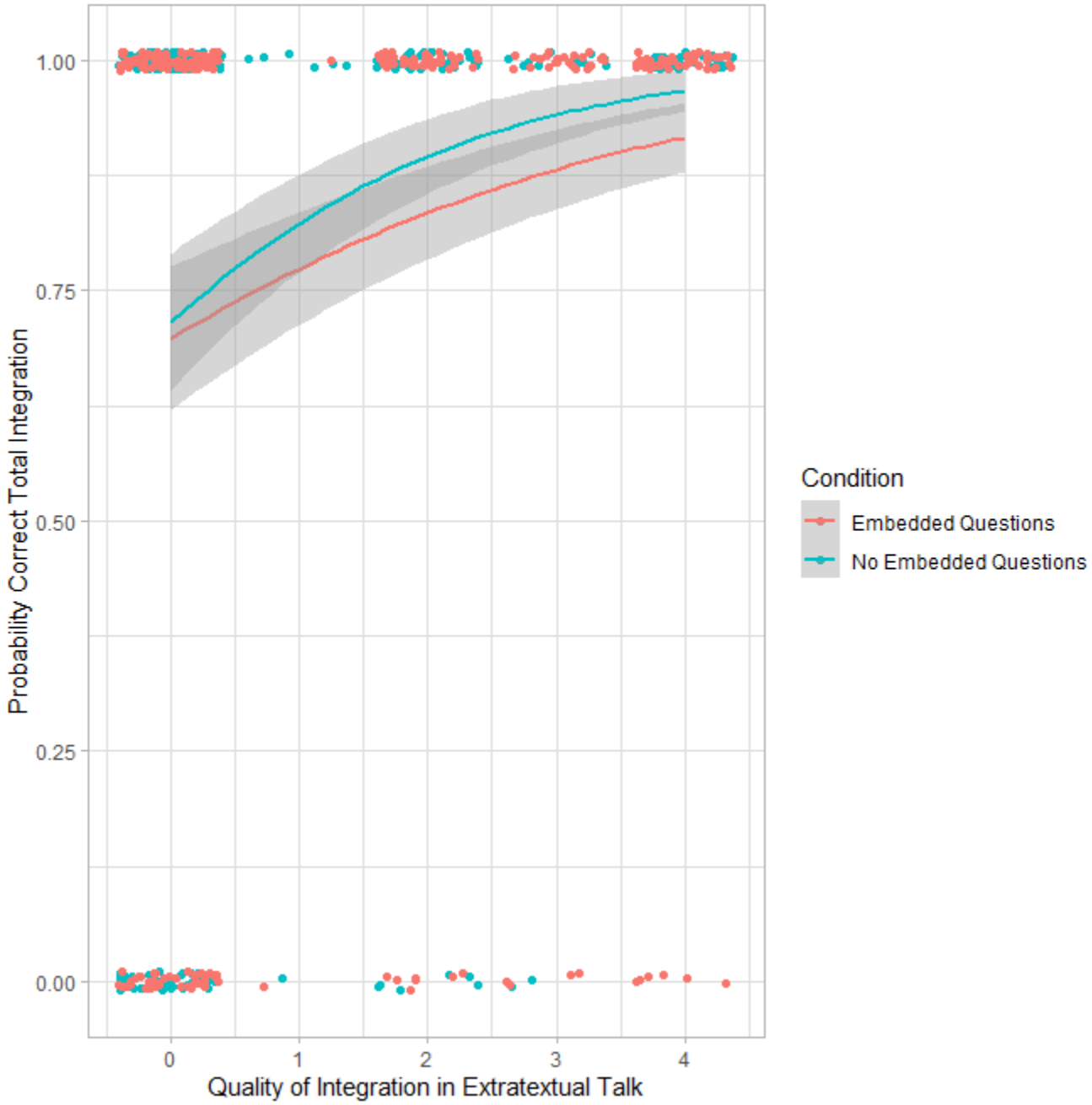


Figure 4

Multilevel Model of Quality of Integration in Extratextual Talk by Total Integration

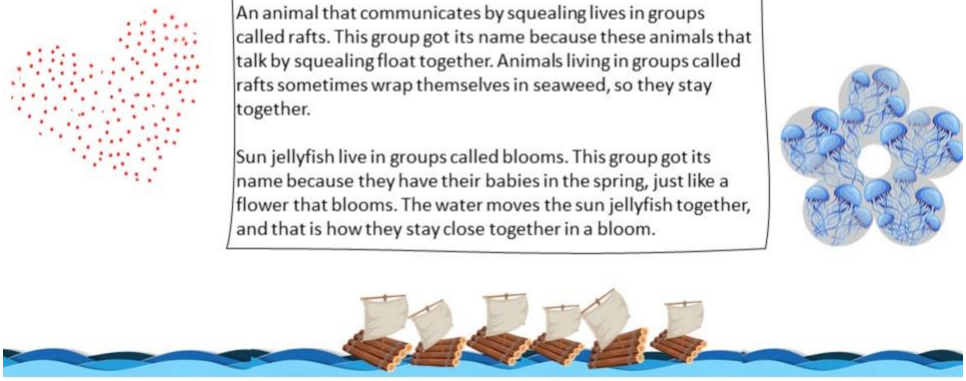


Appendix A

Example Day from Test Book "Rosie's Adventures at School"

On day 3, Rosie walks to school with her friends. She says, "It is great that I have a friend group and each of us has a different family group. I am excited to learn about groups of animals today."

At school, Ms. Apple says, "Hello, group of classmates. Ready to learn about animal groups? Do you know which animal lives in groups called loveliness, which lives in groups called rafts, and which lives in groups called blooms? Take a guess! These animals get their group names for different reasons."


An animal that flies lives in groups called loveliness. This group got its name because gardeners love seeing these animals that fly in their gardens. Gardeners like it when loveliness come because they help get rid of bugs.
An animal that communicates by squealing lives in groups called rafts. This group got its name because these animals that talk by squealing float together. Animals living in groups called rafts sometimes wrap themselves in seaweed, so they stay together.
Sun jellyfish live in groups called blooms. This group got its name because they have their babies in the spring, just like a flower that blooms. The water moves the sun jellyfish together, and that is how they stay close together in a bloom.


Rosie thinks about how animals form different groups, just like how her friend group is different from her family group. It is great that each group got its name for a different reason. What are the different animals' group names? Try to remember!
An animal that flies lives in groups called loveliness because they make gardeners happy. Animals that communicate by squealing have the group name raft because they float together. Sun jellyfish have the group name bloom because they have babies in the spring.

Appendix B

Open-Ended and Forced-Choice Integration Testing Questions

Questions	Forced-Choice Answers
What is the name of the group that otters live in?	raft loveliness blue
Sun jellyfish hold the prize for being a big animal. How are they big? What does the name Cheetah mean?	they are the longest they spin the largest they have the most body fat
What does the name Cheetah mean?	never sleeps spotted one no drink
What animal is the slowest on land?	spiders snails koalas
How do elephants stay cool?	by taking mud baths by making mounds having no hair
How do Hippos communicate?	by honking by flying by scratching