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Explicit and Contextual Vocabulary Intervention: Effects on Word and Definition Learning

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Abstract

Two single-case studies examined the effects of a vocabulary intervention on K-second grade Deaf or Hard-of-Hearing (DHH) children's vocabulary learning. The intervention consisted of (a) explicit instruction that included fast mapping, and drill and practice games and (b) in-context activities that included book reading, conceptual activities, and conversation. Study 1 compared the effectiveness of in-context alone and explicit+in-context instruction for four DHH children. This multiple baseline across content study showed that children learned more words rapidly in the explicit + in-context condition. Study 2 examined the effects of the explicit+in-context intervention on five DHH children's word and definition learning and use of new words in spontaneous communication. A multiple baseline study across participants showed that all children learned the targeted vocabulary, improved expression of definitions, and used target words in spontaneous language. We discuss the value of explicit and in-context instruction on breadth and depth of vocabulary learning.

Introduction

Vocabulary is an important contributor to educational achievement for all children. For typically hearing children, vocabulary size in early childhood predicts language and literacy outcomes up to fifth grade (Lee, 2011). In Deaf or Hard-of-Hearing (DHH) children, vocabulary is a predictor of reading comprehension (Harris et al., 2017). Many DHH children have difficulty acquiring vocabulary words appropriate for their age or grade level (Antia et al., 2020). Thus, vocabulary development is a concern for many teachers of DHH (TODHH) children. Most of the vocabulary intervention research with DHH children has focused on preschool children or on reading vocabulary. The purpose of this article is to describe the results of two single-case vocabulary intervention studies with young elementary DHH children. In the first study, we compared children's learning of targeted spoken or signed vocabulary under two conditions; an in-context condition where children were exposed to target words during book reading and related activities and a condition during which, in addition to in-context exposure, target words were explicitly taught by bringing words to children's attention and engaging them in activities providing receptive and expressive practice (designated the explicit+ condition). In the second study, we examined the effects of the explicit+ intervention on children's learning of vocabulary words and definitions, and the use of newly learned words in spontaneous language.

Vocabulary of DHH Children

Several researchers have documented delays in DHH children's vocabulary learning when compared to their hearing peers (Fitzpatrick et al., 2011; Wake et al., 2004; Yoshinaga-Itano et al., 2017). For many DHH children, vocabulary delays are evident at a young age, even when the children have received early intervention. Yoshinaga-Itano et al. (2017) examined the vocabulary of 448

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DHH children between 1 and 4 years of age, enrolled in early intervention programs, of whom 74% used primarily spoken language. The authors reported the results as a Vocabulary Quotient (VQ). A quotient of 100 would indicate that the child's vocabulary was commensurate with age. The average VQ for DHH children without additional disabilities was 77.6 showing a considerable delay. These authors also found that, although the children's absolute vocabulary size increased with age, the gap between their chronological and vocabulary age also increased. The slower pace of vocabulary growth can lead to difficulties with literacy and content learning by the time DHH children enter school.

Researchers have also reported that, although some groups of young DHH children score within the average range of standardized vocabulary tests, they score below matched groups of hearing peers. Fitzpatrick et al. (2011) compared the receptive spoken vocabulary of preschool DHH children with mild-to-severe hearing loss with their typically hearing (TH) age-mates. Although the DHH students scored within the average range, their scores were significantly lower than the TH comparison group. Similarly, Colin et al. (2013) found that 6-year-old DHH children using cued speech received significantly lower receptive vocabulary scores than their TH age-mates.

Studies of elementary-age DHH children indicate that they might be considerably delayed on both expressive and receptive standardized vocabulary tests. Wake et al. (2004) reported on a population study of Australian DHH children between 7 and 9 years of age. The average receptive vocabulary standard score for the sample was 78, more than 1 SD below the test mean. Antia et al., 2020 assessed the expressive vocabulary of 336 DHH children with moderate-to-profound hearing losses in kindergarten, first, and second grade. Children were assessed in the Fall and the Spring of the academic year. Although they made significant gains during the school year, the group average standard score remained 1 SD below the mean and 56% of the sample scored below the average range of the test.

Effective Vocabulary Intervention for Young Children

While many children with typical hearing learn new vocabulary without specific instruction, simple exposure to new vocabulary might not be sufficient for children with lexicons smaller than usual for their age. In a review of research on vocabulary instruction, the National Reading Panel (National Reading Panel, 2000) concluded that instruction should be both in-context and explicit. During in-context instruction, teachers provide children with multiple exposures to new words through book reading and conversational exchanges. During explicit instruction, teachers additionally provide children information about the new words and engage students in activities designed to provide opportunities for them to express or discuss the new vocabulary. Marulis and Neuman (2013), in a meta-analytical review of interventions for young children at risk for vocabulary delays, found that interventions that combined in-context and explicit instruction had the largest effect size on vocabulary learning outcomes.

Ideally, vocabulary instruction should increase both vocabulary breadth and depth. Breadth refers to the number of words that children know and is typically measured by asking children to recognize or label words. Interventions designed to increase vocabulary breadth expose children multiple times to new words, most often in the context of book reading, conversation, and other everyday activities. Vocabulary depth refers to the quality of knowledge about words including their meanings and appropriate usage (Dickinson et al., 2019). Vocabulary knowledge can be considered on the following continuum (Christ & Chiu, 2018; Phythian-Sence & Wagner, 2007): (a) recognition; (b) context-bound or contextualized meaning knowledge; (c) de-contextualized meaning knowledge; and (d) both contextualized and de-contextualized meaning knowledge. Such deep knowledge is acquired gradually through repeated encounters in different situations. Vocabulary depth can be measured by having children provide definitions of the target vocabulary and by assessing children's use of new words in sentences or spontaneous expressive language. Most effective vocabulary interventions for young children use some combination of in-context and explicit instruction, intentionally exposing children to new vocabulary during teacher–child interactions and during book reading, along with providing explanations and definitions of new words.

Studies with young TH children, particularly those with small lexicons for their age, indicate that they are more likely to learn words through purposeful instruction rather than incidental exposure. Dickinson et al. (2018) compared children's learning of words during embedded book reading alone and embedded book reading supplemented with a play intervention. During embedded book reading, teachers drew the children's attention to target words and asked children inferential and literal questions related to the book. During the play intervention teachers additionally led the children through a re-enactment of the book, using questions and props to elicit children's use of the target words. Children were also exposed to a set of control words during book reading, but these words were neither emphasized nor elicited. Results showed that children made significant and large pre- to post-test gains on both receptive and expressive knowledge of target but not control words in both conditions.

While many children can learn to recognize new vocabulary words through embedded exposure during book reading, acquiring depth of vocabulary meanings is more likely to occur with direct explicit instruction. Dickinson et al. (2019), in a study of four-to-five-year-old TH preschoolers, found that children made similar increases in receptive learning (breadth) of target words through either explicit instruction or exposure to the target words during book reading. However, only explicit instruction, which included provision of word definitions, teacher talk using target words, and activities where children were encouraged to use the target words, resulted in depth of vocabulary learning, measured by children's definitions of the target words.

Coyne et al. (2007) also compared kindergartners' learning of vocabulary words taught through in-context or explicit instruction. During in-context instruction, children were exposed to words during story reading. During explicit instruction, children additionally engaged in activities during which they could discuss and use the target words. Children were better able to define words and understand word definitions through the explicit instruction than the in-context condition. In short, the research with TH children indicates that in-context exposure can result in increasing vocabulary breadth but increasing vocabulary depth requires additional explicit instruction including provision of word definitions and opportunities for children to use target words in conversation and discussion.

Research on Vocabulary Interventions for Young DHH Children

For DHH children, in-context incidental exposure may not be sufficient for expanding vocabulary breadth or depth. Lund and Douglas (2016) used an alternating treatment design to compare

the learning of nine preschool DHH children learning oral language under three conditions: an incidental exposure condition where teachers labeled target words during everyday classroom instruction; an in-context condition where teachers used the target vocabulary when expanding children's utterances during play with objects associated with the target vocabulary; and an explicit instruction condition where teachers engaged children in both expressive and receptive practice with pictures of the targeted vocabulary. Children learned almost no new words through incidental exposure. While they learned some words through in-context instruction, they learned the most words through explicit instruction. Similarly, Mueller and Hurtig (2009) found that exposure to signing e-books resulted in inconsistent learning of new vocabulary by four preschool DHH children.

Cannon et al. (2010) reported that the four elementary-age DHH children in their single-case study were not able to learn new words through in-context exposure to sign language recordings of math expository books. However, they learned the target words rapidly when they received explicit instruction from the teacher prior to watching the recordings. Explicit instruction included drawing attention to the target words through flashcards and providing definitions. In a follow-up single-case study of five DHH students, Guardino et al. (2014) found that all children could label the target words when they received both explicit instruction provided by the teacher, followed by in-context exposure by viewing the recorded sign books. Davenport et al. (2017) showed that explicit instruction resulted in rapid expressive labeling of target vocabulary for two DHH preschool children that was maintained after a week. During the explicit instruction intervention, the teacher labeled the photograph and had children sign the correct word, first jointly with the teacher and then independently. In all these studies, the researchers examined the effect on the number of words the child could label (vocabulary breadth) but did not measure depth.

Several researchers have examined the effectiveness of interactive book reading, which can include both in-context and explicit instruction, on increasing DHH children's vocabulary. Children are exposed to the target vocabulary in-context during repeated readings of the same book, and are prompted, through teacher questions, to use the vocabulary. Trussell and Easterbrooks (2014) and Trussell et al. (2017) examined the effects of interactive book reading on vocabulary learning through two single case research studies, one with four DHH preschoolers (Trussell & Easterbrooks, 2014), the other with 11 preschoolers (Trussell et al., 2017). In both studies, the children were able to label the target words and to retain them for several weeks. In a more recent single case study, Trussell et al. (2018) modified their interactive book reading intervention to include instruction on word meanings and were able to show that the six DHH preschool children who participated learned the targeted vocabulary and increased their ability to define the new words. Richels et al. (2016) also conducted a single case research study on interactive book reading with three DHH preschoolers and reported that the intervention had an effect on vocabulary depth; children could use the new words within sentences and also when retelling the stories. Vocabulary learning also occurs when parents engage in interactive book reading with their DHH children. Fung et al. (2005) found that elementary DHH children whose parents engaged them in interactive book reading made greater gains on a standardized vocabulary test than those children whose parents engaged them in repeated readings of the same story books. Thus, interactive book reading is a strategy that has the potential to improve breadth and depth of vocabulary learning.

In a study of elementary students, Coleman et al. (2015) showed that three second-grade DHH children were able to increase vocabulary depth by learning to define new vocabulary words after receiving explicit instruction either live by a teacher, or by a recording of the teacher's instruction. In both conditions the teacher signed, fingerspelled, and provided definitions of the target vocabulary and children were prompted to fingerspell the word and repeat the definition.

The results of the vocabulary intervention research with young DHH children indicates that (a) exposure to new vocabulary, whether through conversation or book reading, is not necessarily sufficient for expressive or receptive learning, and (b) a combination of in-context and explicit instruction seems to yield the best results. However, with few exceptions, researchers have focused on pre-school rather than elementary aged children, and few have examined both breadth and depth of vocabulary learning.

The Present Research

Despite the promising research on the effectiveness of vocabulary intervention with DHH students, and the considerable information on effective vocabulary intervention strategies for children with TH, the research on vocabulary intervention with DHH children is comparatively sparse. In a review of published vocabulary studies, Luckner and Cooke (2010) found only 10 intervention studies between 1967 and 2008. With few exceptions (Cannon et al., 2010; Guardino et al., 2014) successful interventions have not been replicated with different samples of DHH children. Several studies reviewed in the previous section did not collect both maintenance and generalization information (Cannon et al., 2010; Lund & Douglas, 2016), nor did they assess both breadth and depth of learning (Davenport et al., 2017; Mueller & Hurtig, 2009). None combined successful vocabulary instruction strategies into a single comprehensive package. Therefore, the purpose of the present research, through two successive and related studies, was to extend our knowledge of vocabulary instruction with kindergarten and elementary-aged DHH children by examining the effect of a comprehensive vocabulary instruction package on both breadth and depth of vocabulary learning by DHH children.

The Intervention: *Explicit and Contextual Vocabulary Instruction for DHH Children (ECV-DHH)*.

Because each study used similar intervention components and strategies, we provide the details of the intervention program in this section. The intervention ECV-DHH was adapted from an intervention for typically hearing preschool and kindergarten children entitled *PAVEd for Success* (Hamilton & Schwanenflugel, 2013; Schwanenflugel et al., 2010). Kindergarten children receiving the *PAVEd for Success* intervention increased their expressive vocabulary in comparison to a control group (Goodson et al., 2010). *PAVEd for Success* consists of explicit and in-context vocabulary instruction that includes (a) providing age-appropriate definitions of target words, (b) a strategy called the Novel-Name Nameless-Category that helps children associate a new vocabulary word with a new picture, (c) interactive book reading, (d) adult-child conversations and (e) extension activities. We included all the components but modified them as necessary.

Target Word Selection

We centered the vocabulary intervention units around science themes. For each vocabulary unit we first selected two children's books, one expository, one narrative, that were appropriate for children between KG—second grade. From these books, we selected approximately 20 target words that included words at tiers 1, 2, and 3 (Beck & McKeown, 2007). Tier 1 words are common words most likely to be learned incidentally through everyday interaction. Tier 2 words are more advanced words that can be used in a variety of contexts but may not be easily learned through casual interactions or infrequent exposure. Tier 3 words are technical and specific to a subject area and usually need targeted instruction. We also included a variety of word types including nouns, verbs, adjectives, and adverbs. Examples of the targeted words, with accompanying definitions, divided by tiers are in Appendix A. For each word, we developed child-friendly definitions adapted as necessary from various children's dictionaries. We made sure that all selected words could be signed as well as spoken. A few targeted words were fingerspelled if there was no appropriate sign or if the child could just point or mime. For example, the word "shade" in the Bats unit had no specific sign, while the word "gums" in the Dental Health unit could involve pointing. Both these words were therefore fingerspelled.

Intervention Components

The intervention consisted of four main components: fast mapping, interactive book reading, conversation, and extension activities. Details of the intervention strategies including completed vocabulary units and recordings illustrating each component are available on the website https://clad-vocab.coe.arizona.edu/.

Fast Mapping

The purpose of this introductory activity was to help draw students' attention to the target words. The fast mapping activity is based on the Novel Name-Nameless Category principle or N3C (Golinkoff et al., 1994; Hamilton & Schwanenflugel, 2013). When children are presented with an unnamed object (or picture) and a new word, they infer that the new word labels the new object. During the fast mapping activity, the teacher presented the child with three pictures, two of known words and one depicting the unknown target word and asked the child to identify the picture depicting the target word. After the child identified the correct picture, the teacher made the fast mapping strategy explicit by explaining, "You know this picture is a puppy, and this picture is a car. So this picture has to be toothpaste." She then gave the definition of the target word.

Interactive Book Reading

The purpose of the interactive book reading was to provide children opportunities to be exposed to, and to use the target word within a thematic and language context. The two books (from which the target words were chosen) were each read twice during the unit. During the book reading sessions, the teachers asked questions that allowed the students to use the target words. Following *PAVEd for Success* (Hamilton & Schwanenflugel, 2013), we developed three kinds of questions: (a) competence questions for which answers could be found within the text or pictures; (b) abstract questions which required the students to predict, infer, or solve problems related to the theme and (c) relate questions which required students to connect the concepts and target words to their own experiences. A total of six questions (two of each kind) were developed for each book. Teachers asked only three questions during each book reading so as not to excessively interrupt the flow of reading.

Extension Activities

These provided opportunities for students to use the target words and definitions. We developed two kinds of extension activities. Drill and practice activities were games where children had frequent opportunities to say or sign the target words and definitions. Conceptual activities included arts and crafts activities, or role plays that gave children opportunities to use the target words in connected language.

Teacher–Child Conversation

Conversations could be stand-alone activities or incorporated into the conceptual extension activities. During teacher–child conversations, the teachers used strategies to encourage child-talk and that gave children opportunities to use the target vocabulary. These strategies included asking open-ended questions, acknowledging student contributions, following the student's lead, and recasting and expanding children's responses (Ruston & Schwanenflugel, 2010; Wood & Wood, 1984).

Study 1

Study 1 was designed to answer the question: Which instructional condition a) in-context only, or b) explicit plus in-context (explicit +) is more effective for learning and retaining vocabulary words? In-context instruction included interactive book reading, conceptual extension activities, and teacher–child conversations. Explicit instruction additionally included fast mapping and drill and practice extension activities.

Methods

Participants

Four DHH children participated in study 1. Two attended a center school for DHH and two attended a public school co-enrolled program. Children were referred to the study by their teachers. We obtained information on each child's degree of hearing loss and use of hearing technology from school files. Teachers rated the children on their thinking/reasoning and their expressive and receptive communication based on their typical mode of communication and their functioning (normally, mildly limited, severely limited) within the classroom (Antia et al., 2009). Children were also given the Expressive One Word Picture Vocabulary Test (EOWPVT; Martin & Brownell, 2011) which was adapted for use with students who used sign (Antia et al., 2020; Lederberg et al., 2019).

Emily Emily was a second grader with a profound bilateral loss. She was fitted with binaural hearing aids but did not use these consistently. Her home communication was simultaneous signed and spoken English. She used American Sign Language (ASL) at school. Her teachers rated her as functioning normally

in thinking and reasoning, and mildly limited in expressive and receptive communication. She received a standard score of 100 on the EOWPVT.

Martin Martin was a kindergartner with a cochlear implant that he used consistently. His home communication was spoken English. He used English-like sign at school. His teachers rated him as functioning normally in thinking and reasoning and severely limited in expressive and receptive communication. He received a standard score of 71 on the EOWPVT.

Hope Hope was a first grader with a cochlear implant that she used consistently. Her home communication was spoken English. She used simultaneous sign and spoken English at school. Her teachers rated her as functioning normally in thinking and reasoning, and mildly limited in expressive and receptive communication. She received a standard score of 66 on the EOWPVT.

Callie Callie was a kindergartner with a profound bilateral loss. She did not use any hearing assistive technology. Her home language was ASL and she also used ASL at school. Her teachers rated her as functioning normally in thinking and reasoning and in expressive and receptive communication. She received a standard score of 88 on the EOWPVT.

Experimental Design and Procedures

We used a non-concurrent multiple baseline design (Harvey et al., 2004) across three vocabulary units to answer the research questions. As in a multiple baseline design, the intervention phase of the three vocabulary units was introduced sequentially for each child. However, in non-concurrent multiple baseline designs, for logistical and practical purposes, baseline data are not collected concurrently and continuously across all data series (Gast, 2010). We did not start baseline assessments for all units at the beginning of the study. Instead, the baseline phase for Unit 2 was started during the intervention phase for Unit 1 and the baseline phase for Unit 3 was started during the intervention phase of Unit 2. Our pilot studies had shown us that children displayed distress at being repeatedly assessed on words they did not know. The non-concurrent design allowed us to complete a baseline assessment for each unit immediately prior to the intervention for that unit, thus avoiding extended and repeated baseline assessments (not to mention child frustration). After the intervention activities for the unit were completed, intervention ceased, and maintenance data were obtained during a maintenance phase.

We developed three vocabulary units around science content: Bats (unit 1), the Moon (unit 2), and Dental Health (unit 3). We checked with children's teachers that these topics were not going to be taught during the semester that we conducted the vocabulary intervention. For each unit we selected one expository and one narrative children's book. From these books, we selected 15–20 possible target vocabulary words and created accompanying child-friendly definitions. The teacher researchers decided jointly on signs for each vocabulary word to ensure that they were consistent in signing the target vocabulary during intervention. We screened children for their knowledge of all possible target words and selected 10 unknown target words for each child. Each child had a different list of unknown target words. Although we did not balance each child's list for word difficulty across units, we tried to target as many tier 2 words as possible, without excluding tier 1 or tier 3 words. We also tried to target a mix of nouns, verbs and adjectives for each child, though again, these were not balanced across units or children.

For each child, five of the 10 target words were randomly selected to be taught only during the in-context activities, (the in-context condition). The other five were taught during both the explicit and in-context activities (the explicit + condition). As an example of the kinds of words taught, Emily's in-context condition words for Unit 1 (Bats) were *upside down*, *search*, *dive*, *thumb*, *roof*; her explicit+ condition words were *hang*, *wings*, *mango*, *cave*, and *young*. Martin's in-context words were *dive*, *wings*, *feet*, *young* and *hang*; his explicit+ words were *branch*, *mango, delicious*, *roof*, and *search*. Assessment and intervention were conducted in children's preferred communication mode.

The intervention was conducted by two researchers who were also experienced TODHHs. We refer to them as teacher researchers. Each had over 15 years of experience working with DHH children at preschool and elementary levels. One is TH and a fluent signer; one is Deaf and a native signer. They both worked full-time on the research project and were involved in all aspects of design, intervention, and data analysis. Because both teacher researchers worked full-time for the research study and designed the intervention with the research team, they received no additional training. However, the research team (the two teacher researchers and the first three authors) met weekly to discuss intervention and assessment procedures as needed. Each teacher researcher was assigned specific children with whom she worked during the course of the study. Assignments were made based on the preferred communication mode of the child and the children's and teacher researchers' schedules.

Assessment

Words We created picture cards depicting each word. All 10 target word cards (5 in-context words, 5 explicit + words) were presented in random order at each assessment. The teacher researcher showed the word card to the child and elicited the target word with an appropriate question, for example, "What is this?", "What is she doing?" All target words were assessed in the same manner during baseline, intervention, and maintenance phases. All assessments were conducted by the teacher researcher who was working with the child. Each assessment was recorded.

Child responses were initially scored live during the assessment administration by the teacher researcher who re-scored from the recording. If there were discrepancies between live scoring and scoring from the recordings, we used the score obtained from the recording. Target words were scored as correct or incorrect. Fingerspelled words were scored as correct if the child produced most of the letters within a fluent envelope. To obtain inter-scorer reliability, a second researcher re-scored one baseline, one intervention, and the follow up assessment for each child for each unit from the recordings for a total of 43% of all assessment sessions.

Treatment Integrity We created a treatment integrity checklist that was used by the teacher researchers to create their lesson plans (see Appendix B). Each intervention session was recorded. A second researcher obtained treatment integrity data using the checklist. Each item on the checklist received a score of 0 (if absent) or 1(if present). Treatment integrity was calculated as a percentage of the total observed items for each component divided by the total possible items for that component. Thus, we obtained treatment integrity for each intervention component

(fast mapping, book reading, conceptual activity, drill and practice activity, and teacher–child conversation) for each of the three units for each child. We were able to examine total treatment integrity (averaged across all components and all units for all children) and also integrity for each intervention component averaged across units and children. To obtain inter-rater reliability for treatment integrity, a third researcher observed recordings of four different intervention sessions and independently completed the treatment integrity checklist for each.

Study Phases

Baseline During baseline, the teacher researchers assessed each child three times (once per session) on all target words for the unit. We tried to obtain at least two of these baseline assessments on meeting days that were immediately prior to the intervention sessions for that unit. However, because of children's absences and school activities we did not always obtain three contiguous assessments. Because we selected an individualized list of unknown target words for each child, we expected baseline scores to be consistently at 0.

Intervention During intervention, the teacher researchers met with each child, one-on-one, in a quiet room for approximately 15–20 minutes, 3 days a week. Each 15-minute session included two or more intervention components (fast mapping; interactive book reading; conceptual extension activities; drill and practice extension activities). Target words for both the in-context and explicit + condition were included during the interactive book reading and the conceptual extension activities. Additionally, the target words for the explicit + condition were introduced with the fast mapping activity and were practiced during the drill and practice extension activities. Thus, children encountered all 10 target words during the interactive book reading and extension activities but encountered, and were instructed on, only the 5 explicit+ target words during the fast mapping and drill and practice activities.

The fast mapping activity occurred once at the beginning of the intervention. Interactive book reading occurred four times with each of the two books being read twice. The entire book was usually read at a single session and teachers asked a combination of competence, abstract, and relate questions during each reading. Extension activities included two conceptual activities and two or three drill and practice activities. We assessed target vocabulary three times during the intervention phase at about every second or third intervention session. Assessment always occurred at the beginning of the session. Because the purpose of the study was to compare words learned in the two conditions, the intervention phase ended when all intervention activities were completed, whether or not children had mastered the targeted words.

Maintenance We were able to take one maintenance data point approximately three weeks after intervention ceased. The end of the school semester prevented us from obtaining additional maintenance data.

Results

Inter-scorer Reliability and Treatment Integrity

We calculated simple percentage reliability between scorers for each intervention session. For each child, 43% of sessions were scored by one of two independent observers from the recordings.

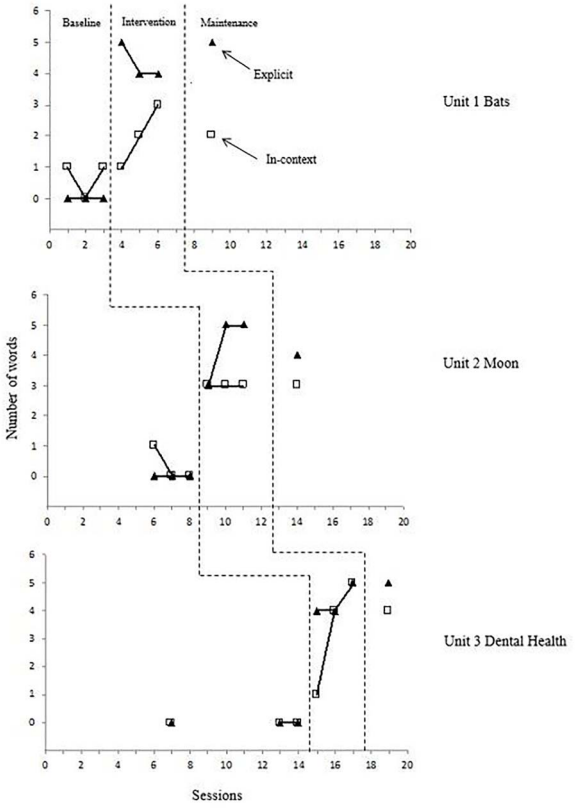

Figure 1 Study1: number of explicit and in-context target words learned by Emily.

Overall reliability between observers across sessions averaged 97% with a range from 85% to 100%.

Treatment integrity ranged from 87% to 94% across units. We also examined treatment fidelity by activity. Treatment integrity was highest for drill and practice extension activities (98%), followed by fast mapping (94%), conceptual activities (92%), teacher–child conversation (82%), and book reading (73%). Inter-rater reliability for treatment integrity ranged from 83–100%.

Comparison of Conditions

Figures 1–4 show the results for each child in the study for both the in-context and explicit + target words.

In-context Condition Baselines were at 0 for all children for all units with the exception of Emily who knew 1 target word for Unit1. All four children learned some targeted words in the in-context condition, though target words were not consistently learned across all three units. We counted as learned those words that children knew at the end of the intervention phase. Emily learned between 3 and 5 words across units; Martin learned between 0 and 1 word; Hope learned between 1 and 4 words; and Callie learned between 0 and 4 words. Emily showed immediacy of effect for Units 2 and 3. She showed an immediate and stable change in level for Unit 2 and an upward learning trend for Units 1 and 3. Martin showed no immediacy of effect for any of the three units. He did not learn any words in Unit 1 but did exhibit an upward learning trend for Units 2 and 3. Hope showed immediacy of effect for Unit 3 and an upward learning trend for Units 1 and 2. Callie showed immediacy of effect for Unit 2 and an upward trend for Units 1 and 3. All

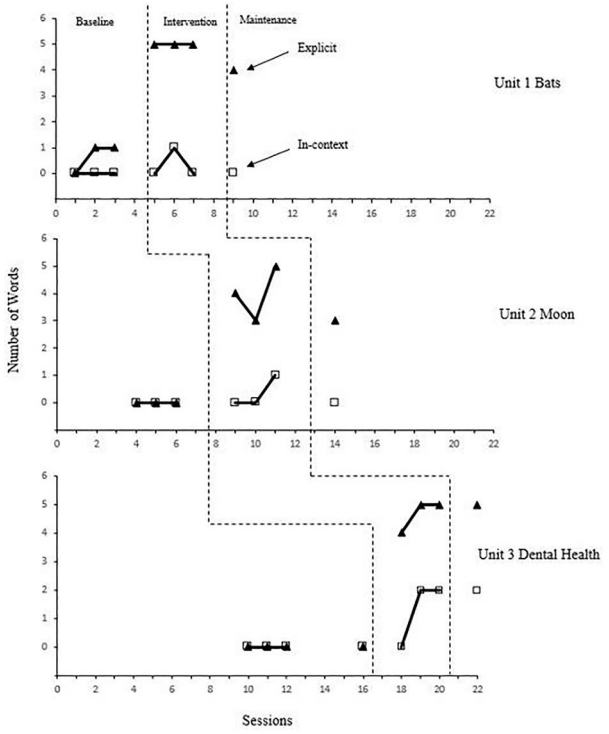

Figure 2 Study1: number of explicit and in-context target words learned by Martin.

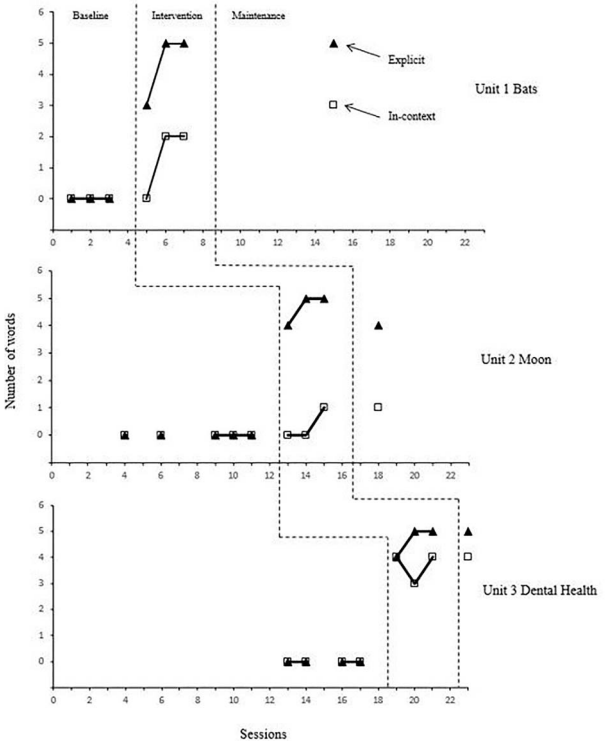

Figure 3 Study1: number of explicit and in-context target words learned by Hope.

children retained most but not all learned words. Over the course of the three units Emily learned 11 words and retained 9; Martin learned three and retained two; Hope learned seven and retained eight; and Callie learned and retained 6. PND (percentage of

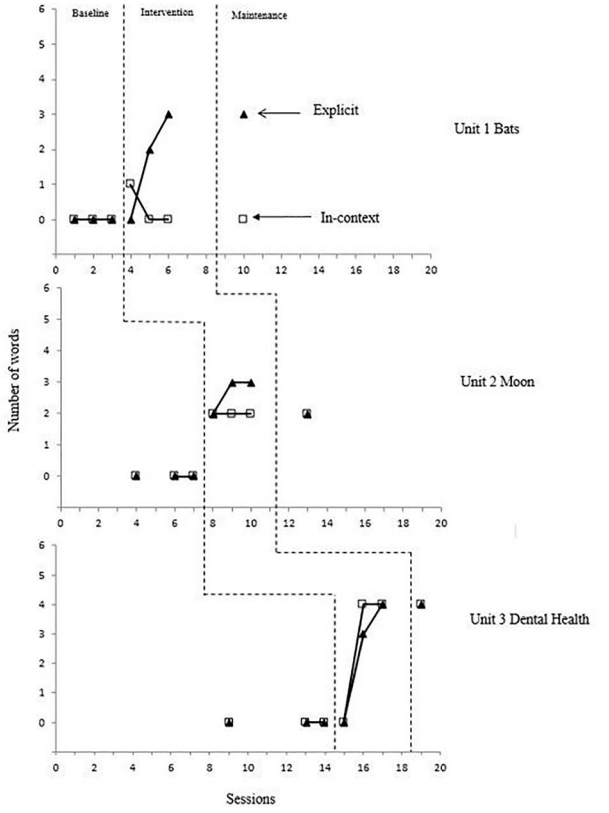

Figure 4 Study1: number of explicit and in-context target words learned by Callie.

non-overlapping data points, which provides a measure of the magnitude of the intervention) was variable across children and across units. For no child was PND 100% for all units. PND was 100% for Units 2 and 3 for Emily, Unit 3 for Hope, Unit 2 for Callie and none for Martin. PND ranged from 33% to 66% for all other units for all four children.

Explicit + Condition Emily, Martin, and Hope learned between 4 and 5 target words across all three units while Callie learned between three and four words. Emily, Martin, and Hope showed immediacy of effect and an upward learning trend for all three units with the exception of Unit 1 for Emily. Callie showed immediacy of effect for Unit 2 and an upward trend for Units 1 and 3. Over the course of the three units children retained most, but not all of the target words. Emily learned 14 and retained 15 words; Martin learned 15 and retained 12; Hope learned 15 and retained 14; and Callie learned 10 and retained 9. PND was 100% across all three units for the explicit+ condition for Emily and Hope, for units 1 and 2 for Martin, and unit 2 for Callie. PND was 66% for all other units for Martin and Callie.

Contrast between Conditions All children learned more target words and also learned them more rapidly in the explicit+ condition than in the in-context condition. They retained most learned words in both conditions, but since fewer words were learned in the in-context condition, fewer words were retained. Across children, PND was more consistently at 100% for the explicit+ condition than the in-context condition. All four children learned and retained more in-context words during the third and last unit (Dental Health) than during the other units.

Study 2

Study 1 showed that the explicit+ instruction had a greater impact on target word learning as shown both by number of words learned and consistent PND. Therefore Study 2 was designed to replicate the results of the explicit + instruction with another group of participants and to examine depth of vocabulary learning. We examined children's ability to provide meaningful definitions of target words (a skill required in content areas such as science and social studies) and generalization of target words to children's spontaneous communication. Study 2 was designed to answer the following specific questions:

- Will children learn and maintain new vocabulary as a result of explicit plus in-context (explicit+) instruction?
- Will children improve their ability to provide definitions of new vocabulary as a result of the intervention?
- Will children use newly learned vocabulary in spontaneous connected language?

Participants

Five children participated in Study 2. Three attended a center school for DHH and two attended a public school co-enrolled program. They were referred to the study by their teachers. Demographic information obtained was similar to that obtained for Study 1. The intervention was conducted by the same teacher researchers as in Study 1.

Allison Allison was a second grader with a bilateral profound loss. She was fitted with binaural aids but did not wear them consistently. ASL was her home language and the language she used at school. Her teachers rated her as functioning normally in thinking/reasoning and in receptive and expressive sign communication. She received a standard score of 88 on the EOWPVT.

Dylan Dylan was a second grader with a bilateral severe loss. He wore binaural aids and used an FM system consistently. His home language was English. He used simultaneous sign and spoken communication in school. His teachers rated him as functioning normally in thinking/reasoning, and in receptive communication and mildly limited in expressive communication. He received a standard score of 78 on the EOWPVT.

Darrell Darrell was a first grader with a bilateral moderate loss. His home languages were spoken English and Spanish. He used simultaneous sign and spoken English in school. We did not receive ratings from his teacher for thinking/reasoning skills. She rated him as mildly limited in both expressive and receptive communication. He received a standard score of 56 on the EOWPVT.

Sherry Sherry was a second grader. Her teacher was unable to give us any information about her hearing loss or HAT use. Her home language was spoken English, and she used simultaneous spoken and signed communication at school. We did not obtain ratings from her teacher for thinking/reasoning, but she was rated as mildly limited in expressive and receptive simultaneous communication. She received a standard score of 67 on the EOWPVT.

Monica Monica was a first grader with bilateral cochlear implants. Her home language was spoken and signed English. She used simultaneous spoken and signed communication at school. Her teachers rated her as functioning normally in thinking/reasoning skills and receptive communication and mildly limited in expressive communication. She received a standard score of 80 on the EOWPVT.

Experimental Design and Procedures

We used a single-case, multiple probe design across participants. For this study the children were taught one unit (Dental Health) and the intervention was introduced across participants in a staggered manner. Each participant was initially assessed on the entire list of possible target words; we selected eight unknown words as target words for each student. As in Study 1, the selected list was different for each student.

Assessment and Scoring Target words were assessed in the same way as for Study 1. Picture cards for all eight words were presented in random order at each assessment probe. Scoring was similar to that completed for Study 1. Definitions were probed once each during baseline, intervention, and maintenance phases. We had piloted asking children for definitions at each assessment, and found that, because of the short time we could spend with the children (20 minutes a day, three days a week), and the time it took to repeatedly assess definitions, we could not both assess and implement the intervention during our assigned time. We also found that children became extremely frustrated at being asked to repeatedly complete this task.

In order to assess definitions, the teacher researcher elicited a definition of each word by prompting the child with a question such as "Tell me about it" or "What does it mean?" Definitions were scored only on children's spoken or sign expressions; points, gestures or pantomimed actions were not considered definitions. We created a scale for definition scoring and created examples for each target word (available from authors). Definitions were scored on a scale of 0 to 3. A score of 3 indicated complete knowledge, defined as providing a synonym or a paraphrase of the definition provided by the teacher during intervention. A score of 2 indicated partial knowledge, defined as use of the target word in a phrase that partially illustrated the word meaning, or a definition that omitted some critical information. A score of 1 indicated beginning knowledge, defined as providing a word or phrase related to the definition. A score of 0 indicated no knowledge, defined as providing an unrelated word or no response. To illustrate, the target word *decay* was defined by the teacher as "when teeth get slowly ruined." A score of 3 was given for the child definition "teeth get black from eating candy." A score of 2 was given for "teeth are dirty." A score of 1 was given for "bad." A score of 0 was given to "bugs." Detailed scoring guidelines are available from the authors.

Use of target words in spontaneous connected language was assessed during a pre- and post-intervention book walk. We asked children to look at and narrate a book on the topic (Dental Health) that would elicit the target words. The book was not one of the two used for the interactive book readings during the intervention. The book had pictures and text, but none of the children could read the books; they were asked to narrate from the pictures. Prior to the post-intervention book walk, the target words were displayed on a chart and children were reminded of their newly learned words. However, the teacher researchers did not prompt use of the target words during the children's narration. Target words were scored as being used if they were used at least once by the child during the narration. Thus, the

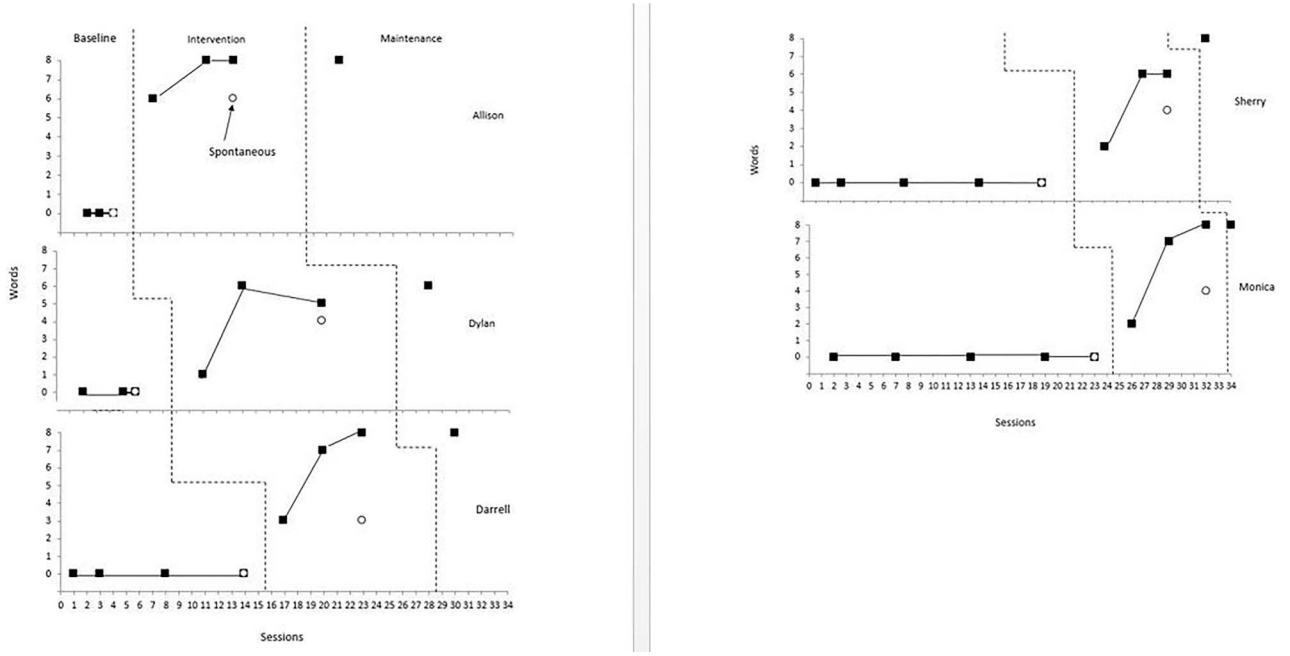

Figure 5 Study 2: number of words learned and number used spontaneously.

highest score that could be obtained was eight as there were eight target words for each child.

Study Phases

Baseline Baseline probes for target words were conducted periodically for each child (Figure 5). We assessed definitions during the second baseline assessment. The book walk to assess the use of target words in spontaneous connected language was conducted during the final baseline assessment.

Intervention As in Study 1, teachers met with the children one-on-one in a quiet room for 15–20 minutes, three days a week. All target words were introduced with the fast mapping activity. Interactive book reading was conducted as described for Study 1. Extension activities included two or three conceptual and two or three drill and practice activities. Teacher–child conversations were either stand-alone or incorporated into the conceptual activities. Acquisition of target words was assessed at approximately every third intervention session at the beginning of the session. Definitions were probed at the final intervention session as was the post-intervention book walk to assess spontaneous use of target words.

Maintenance We obtained one maintenance data point on target words and definitions approximately two-to-three weeks after intervention ceased.

Treatment integrity We used the same treatment integrity checklist as for Study 1 (see Appendix B). The teacher researchers used the integrity checklist to plan and evaluate each intervention session. Recordings of intervention sessions were observed by the second and third authors who examined one recording of each intervention component (fast mapping, interactive book reading, conceptual and drill and practice extension activities, teacher–child conversation exchanges) for fidelity. We also checked that each targeted word was used at least once by the teacher researcher during the fast mapping, and the conceptual and drill and practice activities.

Results

Interscorer Reliability and Treatment Integrity

Words were scored by the teacher researchers during the assessments. Definitions were scored from video recordings by the second and third authors. Thirty-three percent of all assessments were rescored by either the second or third authors. Overall percentage agreement was 100% for words and 96% for definitions.

Treatment integrity was 100% for the fast mapping, interactive book reading, drill and practice and conceptual extension activities, and 93% for conversational exchange. A total of four intervention components were observed by two researchers to obtain 94% interobserver reliability for treatment integrity.

Words

Figure 5 shows the results of single word learning for all five children. Baseline probes showed that none of the children knew any of the targeted words prior to intervention. Three children, Allison, Darrell, and Monica, learned and maintained all eight target words; Dylan learned and maintained six words. Sherry learned six target words by the end of the intervention and was able to label all eight words at maintenance. There was no overlap between baseline and intervention scores for any child; therefore, PND was 100% for each child. The pattern of learning was similar across children. Immediacy of effect was seen for all five children though magnitude of change varied at the first intervention assessment; Allison, learned six words while all the others learned between 1 and 3 target words within the first three intervention sessions (shown by the first intervention

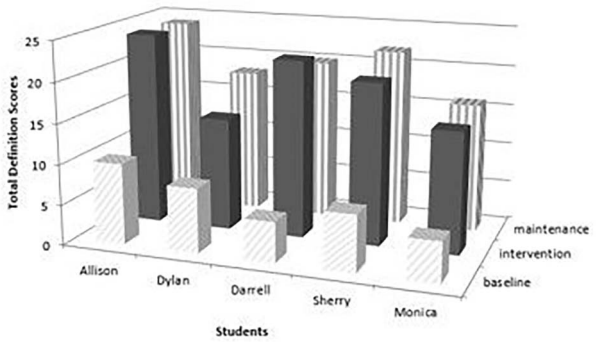

Figure 6 Total definition scores for target words.

assessment data point). Four children showed an upward or level trend for the second and third intervention assessment. Dylan showed a slight downward trend at intervention session 3 (from six to five words). All children maintained learned words during intervention.

Definitions

Figure 6 shows the results for definitions during baseline, at the end of the intervention and at maintenance. The maximum score possible for definitions was 24 (if each of the eight targeted words received the highest score of 3). The scores for all children increased from baseline to intervention and remained high during maintenance. At the end of the intervention and during maintenance, Darrell gave improved definitions for all eight target words while Allison, Sherry, and Monica gave improved definitions for seven words. Dylan gave improved definitions for four target words at the end of intervention and six words at maintenance.

Spontaneous Word Use

Figure 5 also shows children's spontaneous use of the target words in connected language during the book walks. None of the five children used any target words during the book walk conducted during the baseline phase. Allison used six words during the post-intervention book walk. Dylan, Sherry, and Monica each used four words, while Darrell used three words.

Discussion

In both studies we demonstrate a functional relation between the explicit+ vocabulary intervention and children's learning of target words. This is shown by the immediacy of effect at intervention, the non-overlapping data between baseline and intervention assessments and maintenance of new words at levels similar to intervention levels. A similar functional relation is not clearly seen for words in the in-context condition. The results of the two studies also showed that explicit instruction combined with in-context instruction resulted in increases in both breadth and depth of vocabulary learning. Children were able to label the new words, improve their ability to provide definitions of these words, and also to use the target word in spontaneous connected language. While several previous studies have shown that young DHH children can learn to recognize and name new words as a result of interventions (Davenport et al., 2017; Guardino et al., 2014; Trussell et al., 2017; Trussell & Easterbrooks, 2014) few have examined the effect of intervention on depth of vocabulary learning. Richels et al. (2016) found that an explicit intervention based around story books resulted in children's use of the target vocabulary within sentences and phrases, as well as during retelling books used during intervention while Trussell (2018) reported that children were able to provide definitions if teachers defined the target words during an interactive story book reading intervention. Our work extends these findings by showing that children could also use learned words while communicating about a novel expository book.

While increasing breadth of vocabulary is important, increasing depth of vocabulary may be more important for subsequent academic learning (Goodson et al., 2010). Depth of learning requires that students engage with the new vocabulary in several different contexts. The advantage of the multi-faceted intervention was that children were able to receptively see and/or hear the vocabulary used by the teacher in contexts as different as book reading and games; they also had many opportunities to use the vocabulary in connected language during teacher–child conversations and extension activities. While Study 2 showed that the intervention improved children's ability to provide definitions and use the words expressively during the book walks, we did not assess children's word knowledge apart from the unit theme. It still remains to be seen if this intervention can result in children's use of new words in unrelated contexts.

Understanding and expressing word definitions is an academic skill that is needed at higher grade levels to comprehend and write expository text. Our informal observations indicated that children initially had trouble separating the definition from the word. However, with practice in expressing definitions, and exposure to multiple examples of definitions during the intervention, each child improved in their ability to express definitions. Improvement did not mean that children learned definitions by rote. The scoring system allowed us to score partially correct definitions for each word, and therefore to examine incremental improvement. Nevertheless, the level of improvement was impressive, as four of the five children in Study 2 improved definitions of seven of eight new words.

Even though the explicit + instruction was more effective than the in-context instruction alone, all children learned some targeted words from in-context instruction. The in-context condition was similar to the incidental instruction that young children often encounter during adult–child interaction that occurs while reading stories and engaging in conversations. Our results are similar to that of Lund and Douglas (2016) who reported that, while incidental exposure was not always sufficient for children to learn new words, children learned some words through in-context instruction. However, in Study 1 we did not examine children's ability to use these words during unprompted spontaneous communication. Thus, it remains to be seen whether in-context instruction alone leads to both breadth and depth of vocabulary learning. Nevertheless, this finding is encouraging, because there is not sufficient time in a school day to teach all possible vocabulary words using explicit instruction.

It was not surprising that treatment integrity was high, as the teachers who conducted the intervention were also part of the research team that developed and adapted the intervention. It is also not surprising that treatment integrity was higher for Study 2 than Study 1 as the teacher researchers had gained experience delivering the instruction. However, it is worth noting that some components, namely teacher–child conversations and

interactive book reading had the lowest fidelity scores in Study 1. These are both in-context components, providing some possible insight as to why in-context instruction alone was not as effective as instruction that combined explicit instruction with the in-context components. The explicit components, such as fast mapping and drill and practice activities were more scripted than the in-context activities, and therefore may have been easier for teachers to conduct. While we did not examine the impact of explicit instruction alone, based on the vocabulary literature we would expect that the explicit instruction components by themselves are likely to result in single-word learning, but that the in-context components are necessary for learning how words are used and thus contribute to vocabulary depth.

Strengths and Limitations

There are several strengths that need to be pointed out. First, our ability to conduct two studies in sequence with different children allowed us to replicate the most effective intervention and to extend our work to examine both breadth and depth of vocabulary learning. The ability to work with teachers who were also part of the research team allowed us to capitalize on teacher knowledge and expertise and modify the intervention components as necessary. For example, the teacher researchers pointed out that they found the fast mapping activity extremely powerful in drawing children's attention to the new words and their definitions, and recommended it be conducted more than once during unit. And finally, we are able to show that the intervention is equally successful with children who use spoken language, sign language, or both.

Our strength in having teachers on the research team, is also a limitation, because we are not able to show that classroom teachers can use the intervention efficiently or easily. We have coached itinerant teachers to use the intervention in individual sessions with children whom they serve (manuscript forthcoming). Another limitation is that, because we conducted the intervention with individual children, we expect that strategies and intervention components will need to be modified when teachers work with groups of children.

Some methodological limitations should also be pointed out. In Study 1, children probably encountered the in-context target words less frequently than the explicit+ target words. We did not keep track of the teacher frequency of use of target words in either condition. In Study 2 we did not draw children's attention to the target words during the pre-intervention book walk though we did so at the post-intervention book walk. Although all target words were unknown to children based on our first baseline assessment, it is not impossible that children might have been able to use target words in context during the pre-intervention book walk.

Implications for Practice

There are two major implications for practice. One is that explicit instruction that draws children's attention to words and definitions to be learned and also provides them with practice in expressing both words and definitions results in rapid learning of new words and increases their ability to provide definitions. The second is that in-context instruction through book reading, and conversations about content during which the new words can be used by both teachers and children, enhances the ability of children to use the words in spontaneous connected language. Thus, explicit and in-context components are complementary and should be used by teachers.

Also, we recommend that teachers select Tier 2 words for instruction through the explicit+ intervention. Tier 1 words can likely be learned through in-context instruction alone. Tier 3 words are content specific and should be incorporated into instruction in content areas as they are unlikely to be used outside of those content areas. Tier 2 words, however, are those that are used in a variety of contexts but may not be learned incidentally through exposure.

We were careful to choose words that children did not know. For teachers who meet individually with children, pre-assessment to determine unknown words is important, because there is no point in spending time and effort on teaching known words. This might be more difficult in a group situation. But again, we would emphasize selecting and targeting unknown Tier 2 words for explicit + instruction and selecting and targeting unknown Tier 1 words for less time-consuming in-context instruction alone.

Implications for Further Research

Obviously, we need to examine the effectiveness of the instruction in the classroom with groups of DHH students. While we have short term maintenance results, researchers of future studies should probe for longer term maintenance, perhaps three months instead of three weeks. In addition, research using single case designs usually includes relatively few children and replication with additional children with different characteristics is warranted.

One intriguing finding from Study 1 was that children learned more words from in-context instruction during the final unit (Dental Health), bringing up the possibility that, over time they became more aware of words and actively used the fast mapping strategy to learn words they did not know. Thus, it may be that the explicit components of the vocabulary intervention can be phased out or reduced in intensity over time as children become more independent word learners.

Previous studies have focused on pre-school children, and the studies reported here were conducted with children in K-second grade. We need to examine whether the intervention can be used equally effectively with children in the upper elementary grades and how it might need to be modified for different groups of children including deaf plus children. And finally, we need to examine how some of these strategies might be incorporated into children's learning of print vocabulary.

Conclusion

Our research shows that a multi-faceted vocabulary intervention that deliberately includes both explicit and in-context components can result in breadth and depth of vocabulary learning within a relatively short time. We have also shown that the strategies for vocabulary teaching are equally effective for children using sign or spoken language. The next steps will include adapting the intervention for efficient classroom instruction and for older DHH children and also assisting parents to use some of these strategies to enhance the vocabulary of their DHH children. The complete intervention manual can be obtained from the authors, and teaching strategies and vocabulary units are available on the website https://clad-vocab.coe.arizona.edu/.

Conflict of Interest

No conflict of interest was reported.

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A. Examples of Target Words and Definitions

Words	Definitions
Level 1	
Chewing	Use your teeth to make food soft
Worry	Think about problems
Healthy	Good for your body
People	Boys, girls, men, and women
Level 2	
Assistant	Someone who helps
Decay	When teeth get slowly ruined
Remarkable	Very good and amazing
Travel	Move from one place to another
Cling	Hold on tight
Level 3	
Roost	A place where bats sleep
Plaque	Sticky stuff from food and drink
Chalky	Looks white, dry, and rough

B. Treatment Integrity Checklist

Intervention component	Score
Fast mapping	
Teacher engaged student in fast mapping activity.	/1
Teacher presented picture cards and asked child to identify the card associated with target words.	/8
Teacher explicitly called attention to strategy used at least once by: • Modeling • Pointing out the strategy as used by the child • Having the child identify, explain, or explicitly use the strategy.	/8
Teacher provided quick definition for each word.	/8
Interactive book reading	
Each book is read twice.	/1
Teacher reads book to student.	/1
Teacher asked one competence question during reading.	/1
Teacher asked one abstract question during reading.	/1
Teacher asked one relate question during reading.	/1
Word cards are visible to student during book reading.	/1
Drill and practice extension activities	
Student is given an opportunity to take a turn to say or sign each target vocabulary word.	/8
Student is given an opportunity to take a turn to provide definition of each target vocabulary word.	/8
Conceptual extension activities	
Student is given an opportunity to take a turn to say or sign two or more target vocabulary words.	/1
Teacher uses two or more target vocabulary words during the activity.	/1
Teacher–child conversation	
Teacher engaged in related conversation during book reading or extension activities.	/1
Teacher gave student two or more opportunities to take a conversation turn.	/1
Teacher recast or expanded student utterances two or more times.	/1
Total	