

# Promoting Low-Income Preschoolers' Vocabulary Learning From Educational Media: Does Repetition Support Memory for Learned Word Knowledge?

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Children from diverse backgrounds are able to learn new words from educational media. However, learning is often partial and fragile, leaving much room for uncovering strategies that can increase the efficacy of educational media in supporting children's vocabulary knowledge. The present study investigated one such strategy—repeated viewing of educational media—in a sample of low-income preschoolers. One hundred thirty one preschoolers were randomly assigned to view an educational media clip teaching three vocabulary words in one of three conditions: (a) once, (b) three times in immediate succession (massed repetition), or (c) three times with views spaced 1 hour apart (spaced repetition). Children completed a target vocabulary assessment both immediately after the final view and 1 week later. Results indicate that certain types of word knowledge were supported by repetition, particularly spaced repetition. Children also effectively retained the vocabulary knowledge they acquired from educational media over a 1-week period in all conditions. This suggests that educational media is a strong platform for teaching low-income preschoolers new words, and that spaced repetition might further support low-income preschoolers' vocabulary learning.

**Keywords:** educational media; memory; vocabulary; repeated viewing; spacing effect

Preschoolers today are immersed in technology in their daily lives (Rideout, 2017). Fortunately, they often use this technology to view educational media programs—content delivered through a platform (e.g., television, iPad) that specifically aims to support learning or skills such as building vocabulary knowledge (Rideout, 2014; Vandewater & Bickham, 2004). Supporting vocabulary development is a valuable enterprise for these media

programs since children who enter school with limited vocabulary knowledge are at risk for encountering academic difficulties throughout their schooling (Cunningham & Stanovich, 1997; Storch & Whitehurst, 2002; Tamis-LeMonda, Kuchirko, Luo, Escobar, & Bornstein, 2017). This becomes a particularly salient concern for preschool children from low-income households, as the socioeconomically-based differences in vocabulary that are formed during the early childhood years predict stable and enduring growth trajectories thereafter (Farkas & Beron, 2004).

The ubiquity of media access allows for platforms such as educational media programming to reach diverse populations, and potentially serve as an important contributor to the vocabulary development of young children from low-income households. Prior research shows that this potential is at least partially realized—many studies have shown that preschoolers from a variety of socioeconomic backgrounds can learn new words through educational media (Mares & Pan, 2013; Neuman, Wong, Flynn, & Kaefer, 2019; Rice, Conti-Ramsden, & Snow, 1990). As such, research strongly supports the notion that educational media can be a highly beneficial vehicle for the vocabulary development of low-income preschoolers.

However, in spite of the vocabulary gains children can make through educational media, prior research also consistently finds that not all children learn an equal amount from educational media—children tend to learn more new words from media when they have stronger initial vocabularies (Blewitt, Rump, Shealy, & Cook, 2009; Neuman et al., 2019; Senechal, Thomas, & Monker, 1995). Studies have found that children from lower socioeconomic backgrounds are in need of greater vocabulary development opportunities than their peers from higher income households (Farkas & Beron, 2004). Considering this association between income and vocabulary, educational media may not yet be an equalizing force in vocabulary growth for children from lower socioeconomic backgrounds. Ultimately, we still have much to uncover about the best practices for utilizing educational media to support the vocabulary development of children with diverse backgrounds and learning needs.

In the present study, we contribute to this critical need for understanding how to optimize educational media use for low-income learners by investigating a potentially useful mechanism that could benefit low-income preschoolers' memory for new words taught in educational media—providing repeated exposure to the media. We additionally compare learning from two schedules of repetition—massed repetition that involves repeatedly viewing media in immediate succession, and spaced repetition during which the repeated views are spaced apart in time. Overall, the goal of the present study was to investigate the effects of repetition and repetition timing on low-income preschoolers' immediate vocabulary learning and longer-term retention of new words taught to them through educational media programming—as well as whether repetition might particularly support the vocabulary learning of children with weaker baseline vocabularies.

## **REPETITION AND LEARNING**

The impact of repetition on word learning is derived from theoretical accounts of vocabulary development in children. One of the processes associated with word learning involves the fast mapping of a new word's representation to a partial meaning of that word (Swingley, 2010). This fast mapping occurs quickly and unintentionally with very limited exposure to the word and its meaning. Across a variety of word learning platforms including educational media, children have demonstrated this capacity to map new words to their meanings in incidental learning contexts with remarkably brief exposures to words. However, successful fast mapping of new words does

not always occur for children, and even when fast mapping does occur, the knowledge obtained through fast mapping is likely to be incomplete and fragile. As such, theorists now suggest a combination of word learning processes—one being fast mapping—and another being slow, or extended mapping (Kucker, McMurray, & Samuelson, 2015; Swingley, 2010). The latter process involves the development of a more complete and robust word representation over time through repeated exposure and use of the word over time. In this way, providing repeated exposure to an educational media program would increase the likelihood that these slower mapping processes of word learning could begin to take hold. This might help children create stronger representations of new words.

Aligned with theory, studies looking at word learning by dual-language-learners have shown that repetition can significantly improve their vocabulary learning. In a meta-analysis of 26 studies on repetition and incidental vocabulary learning, Uchihara, Webb, and Yanagisawa (2019) found that repetition supported learning with a medium effects size. Nakata (2017) similarly found that vocabulary learning was stronger overall when a greater number of repetitions were provided. In other learning contexts, when looking at repetition in child populations, repeated reading of text among elementary-aged children has been associated with improvements in learning word meanings from text (Biemiller & Boote, 2006). Read-aloud interventions with preschoolers have similarly shown the benefits of repetition for vocabulary learning (Swanson et al., 2011; Trivette, Simkus, Dunst, & Hamby, 2012). Though extensively studied in foreign language learning and reading contexts, far fewer studies on the influence of repeated exposure have been conducted in the context of educational media. Aligned with the work on reading, these studies have shown that repeated media viewing can support vocabulary development, but different studies have shown variations in the conditions under which such benefits have occurred.

Silverman (2013), for example, studied kindergarten children viewing educational video, and found that viewing the video three times supported word learning more so than viewing it once for expressive vocabulary measures, but not receptive ones. Verhallen, Bus, and de Jong (2006) similarly found that kindergarten-aged children's expressive vocabulary learning was supported through multiple exposures to an e-book that incorporated sound and animations. Korat and Blau (2010) investigated the repeated use of an interactive e-book with dictionary and play features with preschoolers, and found that receptive vocabulary was enhanced through repeated interactive e-book use. Overall, these studies suggest that repetition has the potential to support certain forms of vocabulary learning from educational media. A significant limitation of this body of work, however, is that all discussed studies on repetition of educational media have employed a spaced learning schedule. This means that the repeated exposures typically spanned multiple days. We therefore have limited knowledge of how different schedules of repetition might impact vocabulary learning from educational media.

## **REPETITION SCHEDULES**

Though little work has investigated the effects of varied repetition schedules on word learning from educational media, these effects have been extensively studied in other contexts. The two schedules of repetition that have received the most attention are the massed and spaced schedules (Son & Simon, 2012). Massed schedules involve learning instances occurring one immediately after another with no breaks in between. Spaced schedules, in contrast, involve

temporally spacing out learning instances. Research has been conducted in a variety of settings, including basic experimental paradigms, classroom science lessons, and study schedules for exams, and this work overwhelmingly suggests that spaced presentations result in superior learning as compared to massed presentations (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Donovan & Radosovich, 1999; Son & Simon, 2012).

For example, Vlach, Sandhofer, and Kornell (2008) studied spaced category induction in 3-year-olds and found that spaced presentations allowed children to forget previously seen information and ultimately perform better on a delayed multiple choice test. Even with more complex content, such as learning about the science topic of food chains, spaced lessons produced stronger learning outcomes than massed lessons (Vlach & Sandhofer, 2012a). Real-world applications of vocabulary learning in classrooms have similarly shown that spaced learning supports long-term retention compared to massed learning (Goossens, Camp, Verkoeijen, Tabbers, & Zwaan, 2012; Sobel, Cepeda, & Kapler, 2011). Research on adults has been conducted over dramatically varying spacing intervals, and has found that the length of the gap between learning instances as well as the length of time the learned information needs to be retained are important considerations in how effective spaced learning might be for long-term memory (Cepeda, Vul, Rohrer, Wixted, & Pashler, 2008). For instance, re-learning information a few months after the initial exposure is likely to support remembering that information for much longer than a re-learning after a few days.

Researchers have theorized that spacing learning episodes apart in time is a critical component of bringing fast mapping to the more robust state of slow, or extended mapping. In particular, giving children the time to forget previously learned information before being exposed to it again appears to be a potential mechanism that supports long-term retention and the ability to generalize learned words to new representations or contexts (Vlach & Sandhofer, 2012b). As such, the benefit to spacing (termed the “spacing effect”) might be particularly strong for longer-term retention of information rather than immediate recall (Son & Simon, 2012).

Nonetheless, spacing out learning events has not always been associated with improvements in memory. Slone and Sandhofer (2017), for example, found that spaced presentations resulted in stronger learning than massed presentations for young children only when children were already biased to attend to that category. In other words, the spacing effect was only observed for learning features that children were more likely to spontaneously attend to. In an investigation of spacing effects in intentional versus incidental learning in children, Toppino, Fearnow-Kenney, Kiepert, and Teremula (2009), demonstrated a spacing effect for intentional learning, but also found that children did not show a spacing effect in an incidental learning task. As such, intentional, explicit learning and study events have often shown a spacing effect, but results are less clear for incidental, unintentional learning contexts.

Overall, prior research on repetition schedules suggest that spaced schedules may be helpful for children’s vocabulary learning from educational media—and particularly for their long-term retention. However, learning from educational media is largely incidental in nature. This media is typically viewed for entertainment, and preschoolers are rarely explicitly trying to learn and remember words being discussed in the program. In this light, research by Toppino et al. (2009) suggests that the incidental learning context of educational media might not lend itself as readily to a spacing effect. If this is the case, it is possible that both massed and spaced schedules produce similar benefits to word learning from educational media. The present study therefore investigates how incidental vocabulary learning from educational media is impacted by spaced and massed repetitions of media exposure.

## THE PRESENT STUDY

The aim of the present study was to investigate the role of repeated viewing of educational media as well as two repetition schedules (spaced and massed) on children's immediate learning and long-term retention of vocabulary discussed in the media. We investigated this question in a low-income sample of preschoolers—a group in particular need of vocabulary support. Preschoolers were randomly assigned to one of three conditions: one view of the media clip, three views massed together, or three views with a 1-hour spacing between each view. Children viewed an educational media clip that incorporated three vocabulary words in their respective condition, and were given a vocabulary posttest both immediately after the final view of the clip and 1 week later. We sought to answer the following research questions in our investigation:

- i. Does providing repeated exposure to educational media clips on varying schedules support low-income preschoolers' vocabulary learning?
- ii. Does massed and/or spaced repetition support longer-term retention of vocabulary knowledge compared to a single exposure?
- iii. Does spacing or repetition particularly support the learning of children with weaker baseline vocabularies?

## METHOD

### *Participants*

Participants were 131 preschoolers enrolled in three Head Start Centers located in high poverty areas in a large urban city in the United States ( $M_{age} = 54.31$  months; standard deviation ( $SD$ ) $_{age} = 3.50$  months; 47% female). Head Start centers were developed to provide free preschool education for young children in families that have incomes below the federally determined poverty line, and these centers exclusively serve this low-income population. The sample was representative of the diversity of low-income households in the area: 54% were Hispanic, 29% were African American, 12% were West Indian/Caribbean, and 5% were Asian or Other. All children qualified for free and reduced lunch. Institutional Review Board (IRB) approval was obtained for this study. Educational directors, teachers, and parents provided consent for participation in the study, and children provided verbal assent.

### *Research Design*

The present study used a between-subjects design to assess the influence of repeated viewing of educational media on vocabulary learning. Children were randomly assigned to one of three conditions: the one view condition, in which children viewed the educational media clip once, the massed repetition condition, in which children viewed the clip three times in immediate succession, and the spaced repetition condition, in which children viewed the clip three times with a spacing of approximately 1 hour between views. All videos were viewed on laptop computers. Children completed a vocabulary posttest immediately after the final viewing of the video (immediate posttest) as well as 1 week later (delayed posttest).

Our primary comparisons of interest included the between-subjects factor of repetition condition (3: one view, massed repetition, spaced repetition) and the within-subjects factor of posttest timing (2: immediate, delayed). We additionally included median splits on peabody picture vocabulary test (PPVT) scores (2: lower PPVT, higher PPVT) and age (2: younger, older) to

determine if repetition condition impacted children differently based on extant vocabulary or developmental factors. The covariate of prior target vocabulary receptive pretest knowledge was also entered as a covariate to account for any preexisting understanding of the target vocabulary words.

### *Educational Media Episode and Word Selection*

All participants viewed the same video clip in their assigned condition. The video clip was derived from the educational program *Bubble Guppies*. This program was selected because it provided an engaging context for vocabulary learning, which included repetition, clear visual depictions of words, and actively engaging viewers by asking viewers questions about the target words. One condensed, 4-minute episode was generated for this study that incorporated three thematically-linked words: *organs*, *lungs*, and *stomach*.

The clip and three vocabulary words were selected based on three criteria. First, all words needed to be repeated 5–10 times, provide an ostensive definition, and include clear visual depictions of the word that were temporally aligned with the auditory labels. The second criterion was that the selected words are important and useful to learn—Tier 2 words as described by Beck, McKeown, and Kucan (2002). Finally, we attempted to minimize the likelihood of children having prior knowledge of the words by limiting words to those with low frequencies on the CHILDES ChildFreq database (MacWhinney, 2014).

### *Measures*

**Expressive Screening and Receptive Pretest Measure.** Participants completed an expressive screening and receptive pretest measure prior to participating in the study. For the expressive screening, children were shown a picture depicting each target word and were asked, “What part of the body is this?” Children were eligible to participate in the study if they did not have an expressive understanding of any of the target words. Twenty-four children answered one or more expressive questions correctly, and did not participate in the main study protocol. The receptive pretest incorporated six questions (three target words and three foil words), in which children were shown three pictures and were asked to point to a word (e.g., “Point to the *lungs*”). Scores on the receptive pretest for target words represented an index of partial understanding, and were included as a covariate in analyses.

**PPVT** (Dunn & Dunn, 2007). The PPVT is a validated, norm-referenced assessment with reliability ranging from .91–.94. Age-standardized scores on the PPVT were used to assess baseline receptive vocabulary.

**Posttest Vocabulary Assessment.** Children’s learning from the educational media clip was assessed through a 12-item assessment that included four question types: receptive word labeling–screenshot images (three items), receptive word labeling–cartoon images (three items), expressive vocabulary (three items), and auditory definitional understanding (three items). Reliability for the posttest vocabulary assessment was  $\alpha = .64$ . The same posttest was administered twice to each child—once immediately following the final video view, and once a week after the immediate posttest. Details of each question type are outlined below.

**Receptive Word Labeling–Screenshot Images.** Receptive word labeling utilized a format similar to the PPVT and receptive pretest. Children viewed three picture options, and selected one of the three images representing the target word (e.g., “Point to the *lungs*”). The receptive-screenshot images were all screenshots from the educational media clip. Questions were designed to be

challenging—both distractor images were strongly perceptually and thematically related to the target word. For example, the distractor screenshot images for the word *stomach* were a screenshot of the lungs (another target word), and a screenshot of arteries and veins in the neck. Children answered one receptive screenshot question per target word.

*Receptive Word Labeling–Cartoon Images.* This assessment format was identical to the receptive-screenshot image questions, only using non-screenshot cartoon images. This question type assessed whether children were able to extend their receptive labeling knowledge to new, unfamiliar visual representations of the target words. We used one cartoon image question per word, for a total of three items on this assessment type.

*Expressive Vocabulary.* For this assessment, children viewed one cartoon image of each target word and were asked to provide the label for the word (e.g., “What part of the body is this?”). Children answered one expressive vocabulary question per word.

*Auditory Definitional Understanding.* Auditory definitional questions were the only question type that did not include any visual components or aids. This assessment tested how effectively children linked the target words to definitional details independent of the visual elements provided by the media clips. We asked children one forced-choice question about a fundamental definitional feature of each vocabulary word (three items total). For example, for the word *lungs*, children were asked, “What do *lungs* help us do? Breathe, or Buy toys?” Children then provided an expressive response to indicate their choice. The correct answer was represented by the first option for two of the questions and the second option for the remaining question.

### Procedure

Children participated individually in the study in a quiet location at their preschool. Trained graduate student assessors blind to the hypotheses of the study first administered the screening pretest measure and PPVT, and randomly assigned eligible children to one of the three repetition conditions. On a different day from the pretest, children participated in the main study protocol in their respective condition. Children viewed all media clips on a laptop computer. All posttests were administered in paper-and-pencil format in which children saw color pictures printed on paper, while the assessor asked questions written on a separate sheet of paper and recorded their answers. For the one view condition, children watched the 4-minute educational media clip once and completed the posttest immediately after.

Children in the massed repetition condition viewed the media clip three times in a row. In between views, assessors told children that they would be watching the same video again as they rewound the clip. Children completed the posttest immediately after the third and final view.

In the spaced repetition condition, children viewed the media clip three times, with approximately 1 hour between views. The average time between the first and second view was 64.84 minutes ( $SD = 5.87$  minutes), and the average time between the second and final view was 61.93 minutes ( $SD = 4.81$  minutes). Children completed the post-test immediately after the third and final view.

One week following the main study and immediate posttest, children in all conditions completed the same posttest a second time (delayed posttest) to assess whether they retained the information learned from the media clips after a 1-week delay.

### Analysis

In order to assess how repetition condition impacted (a) vocabulary learning from educational media, (b) retention of vocabulary knowledge 1 week later, and (c) different groups of participants based on baseline vocabulary (PPVT) and age, we used a repeated measures analysis of covariance. The model included the within-subjects factor of posttest timing (2: immediate, 1-week delayed), the between-subjects factors of a median split on baseline vocabulary (2: lower PPVT, higher PPVT), and age (2: younger, older), and the covariate of receptive pretest scores (mean-centered) to account for possible prior knowledge influences. Dependent variables were the accuracy proportions on the four posttest assessment question formats. Standard PPVT scores for the lower PPVT group averaged 69.43 ( $SD = 8.53$ ), approximately two standard deviations below the population mean, while the higher PPVT group averaged 93.83 ( $SD = 9.39$ ), slightly below the population mean of 100. The three repetition condition groups were comparable at baseline, with no significant differences ( $ps > .500$ ) between groups on age, PPVT standard score, or receptive pretest score (see Table 1 for means).

## RESULTS

In the present study, we investigated whether vocabulary learning from educational media would improve with repeated exposure to the media clip on two different schedules (massed and spaced). We had three primary research questions: (a) Does repeated massed and/or spaced viewing of educational media improve vocabulary learning compared to a single view, (b) Does repeated viewing impact retention of learned information over a 1-week lag, and (c) Does repetition promote learning for certain sub-groups of our sample such as those with lower baseline vocabularies or younger children. Results for each research question are presented below.

### *Effects of Repetition Condition on Vocabulary Learning*

In order to determine how vocabulary learning differed by repetition condition overall, we conducted repeated-measures analyses of covariance on each of the four posttest question types and ascertained the main effect of the between-subjects factor of repetition condition.

Analyses revealed a significant main effect for the between-subjects factor of repetition condition on two of the four vocabulary assessment types: receptive word labeling of screenshot images,  $F(2, 118) = 3.69, p = .028$  and expressive vocabulary,  $F(2, 118) = 3.70, p = .028$ . For

**TABLE 1.** Means (Standard Deviations) of Demographic and Baseline Variables Between Groups

	One View	Massed Repetition	Spaced Repetition
Age (months)	54.02 (3.79)	54.46 (3.12)	54.46 (3.63)
PPVT standard score	81.70 (15.09)	80.28 (14.23)	83.71 (15.76)
Receptive pretest score	.24 (.23)	.28 (.25)	.24 (.22)

*Note.* PPVT = peabody picture vocabulary test.  
No significant differences between the three conditions ( $p > .50$ ).



receptive word labeling–screenshot questions, the spaced repetition condition scores were significantly higher than the one view condition scores,  $t(83) = -2.22, p = .029$ , while the massed repetition condition scores fell between the two and did not significantly differ from either. For expressive vocabulary, the massed repetition and one view conditions had equivalent scores,  $t(88) = .23, p = .817$ , while the spaced repetition condition scored marginally higher than the other conditions,  $t(85) = -1.92, p = .058$ . Overall, the spaced repetition condition appeared to be most beneficial to vocabulary learning for the children in our sample.

### *Effects of Repetition Condition on Vocabulary Retention*

We next investigated whether children retained the vocabulary knowledge they acquired from educational media 1 week later, and whether this retention differed based on repetition condition. Table 2 shows the means and standard deviations of scores on the immediate and delayed posttests for each assessment type.

The main effect for the within-subjects factor of posttest timing revealed that children did in fact retain the information from the immediate to the delayed posttest. There was no significant main effect of posttest timing for receptive word labeling–screenshot questions,  $F(1, 118) = .083, p = .774$ , receptive word labeling–cartoon questions,  $F(1, 118) = .218, p = .642$ , or auditory definitional questions,  $F(1, 118) = .119, p = .731$ . For expressive vocabulary, there was a significant increase from the immediate to the delayed post-test,  $F(1, 118) = 17.05, p < .001$ .

In order to determine if retention of vocabulary knowledge differed by repetition condition, we used the interaction between repetition condition and posttest timing. A significant interaction between repetition condition and posttest timing emerged for one of the four posttest question types—auditory definitional questions,  $F(2, 118) = 4.48, p = .013$ . Follow-up paired  $t$  tests for each repetition group revealed that there were no differences between the immediate and delayed posttests for the two repetition groups, but that performance significantly declined from the immediate to the delayed posttest for the one view condition,  $t(43) = 2.63, p = .012$ .

**TABLE 2.** Means (Standard Deviations) of the Proportion of Questions Answered Correctly on the Immediate and 1-Week Delayed Posttests by Repetition Condition

Assessment	One View		Massed Repetition		Spaced Repetition	
	Immediate Posttest	Delayed Posttest	Immediate Posttest	Delayed Posttest	Immediate Posttest	Delayed Posttest
Receptive screenshot	.71 (.33)	.73 (.27)	.81 (.24)	.73 (.27)	.78 (.22)	.85 (.21)
Receptive cartoon	.69 (.32)	.71 (.30)	.64 (.35)	.62 (.36)	.76 (.34)	.74 (.29)
Auditory definitions	.67 (.27)	.55 (.30)	.57 (.27)	.62 (.31)	.67 (.27)	.67 (.27)
Expressive	.21 (.24)	.28 (.28)	.20 (.21)	.28 (.28)	.27 (.25)	.39 (.29)

We next compared performance on auditory definitional questions against chance levels (.5 correct—the proportion of correct responses that would be expected if children were guessing on the multiple choice two-response-option questions). Results revealed that in the one view condition, children performed significantly better on auditory definitional questions than chance level on the immediate posttest,  $t(43) = 4.11, p < .001$ , but that this dropped to performing at chance level by the delayed posttest,  $t(43) = 1.02, p = .316$ . For the massed repetition condition, children performed at chance on the immediate posttest,  $t(45) = 1.63, p = .110$ , but better than chance at the delayed posttest,  $t(45) = 2.69, p = .010$ . The spaced repetition condition was the only one that consistently resulted in performance above chance levels on the auditory definitional questions, both at the immediate posttest,  $t(40) = 3.97, p < .001$  and at delayed posttest,  $t(40) = 3.97, p < .001$ .

Overall, children appeared to retain the information they learned from educational media for at least 1 week. This retention occurred regardless of repetition condition for all visual post-tests, and occurred in the massed and spaced repetition conditions, but not the one view condition for the auditory-only posttest. For the auditory-only posttest, the spaced repetition condition was the only one that consistently produced performance above chance levels at both testing points.

### *Baseline Vocabulary and Age Effects*

We then sought to understand how vocabulary learning differed based on PPVT and age (main effects), as well as whether repetition condition differentially impacted children with differing baseline characteristics (interactions between repetition condition and PPVT/age).

Age had a significant main effect only on the receptive word labeling–cartoon image questions,  $F(1, 118) = 5.05, p = .026$  such that older children received higher scores than younger children. Baseline receptive vocabulary (PPVT) had a more ubiquitous main effect, with children with higher PPVT scores outscoring their lower PPVT peers on all four posttests—receptive screenshots,  $F(1, 118) = 7.64, p = .007$ , receptive cartoons,  $F(1, 118) = 13.44, p < .001$ , expressive vocabulary,  $F(1, 118) = 30.38, p < .001$ , and auditory definitional questions,  $F(1, 118) = 18.49, p < .001$ .

An investigation of the interactions between PPVT scores and repetition condition showed that repetition condition differentially impacted learning based on baseline vocabulary for one posttest – receptive word labeling of cartoon images,  $F(2, 118) = 3.84, p = .024$ . Follow-up  $t$  tests revealed that there were no differences based on PPVT for the spaced repetition or one view conditions. The lower PPVT group scored significantly lower than the higher PPVT group specifically on the massed repetition condition,  $t(44) = -4.55, p < .001$ . There were no significant interactions between repetition condition and age.

Overall, results suggest that providing additional repetition typically impacted children similarly regardless of their age or baseline vocabulary. The strong main effects of PPVT also revealed that neither form of repetition (massed or spaced) could close the gap in vocabulary learning between children with lower and higher baseline vocabularies.

## **DISCUSSION**

The present study examined how repeated viewing of educational media using massed and spaced schedules impacted low-income preschoolers' immediate learning and long-term retention of vocabulary knowledge. We found that repetition—particularly when the repetitions

were spaced apart in time—benefited children’s learning of certain vocabulary associations. Encouragingly, we also found that children retained the vocabulary knowledge they learned through educational media for at least 1 week. However, we also uncovered a strong effect of baseline vocabulary, such that children with larger vocabularies were still able to learn more words than those with weaker baseline vocabularies even when repetition was provided. This suggests that repetition alone cannot help close the gap in word learning between those with higher and lower baseline language skills.

Prior work investigating how repeated exposure to educational media impacts young children’s vocabulary learning has typically used a spaced schedule— and this line of work has consistently revealed that at least some vocabulary associations are supported by providing these spaced repetitions (Korat & Blau, 2010; Silverman, 2013; Verhallen et al., 2006). Aligned with this research, we found that spaced learning benefited vocabulary learning for two of our measures of vocabulary understanding—receptive questions using screenshot depictions of words, and expressive vocabulary questions. Overall, it seemed that providing three times the exposure to educational media had some benefits to children’s learning, but this did not extend to all types of vocabulary knowledge.

Silverman (2013), for example, found that spaced repeated viewing benefited children’s learning over a single view of educational media only for expressive vocabulary, not receptive vocabulary. The other two studies found benefits to repetition, but assessed only one form of vocabulary knowledge each—one looking at receptive vocabulary, and the other expressive vocabulary. The present study demonstrated learning benefits to repetition in one of our two receptive measures as well as our expressive vocabulary measure. This suggests that repeated viewing of educational media may not support all forms of vocabulary learning, and that the specific media and implementation strategies used may matter for the types of vocabulary associations that are promoted through repetition.

Children were also able to retain the vocabulary knowledge they gained through educational media in all three conditions. Only one type of vocabulary knowledge—questions assessing children’s understanding of the label-definition link without any visual aids—showed superior retention of knowledge in the repeated viewing conditions over the single view condition. For auditory-only vocabulary knowledge that did not directly link to media visuals, it seems that the added auditory input from repetitions helped sustain learning over time. Visual learning, however, was sustained even with a single exposure to educational media. Both massed and spaced repetition aided in maintaining this representation of auditory vocabulary knowledge. As such, the spacing effect—the finding that spaced learning is superior to massed learning, particularly for long-term retention (e.g., Cepeda et al., 2006; Donovan & Radosevich, 1999; Son & Simon, 2012)—was not as pervasive in our study.

The relatively weak spacing effect we observed aligns with the work of Toppino et al. (2009), who found that children’s incidental learning may not show as clear benefits of spacing as more intentional learning. Preschoolers rarely approach media with the explicit intention of learning vocabulary—they view media primarily for entertainment, and the vocabulary they learn is a by-product of their attention to the program more so than the child’s original intent for viewing. The incidental learning nature of educational media may have lessened the benefits of a spaced learning schedule over a massed one. Nonetheless, of the three variations of educational media studied, the spaced presentation provided the strongest gains on at least some aspects of word learning overall. When consuming media in their daily lives, children often enjoy viewing the same programs over and over again. The present study suggests that this natural

tendency for children may be beneficial to strategically employ in educational settings to support preschoolers' vocabulary learning and retention.

Even though repetition showed promise as a strategy for supporting the vocabulary learning of low-income preschoolers, we showed a similar pattern observed in prior work (e.g., Blewitt, et al., 2009; Neuman et al., 2019)—that children with stronger baseline vocabularies learned more effectively from educational media than children with weaker baseline vocabularies. As such, even though repetition predicted some learning gains for children, this was insufficient in closing the gap in learning based on extant language factors. Prior work suggests that repetition is a strategy that might compensate for lack of experience with language, for example, with English Language Learners (Sibold, 2011). We found that the opportunity to repeatedly view educational media did not provide additional support to children who were particularly weak in their English vocabularies. It instead supported all children somewhat equivalently. However, it is possible that our sample of low-income preschoolers more generally represented children in need of additional support—including those with stronger vocabularies. The higher vocabulary group in this study had an average vocabulary that was lower than the standardized population mean, supporting this interpretation. It is possible that the repetition we provided in this study would not have produced as significant gains for children with vocabularies that were above average on a population level.

The present study provided important insight into supporting children's word learning through repeated viewing of educational media, but our study had some limitations. In terms of our educational media materials, we specifically selected a strong educational media clip that provided extensive repetition of vocabulary terms within a single presentation of the clip. It is possible that repetition may show a heightened impact for educational media that has a weaker depiction of vocabulary—a possibility that can be investigated in further research. Even though our study made a valuable contribution by assessing retention of vocabulary over a 1-week period, it is possible that the word knowledge gained through educational media might dissipate over a longer timeframe. We additionally had a relatively small sample size, so future studies should replicate our findings in different geographic areas and with different media. Finally, we assessed only one schedule of spacing in which views were spaced 1 hour apart. Considering our finding that spaced repetition has the potential to support learning, further research should investigate the impact of varied schedules of spacing (e.g., 10 minutes, 1 day) on children's vocabulary learning and retention.

As media becomes common in households across the world, the present study demonstrates that educational media is a platform that can support low-income preschoolers' vocabulary learning, and that children are able to maintain the word knowledge they learn from media over time. Encouragingly, children can learn from even a single exposure to educational media, and having children repeatedly view the media on a spaced schedule can enhance some types of learning. Though we have further to go in terms of lessening the learning divide based on extant income and language factors, the present study brings us one step closer to making educational media learning environments conducive to the needs of diverse, low-income preschoolers.

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