Nonverbal Supports in Word Learning: The Potential of Music and Sound in Fostering Children's Vocabulary Knowledge

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To my loving parents, Scott and Ruta Reynolds, who allowed me to practice cello at odd hours of the night and always supported my passion for music.

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INTRODUCTION

Knowledge about words plays a critical role in one's ability to comprehend oral language and written text. Consequently, children's word knowledge at school entry affects later reading and academic success (Catts, Hogan, & Fey, 2003; Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Snow, Burns, & Griffin, 1998; Storch & Whitehurst, 2002). Various dimensions of vocabulary knowledge, such as the number of words known and the depth of word knowledge, are related to increased reading comprehension outcomes (Ouellette, 2006; Quinn, Wagner, Petscher, & Lopez, 2015; Tannenbaum, Torgesen, & Wagner, 2006). As a result, it is important for young children to build an extensive network of high quality lexical representations that will help make text more accessible (Perfetti, 2007).

Children enter school with varying linguistic experiences and word knowledge (Gee, 2013). Although children from non-dominant groups, such as non-native English speakers and children from low socioeconomic backgrounds, bring valuable linguistic knowledge to school (Moll, Amanti, Neff, & Gonzalez, 1992), these diverse learners tend to have lower vocabulary knowledge in the dominant language valued in school compared to their monolingual peers from higher socioeconomic backgrounds (Hoff, 2013). A consequence of this imbalance in school-valued vocabulary knowledge is that minoritized children face increased challenges in sustaining reading achievement in school, in part due to the difficulty in comprehending school texts (Hoff, 2013; Mancilla-Martinez & Lesaux, 2010; Páez, Bock, & Pizzo, 2011). In response to disparities between children's school-valued vocabulary knowledge, research has sought ways to support

children's word learning in school settings, especially for minoritized children from non-dominant groups.

A majority of vocabulary studies rely heavily upon verbal definitions and didactic approaches to teach children about words, which narrows our understanding of the different supports that may help children learn words. Augmenting typical language-based approaches to vocabulary instruction with nonverbal aids has the potential to broaden children's access to vocabulary learning, particularly minoritized children with lower English-language proficiency (Rowe, Silverman, & Mullan, 2013). To address this potential, this dissertation tests the hypothesis that nonverbal supports, specifically music and sound effects, can be drawn upon as multimodal aids for children's vocabulary acquisition in school settings.

Most research on multimodal vocabulary supports in early education limits their focus to the effectiveness of visual and verbal modalities, such as pictures, gestures, definitions, and books (Beck & McKeown, 2007; Biemiller & Boote, 2006; Coyne, Simmons, Kame'enui, & Stoolmiller, 2004; Dickinson et al., 2019; Gonzalez, et al., 2010; Pollard-Durodola, et al., 2011; Rowe et al., 2013; Tellier, 2008). While findings indicate that children learn words through these approaches to vocabulary instruction, current studies do not consider the isolated contributions of nonverbal supports in word learning or the potential of other multimodal activities that children and teachers engage in throughout the school day, such as music. Music-related contexts, in particular, might provide unique opportunities for fostering children's vocabulary knowledge. Music activates children's auditory senses though playful, interactive activities that promote positive emotional responses (Menon & Levitin, 2005; Gold, Zeighami, Benovoy, Dagher, & Zatorre, 2019). Additionally, music provides children the opportunity to hear and engage with words through songs, rhymes, and instrumental timbres. However, teaching vocabulary through

music has not been investigated by literacy researchers. As a result, it is unknown whether music-based activities might help children learn new words and deepen their word knowledge.

This dissertation draws from cognitive and semiotic theoretical perspectives to consider the effectiveness of music and sound in supporting children's word learning. The first paper advances a theoretical framework that provides a rationale for the need to examine semantic and attention-directing features of nonverbal supports and reviews the vocabulary literature to explore how nonverbal supports (gestures, pictures, and sounds) contribute to children's lexical representations. The second paper examines children's word learning with nonverbal sound effects, and the third paper explores children's word learning through songs.

In my first paper, I note that there is a lack of theory and empirical evidence regarding how nonverbal supports, including music and sounds, might impact children's knowledge about words. In my theoretical framing of the issue, I draw from the Lexical Quality Hypothesis (LQH; Perfetti, 2007) and Dual Coding Theory (DCT; Clark & Paivio, 1991; Paivio, 1986) to identify the components of lexical representations that affect reading comprehension and consider how lexical representations store nonverbal information about words. Pulling from these two cognitive theories, I argue that lexical representations are multimodal and benefit from multimodal instructional supports. The notion of multimodal lexical representations is woven across the three papers and informs my research on music and word learning.

To conceptualize how music, sounds, and other nonverbal supports function as an aid for teaching vocabulary, I employ Peirce's theory of signs (Peirce, 1958). According to Peirce, humans experience the world through verbal and nonverbal signs and use these signs to construct meaning in a process known as semiosis (Chandler, 2017). Signs can take on a variety of forms, including pictures, gestures, and sounds. These nonverbal aids can relate to words as signs in a

variety of ways. For example, sounds can perceptually represent a word's meaning (e.g., going from low to high pitch to represent the word *ascend*), be arbitrarily associated with a word (e.g., using a random sound to represent *ascend* with no tie to the word's meaning), or direct one's attention to important information about words (e.g., hearing a sound and focusing on what the teacher is saying about the word *ascend*). Informed by this perspective, I posit that the semantic content and the attention-directing properties of nonverbal supports in particular are important for conveying information about words. When considering music, I argue that sounds hold the potential to semantically represent word meanings and draw attention to words of interest.

An important concept that informed my argument of how words are learned through signs is the idea that signs are built on other signs (Chandler, 2017; Monelle, 1991; Siegel & Rowe, 2011). According to Peirce, "a sign is not a sign unless it translates itself into another sign in which it is more fully developed" (Chandler, 2017, p. 33). As one experiences new signs for a given object, their initial interpretation of the sign is extended and refined (Chandler, 2017; Nöth, 2014), thus creating a web of signs that helps a learner construct meaning. This web of signs framework can be applied to word learning. Initial signs for a new word can be transformed as learners are exposed to other signs that may vary in modality and relation to the object of interest. When children are taught a word's definition, their understanding of the words can be augmented through additional exposure to multimodal signs related to the word (see Nöth, 2014), such as sound. These sources of information can help a child better understand the meaning of the words, as well as the relevant contexts in which a word can occur, which may enhance the child's lexical quality (Perfetti, 2007).

As part of the first paper, I integrate these theoretical ideas in an accessible way and use them to analyze a how nonverbal supports have been used in vocabulary interventions. In a

review of the literature, I attend to the semantic content and attention-directing properties of nonverbal supports and focus on the instructional methods employed when using nonverbal supports to teach vocabulary. Additionally, I consider the types of words that studies have prioritized and how children's word knowledge was measured. My analysis highlights several implications for future research, including the need to consider the unique contributions of nonverbal supports in word learning, especially for abstract word types, and the need to consider other, less commonly researched sensory-based modalities, such music and sound, in word learning.

In the second paper, I focus on children's word learning through semantically related, nonverbal sound effects in a music classroom. Data were drawn from a vocabulary intervention implemented in first grade music classrooms. The intervention focused on an existing music education strategy called a sound story, which is a type of interactive read-aloud in which children help select and perform sound effects to associate with words in a book text (Andress, 1980; Cardany, 2013). Analyses reported in the paper focus on the extent to which children acquired rich lexical representations of words taught with sound effects compared to words taught with no sound during a storybook read-aloud. The findings provide initial evidence that nonverbal sound effects can enhance children's word learning. In congruence with the first paper, I posit that the semantic content and attention-directing properties of the sound effects helped children retain information about the taught words. Additionally, I argue that the method of instruction used in the intervention, which involved students selecting sounds for words and actively performing those sounds on musical instruments, was important for building children's lexical representations.

The third paper examines the effectiveness of songs in building preschool children's knowledge about words. The paper addresses whether songs benefit word learning beyond picture card-only vocabulary instruction and whether word learning is affected by the modality of a song's performance (sung or rhythmically spoken). Data were drawn from an intervention implemented in preschool classrooms in which children were taught words through three instructional activities: 1) picture cards plus a song that was sung, 2) picture cards plus a song that was rhythmically spoken, and 3) picture cards-only. Results suggest that sung and rhythmically spoken songs are effective contexts for word learning and may help deepen children's word knowledge beyond picture card-only instruction. While the nonverbal rhythmic and melodic elements of the songs did not contain semantic information about words, I posit that they directed children's attention to words and promoted engagement in the word learning activity.

Collectively, these papers address the need to consider how sounds and music supply multimodal opportunities for word learning. This line of inquiry is theoretically important because it broadens the range of instructional strategies and learning processes that may promote word learning. Results from this dissertation will contribute to a larger understanding of how musical contexts and activities can make school-valued words more accessible to children, especially language-minority learners and children from high poverty communities.

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CHAPTER II

BUILDING LEXICAL REPRESENTATIONS WITH NONVERBAL SUPPORTS

Introduction

Early word knowledge plays an integral role in children's later academic and reading success (Catts, Hogan, & Fey, 2003; Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Snow, Burns, & Griffin, 1998). Specifically, the quantity and quality of children's word knowledge impacts their reading comprehension (Ouellette & Sénéchal, 2008; Quinn, Wagner, Petscher, & Lopez, 2015; Tannenbaum, Torgesen, & Wagner, 2006). As a result, it is important for young children to build an extensive network of high quality lexical representations that will help make text more accessible (Perfetti, 2007).

Numerous studies have sought to identify key instructional practices that help build and extend lexical representations for young children (Marulis & Neuman, 2010). Most vocabulary interventions examine the advantages of using verbal scaffolds, such as explicit instruction and discussion about words, to enhance children's word knowledge (Beck & McKeown, 2007; Biemiller & Boote, 2006; Cena et al., 2012; Dickinson et al., 2019a). While these studies often incorporate nonverbal scaffolds during vocabulary instruction, such as pictures, gestures, and sounds, few specifically investigate the added value of including nonverbal supports. As a result, there is a need to consider how nonverbal aids are used in vocabulary interventions to better understand if they assist children in learning new words.

The present paper analyzes how nonverbal supports have been used in the vocabulary literature to promote primary grade children's word learning. I draw upon socio-cognitive theories to identify the components of lexical representations that affect reading comprehension

and consider how nonverbal and verbal information about words contributes to building high quality lexical representations. I then highlight the need to address how nonverbal supports enhance children's word learning and identify two key features of nonverbal supports that guide a review of the use of nonverbal gestures, pictures, and sounds in the vocabulary literature. Analyzing the patterns identified across vocabulary studies, I discuss the implications and limitations of current vocabulary research on nonverbal supports. This review underscores the need to consider the specific contributions of nonverbal supports in children's vocabulary acquisition and addresses future directions for research and practice.

Lexical Quality and Reading Comprehension

What a reader knows about words impacts their ability to comprehend text. Not only do readers need to be familiar with a large number of individual words, but they also need to have deep knowledge about word forms and meanings to correctly interpret the meaning of the text (Coyne, McCoach, Loftus, Zipoli, & Kapp, 2009; Ouellette, 2006; Proctor, Silverman, Harring, & Montecillo, 2012). According to Perfetti's (2007) lexical quality hypothesis, a reader's mental representation of a word's form and meaning combined with their experience of word use is crucial for text comprehension. This combination leads to high lexical quality, which helps readers quickly retrieve and integrate words across the text to foster efficient comprehension (Perfetti, 2007).

Perfetti (2007) states that there are five representational properties that are necessary for high quality lexical representations: orthography, phonology, grammar, meaning, and constituent binding, or "the degree to which the first four features are bound together" (p. 362). The orthography, phonology, and grammar constitute a word's form, while meaning is its own knowledge component that entails semantic information about a word. In Perfetti's (2007)

description of the meaning property, he states that high quality representations of meaning are "more generalized [and] less context-bound" (Perfetti, 2007, p. 360) and include a "fuller range of meaning dimensions to discriminate among words in the same semantic field" (Perfetti, 2007, p. 360). As a result, knowledge about the multiple meanings, connotations, and suitability of words across different contexts is important in developing high quality lexical representations and helping readers efficiently access relevant meanings for words (Perfetti, 2007).

Modalities of Lexical Representations

While Perfetti's (2007) conceptualization of lexical quality provides insight into the specific features of word knowledge that contribute to comprehension in reading, his lexical quality hypothesis does not explicitly address the modality in which the representational properties of a lexicon are stored. Descriptions of the representational properties in the lexical quality hypothesis seem to imply that lexical representations consist primarily of verbal information, such as word labels, phonological units, verbal definitions and synonyms, and visual language, or print. However, drawing from the Dual Coding Theory (DCT; Clark & Paivio, 1991; Paivio, 1986), lexical representations can also feature nonverbal information.

According to the DCT (Clark & Paivio, 1991; Paivio, 1986), learners interpret and store verbal and nonverbal information about words through verbal and nonverbal processing systems. The verbal system holds verbal information related to a word's form and meaning, including word labels, verbal definitions, and print (Clark & Paivio, 1991; Sadoski & Paivio, 2004). In contrast, the nonverbal system retains imaginal representations of sensorimotor experiences related to objects and/or events (Clark & Paivio, 1991). Visual, auditory, tactile, and olfactory features that are associated with a word or concept are stored as mental images that can evoke memories of sensory experiences related to that word or concept (Clark & Paivio, 1991; Sadoski

& Paivio, 2004). For example, readers who have had prior experience with the pungent smell of a skunk may reexperience that displeasure when they read a text involving skunks. In this manner, the imaginal representations created by nonverbal experiences enables readers to have an affective response to words during the reading process that may reflect their deeper knowledge and more refined representation of the word.

In terms of lexical quality, the verbal and nonverbal systems of the DCT account for all five representational properties of lexicons specified by Perfetti (2007). The verbal system stores verbal representations of a word's orthography, phonology, grammar, and meaning, while the nonverbal system stores mental images that can enrich the verbal knowledge components through salient memories of sensorimotor events that either reinforce or add to knowledge of a word's form and meaning. Furthermore, according to the DCT, the verbal and nonverbal mental structures of each processing system are connected through referential and associative connections. These connections function similarly to the constituent binding property specified by the lexical quality hypothesis (Perfetti, 2007) by bridging conceptually relevant verbal and nonverbal knowledge sources. As a result, verbal and nonverbal representations of words, and the degree to which they are interconnected, likely determines the lexical quality of words.

Nonverbal Supports and Language Learning

As infants and toddlers begin to learn language, they depend upon both verbal and nonverbal supports to build their initial multimodal word knowledge. Studies of infants' and toddlers' word learning reveal that young children from birth to 2 years of age observe patterns between word labels and nonverbal referents in multiple contexts (McMurray, Horst, & Samuelson, 2012). Building associations between word labels and nonverbal referents is a prerequisite to learning verbal word meanings (Deacon, 1997; Nelson, 2007). Young children

use cues in their environment to identify these patterns (Hollich, Hirsh-Pasek, & Golinkoff, 2000; Yu et al., 2005). According to the Emergentist Coalition Model (Hollich et al., 2000), attentional, social, and linguistic cues direct children's attention to desired associations between words and objects or events relevant to establishing the meaning of words. These theorists argue that children's reliance on the various cues shifts as their language develops. Starting around 2 years-old, children rely more readily on social cues, such as a speaker's gestures and intention, and depend less on their personal interest in a nonverbal object to learn words.

Theoretical perspectives on early word learning focus primarily on the initial word-referent associations of concrete, tangible objects for infants and toddlers prior to early schooling. Less attention has been given to how school-aged children use nonverbal supports, such as gestures, pictures, and sounds, to deepen their knowledge about words (see Hadley, Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2016) and learn more abstract and complex concepts (see McMurray et al., 2012). For older children in the primary grades, nonverbal supports may play an important role in building lexical representations by enhancing the imageability and perceptual salience of words being taught during vocabulary instruction (Barsalou, 1999; Maguire, Hirsh-Pasek, & Golinkoff, 2006). Nonverbal supports, such as gestures, pictures, and sounds, may help simulate abstract events, actions, and entities that have never been fully experienced (Barsalou, 1999). For example, showing primary grade children a picture of a young girl with ballet shoes watching a professional ballerina may enrich their understanding of the abstract verb *inspire*, a concept they may not fully comprehend without the visual support (see Lawson-Adams & Dickinson, 2019). Because of the limited theoretical attention to the role of nonverbal supports in primary grade children's word learning, there is a need for a theoretical framework that considers how verbal and nonverbal information

contributes to children's development of high quality, multimodal lexical representations during the school years.

Learning Through a Multimodal Web of Supports

Theories on children's early word learning can inform how primary grade children build word knowledge from verbal and nonverbal information. Humans across all ages experience the world through multimodal forms of communication (Chandler, 2017; Golinkoff & Hirsh-Pasek, 2000). We interpret numerous representamen, or sign vehicles, each day that represent and convey concrete and abstract ideas and meanings (Peirce, 1958), such as spoken words, traffic signs, and conversational hand motions. Similarly in word learning, we interpret verbal and nonverbal supports, like word labels, pictures, and gestures, that represent or direct attention to semantically relevant information about words (Chandler, 2017).

Children draw upon multiple modes of support during vocabulary instruction to deepen their knowledge of words. As they build an initial lexical representation from a given modality (verbal or nonverbal), their mental representation of a word can become more stable and refined when they encounter additional verbal and nonverbal supports that provide a new layer of semantic information about the word. For instance, a child learning the word *chaos* may have an initial, but limited, conception of what the word label represents. However, using picture images, gestures, and sound effects as additional supports that perceptually represent chaos may reshape that student's understanding of the word (Nöth, 2014) by highlighting where chaos can occur, how it feels, and how it sounds (Lawson-Adams & Dickinson, 2019). In this manner, verbal and nonverbal supports can build upon each other to create a multimodal web (Chandler, 2017; Peirce, 1958) that helps enhance the children's lexical quality (Perfetti, 2007) through deepening and refining their knowledge about words.

Nonverbal Supports in Word Learning

A number of studies use nonverbal supports for words, yet their effectiveness in bolstering children's word knowledge is unknown because most studies do not specifically consider the isolated contributions of nonverbal supports. Also, vocabulary studies often fail to provide details regarding the quality and instructional use of nonverbal supports during interventions. The lack of attention to the specific use of nonverbal supports in the vocabulary literature is highlighted by the absence of nonverbal supports as a moderating variable in Marulis and Neuman's (2010) meta-analysis on the effectiveness of vocabulary interventions. While nonverbal supports are generally considered an important part of vocabulary instruction, their pervasive use in vocabulary interventions without specific attention to the information they convey has impacted the ability of vocabulary researchers to determine what aspects of nonverbal supports may be crucial in supporting children's word learning. I argue that two key features of nonverbal supports hold the potential to contribute to primary grade children's word learning during instruction and should be explicitly considered in vocabulary research: (1) their semantic content, and (2) their ability to capture and direct children's attention.

Semantic content. Nonverbal supports have the ability to convey semantic meaning for a word through iconic representation (Peirce, 1958). When a nonverbal support is iconic, it perceptually resembles the object, idea, or concept by having a similar "appearance, sound, feeling, taste, or smell" (Chandler, 2017, p. 41). For instance, iconic representations of the word *chaos* may include a picture of a chaotic classroom, sounds that are loud and wild, or gestures that mimic chaotic movements. Not all iconic nonverbal supports carry the same quality or quantity of information related to a word. A picture may be a simple black and white line drawing of a single object (e.g., a stick figure of an adult with a stressed expression), or a picture

may be a colorful, detailed depiction that provides meaningful context for an object (e.g., a drawing of a realistic adult standing in a room where children are throwing clothes around and jumping off of furniture). Both pictures in the example semantically represent the word *chaos*, but the content of the latter picture conveys more information by depicting a detailed, chaotic situation.

Attention-directing attributes. All nonverbal supports feature attributes that can help capture and direct children's attention during word learning events. For example, physically holding a picture or pointing to an object may help children attend to information about words (Chandler, 2017; Clark, 2003; Golinkoff & Hirsh-Pasek, 2000). Attentional attributes may direct attention to relevant semantic information embedded in the nonverbal support itself or help direct children's attention to other nonverbal and verbal sources of information about a word. For instance, the motion of a teacher waving her hands in a wild manner for the word *chaos* may capture children's attention while reinforcing the semantic-meaning of wild and out-of-control. However, the gesture may also simply motivate students to attend to the verbal definition spoken by the teacher, regardless of the semantic content of the gesture.

Nonverbal supports differ in their attentional attributes across modalities and this may affect their capacity to capture and direct attention. For example, hearing a sound effect that represents *texture*, like the smooth, ringing sound of the triangle, may be more salient and interesting to students than looking at a picture of a smooth surface. This may hold implications for whether certain nonverbal modalities of representation can promote more student engagement and attention during vocabulary instruction.

Potential Contributions of Different Nonverbal Supports to Word Learning

Attending to the semantic content and attention-directing attributes of nonverbal supports provides an analytical lens for considering how nonverbal supports in vocabulary interventions assist children in learning new words. However, at present, no current analyses of the literature examine these features of nonverbal supports and how they might impact children's vocabulary acquisition. To explore the role of nonverbal supports in primary grade children's word learning, I conducted an analytical review of the literature. My goal was to first identify the types of nonverbal supports that are often used to teach words in vocabulary studies. I analyzed the semantic content and attention-directing attributes of those nonverbal supports, as well as how they were used as part of vocabulary instruction. I then focused on children's word learning when nonverbal supports were used to teach words by identifying how children's word knowledge was measured, the types of words children were taught, and whether children learned the taught words.

For the analyses, I searched ERIC, Music Periodicals Database, and PsycINFO through the ProQuest database and GoogleScholar to identify vocabulary studies with primary grade children that use nonverbal supports. The main terms in the search included: *vocabulary, word learning, nonverbal, multimodal, primary grade, elementary,* and *early childhood*. I also used the following terms to identify specific nonverbal supports: *gesture, picture(s), images, music, songs, sound effect(s), movement, dance, taste, smell, olfactory, touch,* and *tactile*. The following criteria was used to select studies for this analysis:

1. The study was a vocabulary intervention and/or featured analyses on word learning.
2. The study focused on children in preschool through Grade 2 and/or aged 3 to 8 years. We focused on native and non-native language learners that did not have an identified hearing, language, and/or learning impairment.

3. The study specifically mentioned the use of a nonverbal support as part of instruction.
4. They study was published in English.

I did not exclude studies based on how word learning was measured; as a result, studies varied in their assessment of vocabulary knowledge. Additionally, I focused primarily on articles in peer-reviewed journals. In my search of the literature, I identified three main nonverbal modalities used in vocabulary studies for primary grade children: gestures, pictures, and sounds.

Gestures and Word Learning

Gestures communicate ideas and concepts through visual and motor modalities. As a result, we can see and produce gestures to interpret, clarify, and convey meaning in speech (Belhiah, 2013). Gestures can also be copied and repeated across various contexts. If gestures are used to teach words in a classroom, both teachers and students can replicate those gestures in and out of school. This distinction means gestures are a portable nonverbal support that children can learn and carry with them. Such communicative properties make gestures potentially powerful supports during vocabulary instruction.

Semantic content. Gestures are able to represent semantic information about words through static and dynamic hand motions that capture different aspects of word meanings (i.e., shape versus function of an object). Several studies report that using gestures that are semantically representative of word meanings enhances children's receptive and expressive vocabulary, especially for concrete nouns and verbs (Capone Singleton, 2012; Capone & McGregor, 2005; Mumford & Kita, 2014; Tellier, 2008; Tolar, Lederberg, Gokhale, & Tomasello, 2008; Vogt & Kauschke, 2017). Gámez et al. (2017) found that when kindergarten teachers used semantically related gestures that highlighted novel information about word

meanings, children's general expressive vocabulary knowledge was enhanced. Gámez and colleagues did not publish examples of the gestures produced by teachers in their study, so it is difficult to determine what specific type of information was conveyed; however, they claim that "teachers' gestures, in particular, those that provide additional meaning information not found in speech, may serve a supportive function for children's word learning (Gámez et al., 2017, p. 35)."

Using gestures that are semantically related to words seems to be more effective in building children's lexical representations than gestures that do not contain such semantic information (Vogt & Kauschke, 2017). In a study with German children ages 3- and 4-years-old, Vogt and Kaushke (2017) found that semantically related gestures led to greater receptive and expressive vocabulary knowledge than pointing and arbitrary gestures for verbs and concrete nouns. The pointing gestures were designed to direct children's attention to the instructor, and the semantically unrelated arbitrary gestures bore no perceptual resemblance to object or movement of the target words. Their findings suggest that children read the semantic information in gestures and used it to build higher quality lexical representations.

Not all children may benefit from instruction that utilizes semantically related gestures, especially when teaching novel word labels for familiar concrete objects or actions. Several studies report that semantically related gestures can carry redundant information that does not offer novel semantic meaning above and beyond verbal instruction, leading to differential effects in children's word learning (McNeil, Alibali, & Evans, 2000; Rowe, Silverman, & Mullan, 2013). Primary grade children's age and language proficiency impact their need for redundant information in gestures. Older children and children who are more proficient in the language of instruction do not appear to benefit from semantically related gestures that reinforce familiar

concepts compared to young children with less language proficiency in the language of instruction. This notion aligns with the Emergentist Coalition Model, which asserts that as children's language skills improve with age, they rely less on perceptual nonverbal cues to interpret word meanings (Hollich et al., 2000).

Attention-directing attributes of gestures. Kinesthetic movement is required to produce a gesture, and such movement used during vocabulary instruction has the potential to direct children's attention and engage them in word learning activities (Clark, 2003). When a teacher makes a gesture while teaching a word, the physical and temporal contiguity of that gesture to the taught word may prompt children to attend to verbal and nonverbal information that is either embedded in the semantic content of the gesture or referenced by the gesture. Consequently, gestures are effective nonverbal supports regardless of their degree of perceptual resemblance to the target referent.

Gestures may help children learn complex words and concepts by drawing their attention to words and semantic information (Hansen & Markman, 2009; Sénéchal, 1997; Sénéchal, Thomas, & Monker, 1995; Valenzeno, Alibali, & Klatzky, 2003). Valenzeno et al. (2003) found that teachers' use of attention-directing gestures, such as pointing and tracing, on visual images to teach symmetry contributed to 4- and 5-year-olds' understanding of symmetry and asymmetry. Children who were taught symmetrical properties with attention-directing gestures were better able to select symmetrical and asymmetrical images than children who were taught without the gestures. These findings suggest that pointing and tracing can help children focus on the semantic properties of visual supports, which in turn may enhance their knowledge about taught concepts and words (Valenzeno et al., 2003).

In book reading context, teachers' use of pointing gestures can support children's vocabulary knowledge by calling their attention to illustrative pictures that are associated with key events or words. Working with preschool-aged children, Sènèchal (1997) examined whether having instructors point to illustrations of target words during shared book reading increased children's knowledge of taught verbs and concrete nouns. Results indicated that pointing during a read-aloud significantly enhanced preschool children's receptive and expressive word knowledge of the taught words. Wasik, Bond, & Hindman (2006) similarly found that teachers' use of pointing gestures after book reading events were among the teaching behaviors that were significantly correlated with Head Start children's general expressive vocabulary.

Children's word learning in book reading contexts also benefits from their active engagement in producing pointing gestures. Sènèchal et al. (1995) found that 4-year-old children's active participation in labeling and pointing enhanced their receptive and expressive vocabulary knowledge for concrete nouns and verbs. Children were either asked to point to the illustration that matched the target word or to label illustrations by naming the target word while the book was read. Having children actively point to illustrations was equally as effective in fostering receptive and expressive word knowledge as asking children to label illustrations during book readings. This finding suggests that children's active participation in producing attention-directing gestures, such as pointing, during vocabulary instruction in book reading contexts helped children attend to words and relevant semantic information.

Word types. The use of semantically related gestures and/or attention-directing gestures during vocabulary instruction may not enhance learning for all words, particularly for words that convey more abstract concepts. Best, Dockrell, & Braisby (2006) found that pointing gestures were not a sufficient physical scaffold to support the learning of novel adjectives for children

ages 4 to 6 year-old during science lessons. In their intervention, the instructor introduced the adjective and pointed to a picture that depicted semantic properties of the adjective. Results showed that the instructional use of the gestures, pictures, and word labels did not enhance children's receptive, expressive, or definitional word knowledge. This indicates that pointing gestures may not reliably help children attend to relevant verbal and nonverbal information about abstract word types.

Most interventions that incorporate semantically related gestures and more complex, abstract words stem from book reading studies. However, a majority of these studies report that gesture use during instruction only occurred for some of the target words and often not abstract nouns (Collins, 2010; Hadley et al., 2016; Penno, Wilkinson, & Moore, 2002). Additionally, gesture use in interventions with book reading is usually combined with verbal definitions and other semantically related vocabulary supports, making it difficult to conclude whether the use of semantically related gestures augmented children's vocabulary acquisition of different word types.

One study that illustrates the challenge of teasing out the specific word-learning effects of gesture for different word types in book reading contexts was conducted by Hadley et al. (2016). Preschool children were shown semantically related gestures and pictures and given verbal definitions after book readings; however, gestures were only used for a portion of the words, including some of the concrete nouns, verbs, and adjectives, but not any of the abstract nouns. Hadley and colleagues only used gestures for words they thought could easily be represented by a gesture and did not systematically design or measure the effects of including semantically related gestures as part of vocabulary instruction. For words taught with a gesture, the teacher showed children the semantically related gesture and asked them to replicate it. To measure

children's word knowledge, Hadley et al. (2016) assessed children's depth of knowledge of the words and found that children's depth of word knowledge was enhanced for all word types, with concrete nouns being learned the best. The number of gestures children produced in their responses significantly increased for concrete nouns and verbs, but not for abstract nouns or adjectives. The null findings for children's semantically related gesture production are to be expected for abstract nouns, which were never taught with gestures; however, more than half of the adjectives were explicitly taught with gestures. Though not a specific part of Hadley et al.'s (2016) analysis, this finding suggests that children may have difficulty creating and reproducing gestures for more abstract word types, especially if they were not taught the words with semantically related gestures. Furthermore, the decision to teach abstract nouns and other words without semantically related gestures highlights the need to consider whether nonverbal supports, specifically gesture, can benefit children's learning of diverse and difficult word types.

Pictures and Word Learning

In contrast to gestures, pictures are nonverbal supports that exist outside of one's physical self. Pictures depict three-dimensional objects in a two-dimensional space and vary in size, shape, and visual medium (i.e., photograph, drawing, painting). Unlike gestures, pictures do not disappear; they are a nonverbal support that can be repeatedly revisited. Also, the visual content in pictures can convey more semantic information than gestures as they are able to provide a clearer representation of word meanings through detailed depictions of an object and relevant contextual information. The ease with which pictures can be encoded and retrieved from memory may make them a particularly effective nonverbal cue for building lexical representations during vocabulary instruction (Clark & Paivio, 1991).

Semantic content. Pictures that portray semantically relevant information about words are an important part of many vocabulary interventions. Images, shared through storybook illustrations, picture cards, and other visual media, are thought to help children build high quality lexical representations. Yet, few studies consider how the semantic content of picture images contribute to fostering children's word knowledge. For instance, although there are a number of book reading studies that use illustrated picture books, we were unable to locate any that isolated the word learning effects of semantically relevant book illustrations. This may be particularly important since book illustrations may not depict any relevant semantic content for target vocabulary terms. Additionally, while multiple book reading interventions include an introduction or review of words using semantically relevant picture cards before or after a book's reading (Collins, 2010; Dickinson et al., 2019a; Gonzalez et al., 2011; Hadley et al., 2016; Penno et al., 2002; Pollard-Durodola et al., 2011; Wasik et al., 2006), none of the studies provide much information about the semantic content of the picture cards, including the clarity of the image used and whether it depicts a stand-alone object or an object embedded in a scene. As a result, the degree to which the picture card conveys relevant information about a word is often unknown. Furthermore, studies do not commonly look at the effects of including picture cards in book reading interventions, making it impossible to disentangle the specific contributions of picture cards to children's word learning.

Pollard-Durodola et al. (2018) have begun to consider the contribution of picture cards in book reading and found that semantically related pictures may drive children's word learning. They investigated the effects of picture cards on preschool children's learning of science and social studies content-specific concrete nouns (e.g., *meadow*, *pond*) As part of the study, Spanish-speaking Dual Language Learners (DLLs) with beginning levels of English proficiency

participated in one of two conditions: a comprehensive book reading condition that included picture card instruction of target words or a picture card-only condition with no book reading. Pollard-Durodola and colleagues did not find evidence of differences between the two conditions in children's receptive or expressive vocabulary outcomes, suggesting that picture cards may be play an important role in vocabulary instruction during read aloud.

The effectiveness of picture cards when teaching words may vary based on children's linguistic background and the type of word knowledge being assessed. Two studies directly examined the impact of teaching words with pictures compared to gestures to identify possible differential learning effects (Rowe et al., 2013; Tellier, 2008). Tellier's (2008) investigation assessed whether semantically related pictures differentially affected 5-year-olds' receptive and expressive knowledge from semantically related gestures. English concrete nouns were initially introduced to native French speakers through videos that used both a gesture and picture. The pictures were detailed, perceptually similar drawings of tangible objects, and the gestures formed the objects' shape. After seeing both the picture and gesture for each word, children only saw one modality, either pictures or gestures, for the remainder of the intervention. Tellier (2008) found that semantically related pictures were equally effective in supporting children's receptive vocabulary knowledge as gestures, but that gestures led to significantly higher expressive vocabulary knowledge than pictures.

Rowe et al. (2013) reported contrasting results in preschool children's receptive learning through pictures compared to gestures when considering children's language background. Preschool students with high and low English language abilities were taught novel nonword labels for concrete nouns with a one-word synonym (i.e., *mip* is book) and either a semantically related picture, semantically related gesture, or no nonverbal aid. The pictures used were line

drawings of target objects and the gestures represented the shape and function of the objects. Results varied based on children's native language and level of English proficiency. Monolingual English speakers with low English proficiency (i.e., one standard deviation below the SLAS mean) had higher receptive vocabulary scores for words taught with pictures compared to words taught with gesture or no nonverbal aids. However, monolingual children with high English proficiency (i.e., one standard deviation above the SLAS mean) learned more words overall compared to children with low English proficiency and benefited similarly for words taught with semantically related gestures, pictures, and no nonverbal aids, suggesting that the semantic information provided by pictures did not enhance their receptive knowledge beyond verbal instruction alone.

Rowe et al.'s (2013) findings also vary for Dual Language Learners (DLLs). Similar to monolinguals with low English proficiency, DLLs with low English proficiency had higher receptive scores for words that were taught with semantically related pictures compared to no nonverbal aids. However, they learned 1.4 more words when taught with semantically related gestures instead of pictures. DLLs with high English proficiency had higher scores in their receptive vocabulary knowledge when words were taught with no nonverbal supports, but their receptive scores were negatively affected when words were taught with a picture or gesture. Collectively, Rowe and colleagues' results indicate that the effectiveness of pictures as nonverbal supports in enhancing receptive vocabulary knowledge may depend on children's language background and proficiency in the language of instruction.

Neither Tellier (2008) nor Rowe et al. (2013) consider whether the detail in the semantic content of the picture impacted children's word learning. Both studies used simple line drawings that only featured the target object and lacked context. For example, in Rowe et al. (2013),

children were shown a drawing of an isolated hat for the synonym *hat*. The picture did not provide any contextual information that could have assisted children in better remembering the word, such as a drawing of a person wearing a hat at a ball game to block out the sun. It is possible that pictures that go beyond simple line drawings of objects may enhance monolingual and DLLs' word knowledge better than gestures.

Attention-directing attributes of pictures. Pictures can offer appealing features, such as various colors, sizes, and realistic and/or fantastical elements. These features have the potential to attract children's attention to the semantic content depicted in the picture, as well as to heighten their focus on other verbal and nonverbal information being presented about a particular word. Yet, little is known about the extent to which attention-directing attributes of pictures draw primary grade children's attention and interest to information about words during vocabulary instruction, including the semantic content depicted through the images. Callaghan (2000) found that 3-year-olds may more readily interpret certain types of pictures, including detailed pencil drawings, paintings, and photographs, compared to simple line drawings; however, it is unknown to what degree these different visual mediums impact children's word learning. More research is needed to understand whether the visual mediums differentially direct children's attention to relevant semantic information provided by picture and additional vocabulary supports, such as definitions and/or gestures.

Word types. Although little is known about the unique word learning contributions of the attention-directing attributes of pictures, pictures that convey semantic information appear to benefit children's word learning, particularly for concrete nouns. Static images can easily depict tangible, concrete objects, which enhances imageability as it lessens the demand for individual

interpretation of what the picture is trying to represent. Such direct semantic representation may be particularly helpful for the encoding of verbal and nonverbal information about concrete nouns for children with lower initial English vocabulary knowledge across language backgrounds (Rowe et al., 2013; Silverman & Hines, 2009; Tellier, 2008).

Studies examining the added benefits of teaching words with semantically relevant pictures only consider how pictures impact children's learning of new word labels for familiar, concrete objects (Rowe et al., 2013; Tellier, 2008). As a result, such studies do not address how pictures may assist in learning novel concepts or more complex word types, such as abstract nouns, verbs, or adjectives. Several book reading studies consider more abstract word types and suggest that picture illustrations in combination with explicit verbal instruction and storybook narratives may assist children in learning those words (Hadley et al., 2016; Biemiller & Boote, 2006; Coyne, Simmons, Kame' enui, & Stoolmiller, 2004; Justice, Meier, & Walpole, 2005). However, it is challenging to disentangle the specific word learning benefits of semantically relevant picture illustrations in books from the benefits of the verbal information embedded in book narratives (Mol, Bus, & de Jong, 2009).

Sounds and Word Learning

Nonverbal sounds, such as sound effects and songs, activate our auditory senses and can be memorable for listeners (Wallace, 1994). For instance, we remember tunes and lyrics from our childhood and musical themes from famous movie scenes (e.g., the theme from *Jaws* whenever the shark appears). Memorized sounds can be carried and reexperienced through silent rehearsal (i.e., singing a tune in our head), vocalizations, or performances on instruments. As a result, when words are taught through songs or with sound effects, children are able to recreate

those taught sounds wherever they go. Such properties of sounds make them potentially effective nonverbal tools for learning words.

Semantic content. Sounds can convey semantic information about words (Fritz et al., 2009; Steinbeis & Koelsch, 2011; Zhou, Jiang, Wu, & Yang, 2015). Specifically, we refer to nonverbal sounds that include musical excerpts and/or sound effects produced by instruments[1]. Few studies consider whether semantically relevant nonverbal sounds foster children's learning of novel words (Lawson-Adams & Dickinson, 2019; Smeets et al., 2014). In a study on e-books, Smeets et al. (2014) examined how sound effects and background music impacted kindergarten children's vocabulary learning. The sound effects used in the e-books were not systematically designed to represent or map onto target words; however, some sounds perceptually represented semantic information about words, such as the sound of birds whistling for the Dutch translation of the word *whistle*. Additionally, background music was designed to emphasize mood and stress in the story narratives, but it was not explicitly programmed to occur when target words appeared in the book. To assess word knowledge, Smeets and colleagues administered a sentence completion task in which children were shown a picture from the e-book and asked to complete a sentence using target words from the story. They found that children with lower language skills who were identified as having a speech language impairment (SLI) were not able to produce many target words from the e-books that featured sounds and background music during the story narrative. In contrast, children with typically developing language produced more target words when e-books had sound and music compared to e-books that had no sound or music. Since the sounds used in Smeets et al. (2014) were not specifically designed to play when target words

[1] Nonverbal sounds could be produced by vocalizations; however, the literature on nonverbal vocalized musical sounds and word learning is scarce.

appeared in the text, nor to function as semantic representations of word meanings, it is unclear the extent to which the semantic information conveyed by the sounds directly impacted children's word learning in the e-book context.

In a study using a more traditional book reading context, Lawson-Adams and Dickinson (2019) investigated how purposely creating semantically related sound effects for target words affected first grade children's word learning. Using an instructional strategy called a sound story, investigators asked children to select and perform nonverbal instrumental sounds for abstract nouns and verbs before and during repeated book readings. The sounds were used in conjunction with picture cards and child-friendly definitions. All of the sound effects used in the sound story were designed to function as semantic representations of the words. For example, children performed loud, wild instrumental sounds for the word *chaos.* The findings showed that using sound effects with words significantly improved children's receptive word knowledge and depth of word knowledge for native and non-native English speakers. The results suggest that intentionally creating semantically related sound effects may assist children with diverse language backgrounds in learning novel words in read-aloud contexts.

Attention-directing attributes of sounds. Sound effects and music provide acoustic cues that can capture children's attention during word learning. Nonlinguistic sounds offer an interesting aural contrast to teacher talk during instruction that may attract student interest. As a result, such nonverbal sounds may help children more readily attend to words when that sound is temporally contiguous to hearing a particular word regardless of the semantic relevance of the sound. The attention-directing properties of sound may be further heightened when children watch and perform the sounds. In the previously discussed sound story intervention (Lawson-Adams & Dickinson, 2019), children engaged in sound-producing gestures to play instruments

for the target words. The physical and temporal contiguity of performing and hearing the sounds in relation to other verbal and nonverbal supports for a word's meaning may have directed children's attention to the semantic information embedded in the sound itself and in the other supports of the sound story activity, such as the word's definition, pictures, and story narrative.

Studies investigating semantically related sound effects and children's word learning do not isolate the unique contributions of the attention-directing attributes of sound (Lawson-Adams & Dickinson, 2019; Smeets et al., 2014). However, research on songs as supports for children's word learning provide insight into how music sound structures in songs may help children attend to words. Across the song studies, the musical elements of songs (i.e., melody, rhythm, and instrumental timbre) are never specifically designed to semantically represent words (Madsen, 1991; Schunk, 1999). Instead, these elements work together to help children attend to words highlighted during a song's performance. Songs embed words in repeated, predictable musical phrases that have designated lengths and rhythmic stress patterns (Wallace, 1994), and these components of songs may direct children's attention to the lyrics and other information sources about words (e.g., pictures, gestures) without the sound directly providing semantic information.

In studies with primary grade children, songs with a melody (i.e., songs that are sung to a tune) appear to aid children in learning words (Madsen, 1991; Schunk, 1999). Madsen (1991) compared first grade children's word learning when song lyrics were either sung with a melody or spoken with no melody. Both the sung and spoken songs featured nonword concrete nouns referencing parts of the body (i.e., knee, head), and children performed attention-directing gestures to highlight target body parts whenever the nonword appeared in the song lyrics. An important feature of the study was that the sung song had pitch and rhythmic changes that were designed to bring attention to target words. Children were assessed on whether they could

identify the correct body part, and results showed that children in the singing group were able to produce more correct responses than the speaking group. This indicates that purposely designing musical attentional cues in sung songs, such as pitch and rhythmic changes, assists children in attending to target words and objects. However, it is important to note that no musical attentional cues around words were included in the spoken songs (e.g., changes in rhythm), so it is difficult to make a direct comparison between the effectiveness of the singing and speaking conditions.

When examining songs with no purposeful melodic or rhythmic changes around target words, Schunk (1999) found that that rhythmically spoken songs were as effective as sung songs in supporting children's receptive word learning when other nonverbal supports, such as gestures, were used. Non-native English speakers in kindergarten through second grade were taught three Broadway musical songs in one of four ways: (1) singing with semantically related gestures, (2) speaking with semantically related gestures, (3) singing-only, or (4) speaking-only. Children were introduced to target words with semantically related picture cards prior to performing the song. In the gesture conditions, children performed semantically related gestures whenever target words occurred in the lyrics. Singing and speaking songs with semantically related gestures led to significantly higher receptive vocabulary scores for all children compared to speaking-only songs. The singing-only songs did not result in significantly different receptive vocabulary scores for children compared to the all of the other song conditions. These findings suggest that using extra nonverbal supports that provide semantic information about words, such as gestures, appears to increase the effectiveness of singing and speaking songs by further reinforcing word meanings and directing children's attention to words.

Word types. With so few studies examining children's word learning from semantically related and attention-directing sounds, it is unclear whether nonverbal sounds assist children in learning different word types. Lawson-Adams and Dickinson (2019) found that semantically related sound effects helped children learn both verbs and abstract nouns when used in the context of a story book. In a follow-up analyses (Lawson-Adams & Dickinson, December 2019), they report that children learned abstract nouns better than verbs. This suggests that the semantic component of sound effects may have helped children build higher quality lexical representations of abstract concepts; however, they acknowledge that learning may have also been driven by the attention-directing attributes of the sounds. Hearing and performing the sounds may have attuned children to the target words and helped them focus on additional semantic vocabulary supports, such as the word definitions, picture images, and story book narrative.

Implications

Vocabulary research has long incorporated nonverbal supports as part of rich vocabulary instruction for primary grade children. This review of the literature supports the notion that nonverbal gestures, pictures, and sounds aid in building primary grade children's lexical representations. I argue that these nonverbal supports are able to provide semantic information that enriches children's knowledge about words and help direct children's attention and interest to relevant details about words. Consequently, using nonverbal aids to teach vocabulary offers children multimodal access points to words and enhances their word knowledge, particularly for concrete nouns and verbs. While the reviewed studies suggest that children benefit from vocabulary instruction that features nonverbal supports, this review calls attention to the dearth of research on the specific contributions of nonverbal aids in building children's lexical representations and holds implications for future research and practice.

Measuring Learning

Word knowledge is not simply measured by whether a learner knows or does not know a word. Instead, it functions on a continuum that ranges from initial word-referent associations to deep conceptual knowledge. A majority of the reviewed studies only measured children's receptive and expressive word knowledge by asking them to identify and/or produce words after seeing a visual referent. While findings indicate that nonverbal supports enhance children's receptive and expressive knowledge (Best et al., 2006; Capone Singleton, 2012; Capone & McGregor, 2005; Gonzalez et al., 2011; Mumford & Kita, 2014; Pollard-Durodola et al., 2011; Rowe et al., 2008; Sénéchal, 1997; Sénéchal et al., 1995; Tellier, 2008; Tolar et al., 2008; Vogt & Kauschke, 2017), these assessments only measure children's ability to associate a word with a specific referent and do not provide information about children's deeper word knowledge.

Tapping into children's depth of word knowledge may better capture how nonverbal supports build high quality lexical representations. Several studies asked children to define and/or share what they know about words, and their results demonstrated that incorporating nonverbal aids during instruction can foster deeper word learning (Best et al., 2006; Biemiller & Boote, 2006; Coyne et al., 2004; Hadley et al., 2016; Lawson-Adams & Dickinson, 2019). Lawson-Adams and Dickinson (2019) reported that the unique word learning benefits of nonverbal sound effects were evident in a depth of knowledge measure but not in a receptive task, suggesting that depth measures may provide more nuanced information about the contributions of nonverbal supports. While prior reports posit that productive definitional measures may underestimate word learning compared to receptive tasks for children until grade 2 (see Biemiller, 2005), our review indicates that including measurements of depth may further

reveal how nonverbal supports aid in building primary grade children's high quality lexical representations.

Prior Language Ability

Nonverbal scaffolds appear effective in bolstering various degrees of children's word knowledge; however, their effectiveness may depend on children's language ability and familiarity with the target referent, particularly for concrete word types. Children with more extensive semantic networks in a given language may not need the same assistance from nonverbal supports when learning concrete words as children that do not have as well-developed semantic networks (Blewitt, Rump, Shealy, & Cook, 2009; Cain & Oakhill, 2011; Hadley, Dickinson, Hirsh-Pasek, & Golinkof, 2019b; Penno et al., 2002; Silverman & Crandell, 2010). As a result, children with lower initial vocabulary knowledge need more nonverbal scaffolds (Grifenhagen, 2013) as these nonverbal supports can overcome language barriers by conveying meaning when vocabulary knowledge is limited.

Abstract Words

Only a few of the reviewed vocabulary studies consider whether nonverbal supports affect children's learning of abstract words (Hadley et al., 2016; Lawson-Adams & Dickinson, 2019, 2019, December). These studies report increased definitional and depth of word knowledge for abstract nouns when nonverbal supports are used, even for non-native English speakers. However, the studies utilize a variety of verbal and nonverbal supports during instruction, thus making it difficult to ascertain the unique contributions nonverbal supports made to learning more conceptually-complex words. The use of nonverbal scaffolds to teach abstract words is promising and warrants future research. Nonverbal supports can provide

children with sensory experiences for abstract concepts and ideas they may have never experienced (Barsalou, 1999). As a result, using nonverbal supports that perceptually represent abstract words (Barsalou, 1999) may be effective in conveying semantic information about more complex, abstract concepts to word learners compared to verbal instruction alone.

Mixing Nonverbal and Verbal Supports

Across interventions, it is common to mix nonverbal and verbal supports so that children interact with multiple supports, such as pictures, objects, gestures, story narratives, and sounds (Collins, 2010; Gonzalez et al., 2011; Hadley et al., 2016; Lawson-Adams & Dickinson, 2019; Madsen, 1991; Penno et al., 2002; Pollard-Durodola et al., 2011; Silverman & Hines, 2009; Wasik et al., 2006). Employing multiple supports in vocabulary interventions makes it challenging to distinguish which factors contribute the most to children's word knowledge. Studies such as Rowe et al. (2013) try to equate children's exposure to extra nonverbal aids as a means to decipher which supports better foster children's word learning; however, the interaction between the nonverbal supports and verbal scaffolds may still impact how children take up information during vocabulary instruction. It is possible that a combination of multiple nonverbal and verbal supports is necessary for children to make large gains in their vocabulary knowledge. All studies that report using a mixture of multimodal supports also report that the incorporation of multiple types of modalities in vocabulary instruction led to positive and significant results across word types (Collins, 2010; Gonzalez et al., 2011; Hadley et al., 2016; Lawson-Adams & Dickinson, 2019; Madsen, 1991; Penno et al., 2002; Pollard-Durodola et al., 2011; Silverman & Hines, 2009; Wasik et al., 2006). These findings suggest that utilizing one type of nonverbal support may not be sufficient for enhancing children's word knowledge, a conclusion that aligns with the notion that a multimodal web of supports helps word learners build and refine their

knowledge about words (Chandler, 2017; Peirce, 1958). Consequently, it may take experience with an array of multimodal supports for children to develop high quality lexical representations.

Expanding Nonverbal Modalities

Most of the research on nonverbal supports and children's word learning centers around the use of visually salient modalities, such as gestures and pictures. The bias in investigating only nonverbal aids that children can see leaves a gap in the literature regarding how other sensory-based supports, such as sound, movement, smell, and touch, may impact children's word learning. While most other sensory modalities have a visual component, such as seeing objects that produce a heard sound, these additional modalities are able to convey meaning through mediums other than sight.

The current literature review identifies several studies that examine the benefits of nonverbal sound-based supports, such as music and sound effects, on children's word learning. The research on nonverbal aural modalities is still emerging, but early findings indicate sounds that children select and actively produce by playing instruments or singing, may help children learn words and build quality lexical representations (Lawson-Adams & Dickinson, 2019; Schunk, 1999; Madsen, 1991).

There are a few promising works on nonverbal kinesthetic supports and children's word learning that consider how enactment of words and gross motor movement may impact children's memory of words (Mavilidi, Okely, Chandler, Cliff, & Paas, 2015; Toumpaniari, Loyens, Mavilidi, & Paas, 2015). The findings suggest that enactment and gross motor movement may enhance children expressive word knowledge (Mavilidi et al., 2015) and free word recall (Mavilidi et al., 2015; Toumpaniari et al., 2015). Given the limited amount research

on kinesthetic supports, more research is needed to unpack their benefits is enhancing children's word knowledge.

While emerging vocabulary research is starting to consider auditory and kinesthetic modalities, there are still a variety of modalities that have not been investigated in the vocabulary literature. Specifically, a search of databases did not identify word learning studies for primary grade children using olfactory (smell) or tactile (touch) modalities. Clark and Paivio (1991) claim that nonverbal information helps learners form enriched mental representations and these mental representations evoke memories of multisensory experiences. Sensory modalities relating to smell and touch may provide detailed perceptual information about words and concepts. For example, knowing how different *textures* feel or having experience with a *pungent* smell may enhance learners' understanding and memory for those words. Future studies on nonverbal supports and word learning should consider incorporating less common sensory modalities to see how these sensory experiences impact children vocabulary knowledge.

Instructional Considerations

This review found evidence from multiple studies that gestures, pictures, and sounds can help support children's word learning. These nonverbal aids are commonplace in interventions, but the lack of systematic attention to their particular contributions limits the ability to determine what strategies or combinations of strategies are most likely to be effective for teaching particular words to primary grade children with different language abilities.

One notable shortcoming in the instruction of nearly all prior vocabulary studies is that the information conveyed through nonverbal supports is regularly viewed as fixed knowledge that is self-evident to learners (see Cohen, 2011). The majority of the reviewed studies presented nonverbal supports for target words to children through didactic instruction in which children

receive the nonverbal support from the teacher and are never challenged to discuss, explain, create, or extend the nonverbal support used to teach a given word. For example, a teacher might say and define a word while showing the class a picture or gesture that they deem as representing that word and immediately move onto the next word. This instructional practice positions children as passive participants who are expected to accurately interpret the information embedded in the nonverbal support and accept it as an accurate representation of the word's meaning without extended discussion. While the reviewed studies demonstrate that children are able to learn words passively through explicit, didactic instruction, Cohen (2011) argues that this type of instruction limits student participation, discussion, and inquiry and does not reflect ambitious teaching practices. Only a few studies utilizing nonverbal supports attempted to increase student participation during didactic instruction by asking children to repeat the word label and/or replicate the nonverbal support provided by the instructor, such as mimicking a gesture (e.g., Hadley et al., 2016; Sènèchal et al., 1995). Most of the works that promoted active student participation during didactic instruction were vocabulary studies with songs. Although there was no explicit child-centered talk about words, the song studies positioned children as active producers in music activities. Children participated in the songs by being encouraged to sing, speak, and/or move with the music. This active component of the song studies may serve as a critical instructional feature for helping children learn words through music. We contend that having children actively mimic other nonverbal supports would further enhance their word knowledge and require minimal extra instructional time when teaching words through explicit, didactic vocabulary instruction.

In a majority of the studies, the relationship between the semantic content of nonverbal supports and words being taught was not often explained to children. An important consequence

of this approach is that children had to interpret the meaning of nonverbal supports on their own. Children bring their own experiences and world knowledge to instructional contexts that could influence how they understand and interpret nonverbal supports that are used (Chandler, 2017). Never discussing the connections between verbal and nonverbal aids forces children to extrapolate the meaning of nonverbal supports and could result in misconceptions about word meanings. No studies report data on whether children experienced confusion about the meaning of words; as a result, it is unclear whether misconceptions occurred.

Treating nonverbal supports as transmitting fixed, self-evident meanings with minimal discussion about their semantic content is surprising given the vocabulary research on dialogic reading and extratextual talk. A number of studies include child talk around words, but do not include explicit talk about nonverbal supports (Coyne et al., 2004; Gonzalez et al., 2011; Pollard-Durodola et al., 2011; Silverman, 2007; Wasik et al., 2006). Beck and McKeown's (2007) Text Talk curriculum found that engaging kindergarten and first grade children in discussions about words enhanced their word knowledge. As part of the curriculum, children were asked to make verbal judgments about words and provide their own examples of words. These instructional strategies reflect ambitious, inquiry-driven teaching practices (Cohen, 2011) and traditionally have not been extended to nonverbal supports during vocabulary instruction. We were only able to identify a few studies that strived to embrace inquiry-based practices with nonverbal supports. In Wasik et al.'s (2006) work, children had the opportunity to create their own pictorial representations of target words during art centers. While children were drawing, teachers were encouraged to have informal conversations with children about the drawings, which allowed children to share their own interpretation of the target words. The art centers were one aspect of the comprehensive vocabulary intervention, so it is not possible to know if the activity of

drawing made a unique contribution to word learning above the other instructional supports and approaches used. However, it demonstrates the word learning potential for using inquiry-based methods with nonverbal supports.

The sound story intervention also engaged in more inquiry-based practices when using nonverbal sound supports to teach words (Lawson-Adams & Dickinson, 2019). Children made judgments about various sound effects to determine which sound best matched a word's meaning. By allowing children to select nonverbal sounds for novel words, the study approached vocabulary learning as a practice of inquiry (Cohen, 2011). This approach utilized a process known as trans-mediation to extend children's thinking about representations of words (Siegel, 1995). Transmediation is an instructional practice that pushes children to reflectively think about the connections between different forms of representation (Siegel, 1995). Siegel (1995) claims that transmediation augments children's ability to make meaning as children must deeply consider how to convey information presented in one modality to another. We argue that engaging in transmediation with nonverbal supports may press children to think more deeply about word meanings and, in turn, may help build higher quality lexical representations. For instance, when teaching a synonym for the word *bird*, Rowe et al. (2013) used a dynamic gesture of moving both arms up and down. Children's association of the synonym with the gesture and the word *bird* may have been strengthened if they were given the opportunity to generate their own gesture. Such meaningful associations may be particularly effective when teaching more complex, abstract words. For example, allowing children to create their own gesture for a word such as quarrel may help them better understand and remember the word's meaning. Engaging in instruction in which students create their own nonverbal representation of a word does not require significantly more planning for instructors because students drive the creation; however,

it may require allotting more instructional time so students can consider how to represent a word in a different modality.

Conclusions

The field has paid scant attention to the role of nonverbal supports in vocabulary instruction, yet they have the potential to convey semantic content and are able to direct attention to information relevant to understanding word meanings. These components of nonverbal supports assist children in building high quality lexical representations by providing opportunities to construct meaning through multisensory events (Clark & Paivio, 1991). The resulting lexical representations may benefit children's later reading comprehension as children are given multimodal access to print through their past verbal and nonverbal experiences with words (Perfetti, 2007). Although research examining the use of nonverbal supports to teach vocabulary indicates that nonverbal aids bolster children's word learning for concrete word types, more research is needed to understand the unique contributions of nonverbal supports and whether they can foster more abstract word knowledge. Furthermore, instructional approaches to using nonverbal supports requires further investigation in the literature. Collectively, this review highlights the need for more research on nonverbal supports and primary grade children's word learning.

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CHAPTER III

SOUND STORIES: USING NONVERBAL SOUND EFFECTS TO SUPPORT ENGLISH WORD LEARNING IN FIRST GRADE MUSIC CLASSROOMS[1]

Introduction

Research has shown that children's vocabulary knowledge at school entry predicts their later reading success (Catts, Hogan, & Fey, 2003; Cutting & Scarborough, 2006; Dickinson & Porche, 2011; Language and Reading Research Consortium, 2015; NICHD Early Child Care Research Network, 2005; Snow, Burns, & Griffin, 1998). Knowing a variety of words is critical for children's reading comprehension (Braze, Tabor, Shankweiler, & Mencl, 2007; Cain, Oakhill, & Bryant, 2004; Nassaji, 2006; Tunmer & Chapman, 2012; Vellutino, Tunmer, Jaccard, & Chen, 2007) because it helps them make sense of complex texts used in school settings. Children not only need to know a large number of words but also need deep knowledge about word meanings. This depth of word knowledge results from forming associations between words and a broad range of concepts and experiences, and it contributes to reading comprehension over and above measures of vocabulary breadth (Coyne, McCoach, Loftus, Zipoli, & Kapp, 2009; Ouellette, 2006; Proctor, Silverman, Harring, & Montecillo, 2012).

Not all children enter formal schooling with the same linguistic experiences and word knowledge (Gee, 2013). Children from linguistically diverse or low socioeconomic status backgrounds tend to have lower English and school-valued vocabulary knowledge compared with their monolingual peers from higher socioeconomic status homes (Hoff, 2013). As a result, disparities in vocabulary outcomes are associated with socioeconomic and linguistic

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backgrounds, making it potentially challenging for children from diverse, minoritized backgrounds to comprehend school texts and sustain reading achievement in school (Hoff, 2013; Mancilla-Martinez & Lesaux, 2010; Páez, Bock, & Pizzo, 2011).

To date, most vocabulary research has explored the benefits of targeted and direct vocabulary instruction on young learners' word learning (Carlo et al., 2004; Cena et al., 2013; Gersten & Baker, 2000; Rowe, Silverman, & Mullan, 2013). These studies focused on providing young learners with definitions, gestures, and pictures as a way to build word knowledge for native and non-native English speakers. Additionally, a number of studies have examined the use of direct instruction during shared book reading, a common general classroom practice, to enhance word learning (Beck & McKeown, 2007; Biemiller & Boote, 2006; Coyne, Simmons, Kame'enui, & Stoolmiller, 2004; Gonzalez et al., 2010; Justice, Meier, & Walpole, 2005; Pollard-Durodola et al., 2011; Wilkinson & Houston-Price, 2013). However, there are other instructional contexts, such as weekly general music classes, that may provide effective supports for building young students' word knowledge. The possibility that music specialists may be able to foster word learning through music-based instruction has not been explored. Music classrooms might provide a rich space for fostering vocabulary knowledge as learners participate in engaging, interactive activities in which words can be sung, spoken, or played on an instrument. Despite the potential value of teaching vocabulary through music and sounds, it is unknown if sound-based activities in a music class setting might help young students learn new words and deepen their word knowledge.

In the present study, I examined word learning in a music classroom when words were taught with sound effects performed by students using musical instructions typically found in elementary general music classrooms. Data were drawn from a vocabulary intervention

implemented in first-grade music classrooms. The intervention focused on an existing music education strategy called a sound story, which is a type of interactive read-aloud in which students help select and perform sound effects to associate with words in a text (Andress, 1980; Cardany, 2013). Although the sound story strategy is used as an instructional method in elementary music classrooms, I was unable to find any prior research investigating whether the strategy fosters word learning, making this study the first of its kind. Analyses reported in the present study focus on the extent to which children acquired rich lexical representations of words taught with sound effects compared with words taught with no sound during a storybook read-aloud.

Lexical Representations

As children learn and experience words, they build and refine mental representations of their newly acquired vocabulary. These lexical representations contain knowledge about words and how words are used across different contexts, thus making lexical representations crucial for text comprehension (Perfetti, 2007). Knowledge about a word's multiple forms and meanings, and the degree to which that knowledge is connected to prior knowledge, enhances a reader's retrieval and integration of words across various texts (Perfetti, 2007). As a result, high quality lexical representations position readers to better comprehend during the reading process.

Lexical representations contain both verbal and nonverbal information about the forms and meanings of words. Verbal information includes language-based representations, such as word labels, phonological units, language-based semantic knowledge (i.e., verbal definitions, synonyms, and antonyms; Clark & Paivio, 1991), and visual language, or print (Sadoski & Paivio, 2004). In contrast, nonverbal information includes imaginal, mental representations of multisensory experiences (Clark & Paivio, 1991), such as picture images, sounds, actions, and

other modalities (Clark & Paivio, 1991; Schyns & Rodet, 1997; Yu, Ballard, & Aslin, 2005). As a result, a word learner can have a verbal representation of the word (e.g., *chaos* means when everything is out of control) and/or a nonverbal representation of a word (e.g., a mental image of a chaotic scene).

Signs and word learning. Verbal and nonverbal information is stored as lexical representations acquired through multimodal experiences with words (Yu et al., 2005). Peirce's theory of signs (Chandler, 2017; Peirce, 1958) lays the theoretical groundwork to consider how verbal and nonverbal experiences, known as signs, assist in building lexical representations (Golinkoff & Hirsh-Pasek, 2000; Nöth, 2012, 2014). According to the semiotic perspective, word learning occurs as learners are exposed to a number of multimodal signs that shape and refine their knowledge about words (Nöth, 2012). These signs help carry information about words (Nöth, 2012), such as semantic information (Hadley, Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2016; Nöth, 2012) and contextual information about word applicability in different contexts (Hadley et al., 2016; Henriksen, 1999). As word learners experience an array of verbal and nonverbal signs and build associations between them, they construct an interconnected web of signs that contributes to a deeper knowledge about words. Consequently, experiences with multiple verbal and nonverbal signs leads to a more detailed and complex web of signs featuring various modalities of representation, resulting in higher quality lexical representations.

Developmental considerations. Children younger than 5 years of age use a variety of verbal and nonverbal signs in their environment to build initial lexical representations of word-referent associations between concrete objects and word labels (Hollich, Hirsh-Pasek, & Golinkoff, 2000; Yu et al., 2005), which helps them develop a web of signs for concrete word

types. As children get older and learn more word labels, it becomes easier for them to interpret and process verbal information about words. By age 5, children may not rely as heavily on perceptual signs to build initial lexical representations (Hollich et al., 2000), particularly for concrete word types that can be easily understood through verbal definitions. However, when building high-quality representations of more abstract, complex words, verbal signs may not be sufficient for word learning. These more conceptually challenging words may be difficult to define and may reference an experience that has yet to be encountered by children; as a result, children may utilize nonverbal signs to better understand the difficult word meanings. Nonverbal signs can contribute to a deeper knowledge about more abstract word types. Specifically, nonverbal signs that are iconic and convey novel semantic information about words (e.g., loud, wild noises to depict the sound-based dimension of the word *chaos*) may enhance children's grasp and depth of knowledge about abstract concepts by perceptually representing word meanings and simulating sensory experiences related to the word (Barsalou, 1999), making abstract words more accessible to children.

Multimodal Signs and Vocabulary Instruction

It is my position that when children are learning words, they build meaning for those words through both constructing verbally mediated networks and linking words to nonverbal representations to create multimodal networks. Through instruction, students connect sources of information presented to them with their own past experiences and understandings to construct their lexical representations. For example, when learning the word *texture*, a teacher may show students a semantically related, iconic picture that depicts various types of textures. The picture is given meaning as students use their prior knowledge of the pictured items, including the touch and feel of those items, to better understand the concept of texture. The process of learning

words, such as *texture*, is further enhanced as students are exposed to multiple verbal and nonverbal sources of information about words, including definitions, pictures, gestures, and storybook contexts, that help them make a deeper and more refined sense of words.

I posit that adding nonverbal sound effects to other multimodal supports can enhance students' conception about words. Similar to visually based nonverbal signs, such as pictures, sounds provide perceptual information about words. For the word *texture*, students can learn textural sound qualities, such as the roughness or smoothness of sound, which may enrich and extend their lexical representation of what *texture* means and what objects can have texture. Such nonverbal sound-based knowledge may lead to a higher quality lexical representation as learners expand their web of signs beyond spoken language and visual modalities. By tapping into other modal sources of information, students gain a more diverse representation of a word's meaning that gives them access to the multiple meanings and applications of words across different texts and conversations, including discipline-specific musical contexts.

Word Learning and Verbal Signs

Many vocabulary interventions have demonstrated that students with different linguistic backgrounds and varying degrees of vocabulary knowledge are able to acquire novel vocabulary through targeted and integrated word instruction in classroom settings (Beck & McKeown, 2007; Biemiller & Boote, 2006; Wasik, Bond, & Hindman, 2006). Specifically, studies have shown that explicitly teaching words with verbal signs is effective in building young learners' lexical representations (Beck & McKeown, 2007; Biemiller & Boote, 2006; Penno, Wilkinson, & Moore, 2002). Explicit, verbal instruction involves directly stating words, providing clear explanations of words, demonstrating word use, and allowing students to practice using words in

multiple contexts (for a review, see Cena et al., 2013). These techniques provide access for students to build and expand their lexical representations of words (Beck & McKeown, 2007).

Most of the research on explicit vocabulary instructions has examined its benefits when used in conjunction with book reading (Beck & McKeown, 2007; Biemiller & Boote, 2006; Penno et al., 2002; Wilkinson & Houston-Price, 2013). Books provide a meaningful context for learning novel words and building lexical representations through signs such as the story narrative, illustrations, and syntactical structures embedded in the text (Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012). The majority of the studies on explicit instruction of words in book reading have focused on enhancing the English word knowledge of native English speakers. Although not extensively researched, similar results have been found for the English word learning of language-minority students[2] with varying degrees of English language proficiency (Coyne et al., 2004; Gonzalez et al., 2010; Pollard-Durodola et al., 2011). Furthermore, studies have found that integrating native-language supports (Leacox & Jackson, 2014) and including interactive talk about words, such as predicting word meanings and identifying synonyms (Chlapana & Tafa, 2014), also enhanced the English word learning of language-minority learners.

For all learners, factors relating to the word learner and type of word being learned impact the effectiveness of verbal signs in building children's lexical representations. The rate of word learning varies based on the language characteristics of the word learner. Initial vocabulary knowledge functions as the building block for refining and extending lexical representations. Young learners with high initial vocabulary knowledge have more lexical representations to draw on (Blewitt, Rump, Shealy, & Cook, 2009; Cain & Oakhill, 2011; Penno et al., 2002;

[2] Language minority (LM) is a term used to designate non-native speakers of a language. LM learners vary in their proficiency of other languages (see August & Shanahan, 2006).

Silverman & Crandell, 2010), and as a result, these students benefit more from enhanced vocabulary instruction. For children with high vocabulary knowledge, words are often efficiently learned through the verbal signs used in explicit instruction (Rowe et al., 2013; Silverman & Crandell, 2010). However, students with low vocabulary knowledge, including language-minority learners with low English proficiency, may benefit more from vocabulary instruction that includes verbal and nonverbal signs (Grifenhagen, 2012; Rowe et al., 2013).

The speed with which children learn new words also varies based on the imageability of the words (Gillette, Gleitman, Gleitman, & Lederer, 1999; Maguire, Hirsh-Pasek, & Golinkoff, 2006). Specifically, concrete nouns and verbs are more readily learned than abstract nouns and verbs (Dickinson et al., 2019; Hadley et al., 2016). Consequently, more abstract word types may need additional support beyond explicit verbal definitions to make word meanings more accessible and salient to children.

Word Learning and Nonverbal Signs

Nonverbal signs, such as pictures and gestures, may be particularly effective for children with lower initial vocabulary knowledge, because these supports can provide repeated exposure to a word's meaning (Rowe et al., 2013) and highlight information about words (Gámez, Neugebauer, Coyne, McCoach, & Ware, 2017). Prior research has shown that young students with lower initial vocabulary knowledge learn words more effectively when explicit instruction is combined with semantically related, iconic gestures or pictures (Rowe et al., 2013; Silverman & Crandell, 2010). The combination of explicit instruction with nonverbal supports is particularly effective for students learning words in their second, non-native language (Carlo et al., 2004; Cena et al., 2013; Páez et al., 2011; Silverman, 2007).

Although pictures and gestures can enhance word learning, they may have a differential effect on vocabulary acquisition based on children's language background. Several studies have found that gestures were more effective than pictures in fostering language-minority learners' word learning (Mavilidi, Okely, Chandler, Cliff, & Paas, 2015; Rowe et al., 2013; Tellier, 2008), especially for learners with low second-language proficiency (Rowe et al., 2013). However, for others, such as monolingual English speakers with low English proficiency, teaching words with picture images fostered word learning better than gestures (Rowe et al., 2013).

The effects of gestures and pictures on word learning are difficult to parse out in the book-reading literature because they are often both present. Several book-reading studies reported that teaching words with a combination of semantically related, iconic gestures and picture images before or after book-reading events increases various dimensions of young learners' word knowledge, such as receptive, expressive, and definitional knowledge, for different word types, including abstract words (Chlapana and Tafa, 2014; Collins, 2010; Gonzalez et al., 2010; Hadley et al., 2016; Penno et al., 2002; Pollard-Durodola et al., 2011; Wasik et al., 2006). Hadley et al. (2016) found that providing multiple signs, including iconic pictures and gestures with verbal definitions, during a book-reading intervention bolstered preschool students' depth of knowledge about word meanings and relevant contexts associated with words for concrete nouns, abstract nouns, verbs, and adjectives. Similarly, Chlapana and Tafa (2014) considered how active engagement with nonverbal signs during book reading, such as pointing to picture images and using gestural expressions to represent a word, enhanced the word learning of language-minority learners. Chlapana and Tafa found that incorporating nonverbal supports led to increased word learning in the second language. Aligning with the Peircean theory of signs, these findings show that integrating multiple, meaningful verbal and

nonverbal supports during vocabulary instruction can enrich students' word knowledge and contribute to higher lexical quality.

Sounds as Nonverbal Signs

Whereas research on nonverbal signs primarily has focused on the impact of iconic visually based signs, such as pictures and gestures, on children's word learning, the use of sound as an iconic nonverbal support has received less attention. Studies on infants and toddlers have demonstrated that at 1 and 2 years old, children are able to map nonverbal sound effects to visual objects (Campbell & Namy, 2003; Cummings, Saygin, Bates, & Dick, 2009; Hollich et al., 2000; Woodward & Hoyne, 1999). However, the extent to which children can use sounds to learn information about words at older ages remains unexplored.

The practice of using sounds as iconic signs that perceptually resemble and convey meaning is not novel to the music literature. Many musical works use sounds to represent key characters, themes, and emotions (Robinson & Hatten, 2012; Tarasti, 2002). For instance, in Sergei Prokofiev's symphonic fairy tale *Peter and the Wolf,* the horns play a loud, intimidating musical phrase that signifies the presence of the dangerous wolf. Given the role of sounds as signs in musical compositions (Tarasti, 2002), it is possible that sounds can function as meaningful signs for novel words and offer another layer of support for word learning. Sounds can capture contextual and semantic features of words (Fritz et al., 2009; Steinbeis & Koelsch, 2011; Zhou, Jiang, Wu, & Yang, 2015). Specifically, sounds may offer unique support for words that have less imageability and may be difficult to represent through verbal signs (e.g., a verbal definition) and nonverbal visual signs (e.g., a picture). For example, the abstract verb *inspire*, which was used in the present study, can be hard to define. However, I found that first-grade

students were quick to associate the word with soft, chiming handbells. Increasing the imageability of words makes it easier for students to learn words (Maguire et al., 2006), and nonverbal sounds may help make abstract and complex word types more imageable for young learners.

Research has suggested that the semantic relevance of music and sound to a word meaning plays an important role in fostering word learning. In a study with German adults, Fritz et al. (2019) presented printed pseudo-Indonesian word labels for concrete and abstract nouns. Upon seeing the word labels, adults also heard either semantically related or semantically unrelated classical music. Fritz and colleagues found that hearing semantically related excerpts of music when learning the word labels enhanced adults' word learning compared with conditions in which they heard semantically unrelated excerpts of music. This finding suggests that the semantic match between nonverbal musical sounds and words can impact word learning; however, generalizability of the finding to young native and nonnative English speakers is limited because the study focused on adult second-language learners.

In my extensive review of the literature, I was unable to find research investigating the effect of using semantically related, iconic sounds as signs to support children's word learning. Although standard approaches to using books have not considered the impact of iconic sounds on word learning, some have begun to examine the effects of sounds in the context of e-books. Smeets, van Dijken, and Bus (2014) investigated the word-learning effects of background music and sounds during e-book reading. The sounds were not designed to semantically represent all of the target words, but semantic matches occurred for some target words (e.g., a bird whistling during the presentation of the word *whistle*). Smeets and colleagues found that kindergartners with no speech language impairment performed better on a vocabulary sentence completion task

when music and sound effects were present in the e-book. Although promising, the implications of Smeets et al.'s work for the method used in this study was limited because not all of the sounds used in the e-books were designed to semantically represent target words, and the students were not active participants in selecting or producing the sounds.

Sound Stories

Music teachers use varied methods to teach students how music and sounds function as signs that convey meanings and ideas (Eppink, 2009). A sound story is one such practice used in elementary music classrooms (Andress, 1980; Cardany, 2013). Sound stories are interactive read-alouds that add sound effects to characters, scenes, or target words during the story (Andress, 1980; Cardany, 2013). In sound stories, teachers select keywords from the text and then work with students to assign a sound effect that depicts the tone and meaning of each keyword. Teachers often position students as active participants in selecting the sound effects for the words. The primary goal of having students select sound effects is to help them attend to the features of sound; however, this approach also activates students' knowledge about the words and helps them process word meanings in a deeper fashion. Once the sound effect is learned, students perform the sound whenever the word appears in the text. For example, a popular sound story in music education uses the book *Mortimer* by Robert Munsch, in which the main character frequently runs up and down the stairs. Whenever Mortimer runs up in the text, students often play fast sounds that move from low pitch to high pitch (for an example, see Leigh, 2015). This quick movement of pitch functions as a sign for the word *up* in the text and reinforces the musical concept about the directionality of pitch. Although this portrays a simple example of how sound stories work in the music education literature, it is possible that using sounds to

represent more difficult and unfamiliar words, such as *inspire* and *chaos*, may help students more readily grasp word meanings and relevant contexts for word use.

Purpose of Study

Given the lack of research on the use of semantically related sound effects to foster word learning, I sought to address whether integrating interactive sound effects in a traditional read-aloud would build vocabulary knowledge in young students. Specifically, I wanted to consider how nonverbal sound-based signs of word meanings in combination with other verbal and nonverbal signs could contribute to the quality of lexical representations. I hypothesized that using interactive, semantically related sound effects during vocabulary instruction and book reading would enhance word learning for all students and that students would learn more information about words taught with an added sound effect compared with words taught with no sound effect.

Three research questions guided the study:

1. Did teaching vocabulary with a semantically related sound effect foster better growth for receptive and productive definitional word knowledge compared with words taught with no sound effect and control words that were not taught?

2. Did language background, as measured by English learner status, impact the effectiveness of sound effects on receptive and productive definitional word knowledge?

3. How did the lexical information learned vary for words taught with sound effects and words taught with no sound effects as evident by productive definitional word knowledge?

Methods

Participants

Fifty-three children were enrolled in the study, but one child was absent for each day of the intervention, so I only used data from 52 participants (mean age = 85.51 months). All the children attended the same public elementary school, which served a high number of language-minority students from Spanish-speaking homes with low to middle socioeconomic status (see Table 1). During the 2015–2016 academic year, 93.2% of the student population were eligible for free or reduced-price meals, and 51.5% of the students were receiving English learner (EL) services.[2] Students in the study came from four first-grade music classes taught by the same music teacher. Students participated in the intervention in March and April of their first-grade year. The music teacher was in his ninth year of teaching music and his third year of teaching elementary general music. On average, the music teacher taught over 300 students each week and saw all of his students every four or five days.

Table 1

Demographic Information

Demographic factor	Number of participants $N = 52$ (100%)	Grade 1 Music Classes, n (percentage)			
		Class 1 $n = 12$	Class 2 $n = 9$	Class 3 $n = 17$	Class 4 $n = 14$
Sex					
Male	28 (53.8)	9 (75)	7 (77.8)	7 (41.2)	5 (35.7)
Female	24 (46.2)	3 (25)	2 (22.2)	10 (58.8)	9 (64.3)
English learner Status					
Non-English learner	20 (37.7)	5 (41.7)	3 (33.3)	5 (29.4)	7 (50)
English learner	32 (60.4)	7 (58.3)	6 (66.7)	12 (70.6)	7 (50)
Home Language					
English	13 (25)	2 (16.7)	1 (11.1)	4 (23.5)	6 (42.9)
Spanish	33 (63.5)	8 (66.7)	8 (88.9)	11 (64.7)	6 (42.9)
Other	6 (11.5)	2 (16.6)	0 (0)	2 (11.8)	2 (14.2)
Race and/or ethnicity					
White/Caucasian	12 (23.1)	1 (8.3)	0 (0)	5 (29.4)	6 (42.9)
Hispanic/Latino	33 (63.5)	8 (66.7)	8 (88.9)	10 (58.8)	8 (57.1)
Black/African American	3 (5.8)	0 (0)	1 (1.9)	1 (5.9)	0 (0)
Asian/Pacific Islander	2 (3.8)	1 (8.3)	0 (0)	1 (5.9)	0 (0)
Multiracial	2 (3.8)	2 (16.6)	0 (0)	0 (0)	0 (0)

Note. Some percentages do not add up to 100% because of rounding.

Materials and Procedures

Book selection. I selected the storybook *The Knight and the Dragon* by Tomie dePaola (1980) for the sound story because of its engaging theme, supportive illustrations, and space to include additional vocabulary. Furthermore, to adhere to the Common Core State Standards for first grade regarding text complexity (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), I focused on identifying a book that had a Lexile level that was at least one grade level above grade 1. The selected book has a reported Lexile level of AD650L, which falls within the grade 3 reading level (MetaMetrics, n.d.).

Word selection. I selected words for three conditions: sound, no sound, and control. The sound and no-sound words were integrated into the text, and the control words were never taught. Control words were included to control for potential testing effects, which helped ensure that word learning in the sound and no-sound conditions was not attributable to the exposure to words at pretest. A total of 22 words were used: six sound words, six no-sound words, and 10 control words. The sound words were taught using pictures, verbal definitions, and accompanying sound effects, whereas the no-sound words were taught using pictures and definitions only.

To test the effects of teaching words with nonverbal sound effects, I selected words based on their level of difficulty and frequency. I only used verbs and abstract nouns because prior research has indicated that young students often have difficulty in learning these word types (Hadley et al., 2016). Each of the three conditions consisted of half abstract nouns and half verbs.

To select words for the study, I first identified verbs and abstract nouns that fell under the T6 or D category of Biemiller's (2010) word list to ensure that the words were difficult and most likely unfamiliar to first graders. T6 category words are considered high-priority words that are familiar to 40–80% of students by the end of grade 6 (Silverman & Hartranft, 2015), and D category words are more difficult and known by fewer than 40% of students by the end of grade 6 (Silverman & Hartranft, 2015). I also used the ChildFreq website (http://childfreq.sumsar.net/; Bååth, 2010) as an additional check to confirm that words were likely to be unfamiliar to first graders. The website uses the CHILDES database to assess the frequency of children's use of words. All target words used for the present study had no data for ages 0–95 months old, suggesting that first graders were likely to have limited familiarity with the words.

Taught words. For words that were to be taught (sound and no sound), I used the story narrative and illustrations to guide the selection of six verbs and six abstract nouns from Biemiller's (2010) word list. I selected words that already occurred in the book or could be incorporated into the text without detracting from the story's plot. Once 12 words were selected and considered appropriate for the book text, I randomly assigned three abstract nouns and three verbs to the sound and no-sound conditions (see Table 2 for the words). Out of the 12 selected words, 11 had to be inserted into the book's text. Some words fit easily into existing sentences. For example, in the sentence "Finally, the knight and the dragon were both ready" (dePaola, 1980, n.p.), I added *foes* so the sentence read "Finally, the two foes, the knight and the dragon, were both ready." Other words required that I add text to the story. The book has many illustrations that depict additional information about the plot, so I was able to insert sentences that matched the illustrations and followed the story narrative. For example, while the dragon is preparing for the fight, there are illustrations of him baring his teeth and making fierce faces. I incorporated the word *gnaw* by adding the text "He showed his sharp teeth and pretended to gnaw on the knight's armor."

Control words. For control words that were not taught or included in the book's text, I randomly selected five verbs and five abstract nouns that were used in a previous large-scale language intervention and were from the T6 and D categories of Biemiller's (2010) word list (see Table 2 for the words). I used the words from a prior study because test materials had already been created with the words, and I did not have to fit the words into the text of *The Knight and the Dragon*.

Table 2

Words, Word Type, and Level of Difficulty by Level of Instruction

Instructional Condition	Word	Word type	Living Word Vocabulary difficulty rating[a]	On CHILDES database 0 to 95 months[b]
Sound	*chaos*	abstract noun	D	No
	gnaw	verb	T6	No
	hoist	verb	T6	No
	inspire	verb	T6	No
	progress	abstract noun	T6	No
	texture	abstract noun	T6	No
No Sound	*char*	verb	T6	No
	clamor	abstract noun	T6	No
	foes	abstract noun	T6	No
	rummage	verb	T6	No
	shimmer	verb	D	No
	tempo	abstract noun	T6	No
Control	*alter*	verb	T6	No
	baffle	verb	T6	No
	blunder	abstract noun	T6	No
	clutch	verb	T6	No
	escort	verb	D	No
	source	abstract noun	T6	No
	nudge	verb	T6	No
	nuisance	abstract noun	T6	No
	preference	abstract noun	T6	No
	sympathy	abstract noun	D	No

Note. D = words known by fewer than 40% of students by end of Grade 6; T6 = words known by 40-80% of students by end of Grade 6

[a] See Biemiller (2010). [b]See Bååth (2010)

Bias check for sound words. All words were selected without consideration for whether their meanings could be easily represented by sound. As a result, after words were selected, I checked the words in the sound and no-sound conditions to confirm that the sound condition was not favored by more perceptually salient nonverbal sound-based signs compared with the no-sound condition. For example, the word *gnaw* could easily be represented by a crunching sound, whereas the word *inspire* required a more abstract sound representation. A research team

member with no formal music education training and one with formal music education training noted any words that they felt would be difficult to represent with sound. The lists were compared and both member agreed that two words in the sound condition (*inspire* and *progress*) needed more abstract sound representations, whereas only one word in the no-sound condition (*foes*) needed a more abstract sound representation. As a result, no bias for ease of sound representation was found in the sound condition compared with the no-sound condition.

Sound selection. After assigning the words to conditions, a researcher who had taught elementary music worked with the music teacher to identify a matching and a contrasting nonverbal sound effect for each of the assigned sound words using instruments available in the music classroom. The matching sound effect was created to represent word meanings, and the contrasting sound effect was arbitrarily created with no tie to the word meanings. The teacher used the matching and contrasting sound effects during the intervention to engage students in thinking about the features of sounds and their suitability for representing the words. Appendix A lists the definitions, as well as the matching and contrasting sound effects for all of the sound words.

Study Design and Intervention

For the study, I used a within-subject design in which students served as their own controls for word learning. As a result, students were exposed equally to sound, no-sound, and control words. Students were pretested and posttested on all words during the school day. Pretesting was completed within a two-week period, with one week between pretesting and the start of the intervention. Posttesting began one day after the last sound story reading for each class and was completed within a two-week period to accommodate students who were absent.

On average, it took five academic days to complete posttesting for each class. Three total readings of the sound story occurred over three consecutive music class periods. The number of readings was based on prior book-reading studies with students of a similar age (Penno et al., 2002; Wilkinson & Houston-Price, 2013). Because the music teacher only saw classes once every four days, the intervention took a total of three weeks to complete. During each sound story reading, students were first introduced to the words and then participated in the sound story.

Word introduction. Prior to the sound story reading, students were explicitly taught the no-sound and sound words. The teacher first introduced each no-sound word by showing students a picture card, saying the word, and providing a child-friendly definition. Next, the teacher introduced each sound word by showing children a picture card, saying the word, providing a child-friendly definition, and then allowing students to select a sound effect that best represented the word's meaning. The teacher explicitly said the word to the students two times in both conditions.

When teaching the sound words, I sought to avoid arbitrary, meaningless associations between sound effects and words. For example, I did not want students to simply learn that the xylophone should be played whenever they heard the word *hoist* in the text. Instead, I wanted to teach students how sounds could be selected and constructed to reflect word meanings. To scaffold instruction for matching word meanings with sounds, the music teacher had students listen to two sound choices and worked with students to pick the sound that best represented a given word. For instance, when the word *hoist* was presented to students with the definition "to lift up something heavy," they had to decide whether moving from low to high tones on a bass xylophone better represented lifting up something heavy compared with moving from high to

low tones. The music teacher used sound descriptors such as "we need something that sounds like it is going up because we are lifting up," but did not repeat the word to equate students' exposure to the word label in both the sound and no-sound conditions. By demonstrating how sounds could reflect meaning, the sound effects became a sign of the word's definition. During the first two readings, students were given sound choices for words, and by the third reading, the teacher asked students to pick out the instrument that was selected for sound words in prior readings (see Appendix A for the sound choices given to students). The music teacher spent approximately 50 additional seconds when teaching a word with a sound compared with a word with no sound. This additional time was necessary for the teacher to set up the musical instruments and discuss the sound features of the instruments (i.e., "this triangle is made of metal and has a ringing sound"), but it was not used as an additional opportunity to learn the words.

Once sound selections were made for each of the sound words, students were assigned to word groups that featured the instrument selected for a particular sound word. Students were told to only play their sound whenever the matching word appeared in the text. Students participated in different word groups for each of the three readings to vary their exposure to instruments and words.

Sound story. After introducing the sound and no-sound words, the teacher read the story *The Knight and the Dragon* aloud. Both word conditions were randomly dispersed throughout the text. Whenever a no-sound word occurred in the text, the teacher restated the word and provided its child-friendly definition. The same procedure was followed for sound words; however, when students heard the sound word in the text, the teacher cued the corresponding word group to play the matching sound effect.

Teacher Training and Fidelity of Implementation

The music teacher received two training sessions on the sound story intervention with a research team member. Once the intervention began, the teacher video recorded each first-grade music class participating in the study. Half of the videos were double-coded for fidelity of implementation, and the coders reached an inter-rater reliability of .98. The music teacher implemented 97% of the sound story procedures across 12 total music lessons.

Measures

Two vocabulary measures were used at pretest and posttest. Each task included all sound, no-sound, and control words for a total of 22 items. The order of test administration was randomized before pretesting and was maintained for each student at pretest and posttest.

Receptive task. Participants' receptive knowledge of words was measured using a researcher-created receptive task similar to the Peabody Picture Vocabulary Test fourth edition (Dunn & Dunn, 2007). Individual students were shown four pictures and asked to select the image that depicted the target word. The three images that did not match the target word were related to the word by concept, theme, or phonological form. This task required relatively little knowledge of the word's meaning; therefore, correct responses may reflect surface-level semantic knowledge.

Productive word definition. Depth of knowledge in lexical representations was measured using a researcher-created productive word definition task adapted from Hadley et al.'s (2016) study. In the task, individual students were asked to share what they knew about specific words (e.g., "What is *chaos*? Can you tell me or show me more about *chaos*?"). All responses were video recorded and coded using seven information categories: synonym, gesture,

instrument reference, conceptual relation, nuance, contextual example, and extension (see Appendix B for the category descriptions). Students could receive an unlimited amount of points based on their responses. The productive word definition task was coded by research assistants, and 20% of the assessments were randomly selected and double-coded to ensure inter-rater reliability. The overall percentage agreement was 99.3%, with a mean Cohen's kappa value of .92.

Results

I used multilevel models to examine (a) students' overall growth in word knowledge when words were taught with sound, (b) the effects of EL status on students' word learning, and (c) differences in lexical information provided for words taught with sound compared with words taught without sound on the productive word definition task. Multilevel models allowed me to account for the nesting structure of the within-subject data (Snijders & Bosker, 2012). Using two-level models with robust estimation of standard errors, I nested instructional condition (sound, no sound, and control) within students, thus handling the interdependency of student-level clusters, because all students experienced all three instructional conditions.

Descriptive Statistics

I used average scores to account for differences in the number of words per instructional condition. This allowed me to equally compare the control words that were not taught (n = 10) with the sound (n = 6) and no-sound words (n = 6). For the receptive task, the scores represent the average proportion of items answered correctly in a given instructional condition. Because there was a set total number of possible points for each condition, scores ranged from 0 to 1. For the productive word definition task, the scores represent the average number of points per word

in a given instructional condition because there was not a set total number of possible points. Scores of 1 on the productive word definition task indicate that, on average, students provided one information unit per word in a given condition.

Overall, 77% of students had a positive increase in their receptive word knowledge for words taught with sound, and 71% of students had a positive increase in their productive definitional word knowledge for words taught with sound. For the receptive task, students had a mean posttest score of .31 (standard deviation [*SD*] = .14) for control words, .53 (*SD* = .25) for no-sound words, and .55 (*SD* = .26) for sound words. For the productive word definition task, students had a mean posttest score of .018 (*SD* = .065) for control words, .53 (*SD* = .57) for no-sound words, and .88 (*SD* = 1) for sound words. Table 3 shows the descriptive statistics of the receptive and productive word definition tasks for students broken down by EL status.

Table 3

Means (Standard Deviations) and Effect Sizes on Vocabulary Tasks by Condition and English learner (EL) Status

	EL (*n* = 32)				**Non-EL (*n* = 20)**			
Vocabulary Task/ Condition	**Pretest *M (SD)***	**Posttest *M (SD)***	**Cohen's *d* to Control**	**Cohen's *d* to No Sound**	**Pretest *M (SD)***	**Posttest *M (SD)***	**Cohen's *d* to Control**	**Cohen's *d* to No Sound**
Receptive								
Control	0.26 (0.11)	0.33 (0.14)	-	-	0.28 (0.16)	0.28 (0.14)	-	-
No Sound	0.29 (0.20)	0.53 (0.25)	0.56	-	0.37 (0.19)	0.57 (0.26)	0.92	-
Sound	0.18 (0.18)	0.49 (0.26)	0.61	0.36	0.46 (0.21)	0.64 (0.22)	1.49	0.40
Productive word definition								
Control	0.01 (0.04)	0.01 (0.05)	-	-	0.03 (0.07)	0.04 (0.09)	-	-
No Sound	0.07 (0.14)	0.38 (0.46)	1.12	-	0.07 (0.19)	0.78 (0.66)	1.78	-
Sound	0.06 (0.18)	0.60 (0.85)	1.00	0.36	0.24 (0.38)	1.36 (1.09)	1.72	0.55

Note. Cohen's *d* effect sizes compare the pretest to posttest mean difference scores and standard deviations across instructional condition. Positive effect sizes are in favor of sound condition.

Correlation of Tasks

I compared pretest and posttest scores on the receptive and productive word definition tasks to confirm that the assessments should be analyzed using the separate vocabulary scores. Prior studies reported moderate correlations between the receptive and productive word definition tasks (Hadley et al., 2016). I similarly found moderate correlations between the receptive and productive word definition tasks at pretest (r = .43) and posttest (r = .66), suggesting that although the assessments are related measures of vocabulary knowledge, they should be treated in the models as separate dependent variables.

Research Question 1: Word Growth by Task

My first research question asked whether students learned more words when taught with sound words compared with no-sound words or control words that were not taught. I constructed the following multilevel model to assess students' word learning on each of the vocabulary tasks:

$$\text{Posttest}_{ij} = \gamma_{00} + \gamma_{10}\text{Control}_{ij} + \gamma_{20}\text{NoSound}_{ij} + \gamma_{30}\text{Pretest}_{ij} + \gamma_{01}\text{ELStatus}_{j} + u_{0j} + e_{ij}$$

I ran the model separately two times to assess the receptive task scores and the productive word definition task scores. Instructional condition$_{ij}$ (control, no sound, and sound) was nested within students$_j$ (N = 52). I used a random-intercept and fixed-slope model, which allowed us to determine the main effects of level 1 variables across all students. Random slopes were tested in each model; however, because the information criteria and test statistics did not change with the addition of random slopes, I used fixed slopes to conserve parameters and parsimony.

The model was constructed with students' posttest scores as the dependent variable and instructional conditions dummy-coded as level 1 predictors. The sound words served as the reference group, allowing the coefficients in the model to function as a comparison of control (γ_{10}) and no-sound (γ_{20}) posttest scores with the sound posttest scores. I included a level 1 covariate of pretest scores (γ_{30}) and a level 2 covariate of EL status (γ_{01}). EL status was dummy-coded with non-EL as 0 and EL as 1. See Table 4 for results.

Table 4

Parameter Estimates for Multilevel Models by Vocabulary Task.

	Receptive task		**Productive word definition task**	
Variable	**Estimate**	**Standard Error**	**Estimate**	**Standard error**
Fixed effects				
Intercept	0.50***	0.05	0.83***	0.11
Level 1 Control (γ_{10})	–0.24***	0.04	– 0.66***	0.10
Level 1 No Sound (γ_{20})	– 0.05	0.04	– 0.25*	0.10
Level 1 Pretest (γ_{30})	0.30**	0.09	1.77***	0.24
Level 2 EL status (γ_{01})	– 0.03	0.04	– 0.27**	0.10
Random effects				
Level 1 residual variance (σ^2)	0.03***	0.01	0.25***	0.04
Level 2 residual variance (τ_{00})	0.01*	0.01	– 0.04	0.03

Note. EL = English learner.
*Regression coefficient is statistically significant at the .05 level (two-tailed). **Regression coefficient is statistically significant at the .01 level (two-tailed). ***Regression coefficient is statistically significant at the .001 level (two-tailed).

Receptive. The receptive vocabulary model used receptive task posttest and pretest scores in the model. Controlling for receptive task pretest scores ($\gamma_{30} = 0.30$, standard error [*SE*] = 0.09, $p = .002$) and EL status ($\gamma_{01} = -0.03$, $SE = 0.04$, $p = .53$, nonsignificant), the analysis showed that students correctly answered more receptive items for words taught with sound

compared with control words that were not taught ($\gamma_{10} = -0.24$, $SE = 0.04$, $p < .001$). There was no statistically significant difference in the number of correct responses between words taught with sound and words taught with no sound ($\gamma_{20} = -0.05$, $SE = 0.04$, $p = .20$, nonsignificant). On average, students improved their receptive posttest scores by 1.80 points for words taught with sound compared with 0.48 point for control words and 1.26 points for no-sound words. Cohen's *d* calculations of pretest to posttest growth across instructional conditions indicated a large effect size of $d = 1.11$ for sound words compared with control words and a medium effect size of $d = 0.33$ for sound words compared with no-sound words.

PWD. The structure of the productive word definition model was the same as the model for the receptive task, except I used the pretest and posttest scores from the productive word definition task. Controlling for productive word definition task pretest scores ($\gamma_{30} = 1.77$, $SE = 0.24$, $p < .001$) and EL status ($\gamma_{01} = -0.27$, $SE = 0.10$, $p = .01$), the analysis indicated that students provided more information about words taught with sound than control words that were not taught ($\gamma_{10} = -0.66$, $SE = 0.10$, $p < .001$) and words that were taught with no sound ($\gamma_{20} = -0.25$, $SE = 0.10$, $p = .015$). Overall, students provided 4.56 more information units from pretest to posttest for sound words compared with 0.05 information unit for control words and 2.82 information units for no-sound words. Cohen's *d* calculations on the mean differences between pretest to posttest scores across instructional conditions showed a large effect size of $d = 1.21$ for sound words compared with control words and a medium effect size of $d = 0.40$ for sound words compared with no-sound words.

Research Question 2: Word Growth by EL Status

The second research question asked whether students' word learning during the intervention varied by their language background (see Table 5 for item-level results by EL status for the sound and no-sound conditions). In the models specified for the first research question, I used students' school-designated EL status as a level 2 predictor. The multilevel word growth models by task indicated that EL status did not significantly affect students' receptive vocabulary growth ($\gamma_{01} = -0.03$, $SE = 0.04$, $p = .53$, nonsignificant) but significantly affected students' productive definitional word knowledge ($\gamma_{01} = -0.27$, $SE = 0.10$, $p = .01$). As previously noted, the overall model for the productive word definition scores indicated that growth from pretest to posttest was significantly larger for sound words than no-sound words across all students, regardless of EL status ($\gamma_{20} = -0.25$, $SE = 0.10$, $p = .015$). On average, students with a school-designated EL status scored approximately 0.28 point lower on the productive word definition task posttest for sound words than non-EL students. Comparing the pretest to posttest difference scores on the productive word definition task, EL students provided 3.24 more information units for sound words, or 0.54 point per sound word, whereas non-EL students provided 6.27 more information units for sound words, or 1.05 points per sound word. For no-sound words, EL students provided 1.86 more information units from pretest to posttest, or 0.31 point per no-sound word, and non-ELs provided 4.26 information units, or 0.71 point per no-sound word. The two groups showed similar growth for control words, with EL and non-EL students providing less than 0.10 information unit from pretest to posttest.

Table 5

Means (Standard Deviations) and Effect Sizes on the Productive Word Definition Task by Word and English Learner (EL) Status

		ELs (*n* = 32)			Non-ELs (*n* = 20)			
Condition	**Word**	**Pretest** *M* (*SD*)	**Posttest** *M* (*SD*)	**Pretest–posttest gain** *M* (*SD*)	**Pretest** *M* (*SD*)	**Posttest** *M* (*SD*)	**Pretest–posttest gain** *M* (*SD*)	**Cohen's *d* comparing non-ELs with ELs**
Sound	*chaos*	0.13 (0.71)	0.72 (1.05)	0.59 (1.01)	0.28 (0.55)	1.73 (1.68)	1.45 (1.44)	0.69
	gnaw	0.00 (0.00)	0.53 (1.02)	0.53 (1.02)	0.25 (0.72)	0.93 (1.32)	0.68 (1.15)	0.45
	hoist	0.00 (0.00)	0.44 (1.08)	0.44 (1.08)	0.00 (0.00)	1.10 (1.48)	1.10 (1.48)	0.51
	inspire	0.09 (0.39)	0.36 (0.87)	0.27 (0.92)	0.23 (0.80)	0.63 (1.02)	0.40 (0.74)	0.16
	progress	0.13 (0.42)	0.47 (1.05)	0.34 (1.07)	0.00 (0.00)	1.05 (1.73)	1.05 (1.73)	0.49
	texture	0.03 (0.18)	1.11 (1.61)	1.08 (1.59)	0.70 (1.45)	2.75 (2.24)	2.05 (2.37)	0.48
No sound	*char*	0.00 (0.00)	0.33 (0.84)	0.33 (0.84)	0.00 (0.00)	0.90 (1.29)	0.90 (1.29)	0.52
	clamor	0.06 (0.35)	0.22 (0.66)	0.16 (0.77)	0.00 (0.00)	0.40 (0.88)	0.40 (0.88)	0.29
	foes	0.00 (0.00)	0.44 (0.95)	0.44 (0.95)	0.00 (0.00)	1.05 (1.43)	1.05 (1.43)	0.50
	rummage	0.00 (0.00)	0.09 (0.39)	0.09 (0.39)	0.00 (0.00)	0.30 (0.80)	0.30 (0.80)	0.33
	shimmer	0.33 (0.69)	1.03 (1.25)	0.70 (1.11)	0.43 (1.16)	1.60 (1.46)	1.18 (1.44)	0.37
	tempo	0.00 (0.00)	0.19 (0.64)	0.19 (0.64)	0.00 (0.00)	0.45 (0.83)	0.45 (0.83)	0.35

Note. *M* = mean; *SD* = standard deviation. Cohen's *d* effect sizes compare the pretest to posttest mean difference scores and standard deviations of non-EL and EL students. Positive effect sizes are in favor of non-EL students.

Given that EL status was a statistically significant predictor for the productive word definition task, I ran a cross-level interaction model to determine whether there were statistically significant differences between EL and non-EL students' pretest to posttest scores and when comparing sound words with the other two instructional conditions. The initial model was similar to the one used in the first research question but with interaction terms between the level 1 variables (control, no sound, and pretest) and the level 2 variable (EL status). The model had difficulty in converging because it was too complex, so I ran two interaction models that used a subset of data and were more parsimonious. The following model structure was conducted for both interaction models:

$$\text{Posttest}_{ij} = \gamma_{00} + \gamma_{10}\text{Sound}_{ij} + \gamma_{20}\text{Pretest}_{ij} + \gamma_{01}\text{ELStatus}_{j} + \gamma_{11}\text{Sound}_{ij}\text{ELStatus}_{j} + \gamma_{21}\text{Pretest}_{ij}\text{ELStatus}_{j} + u_{0j} + u_{1j}\,\text{Sound}_{ij} + u_{2j}\,\text{Pretest}_{ij} + e_{ij}$$

Model 1 used only scores for the sound and control words, with control words set as the reference group, whereas model 2 used only scores for the sound and no-sound words, with no-sound words set as the reference group. To account for the potential increase in Type I error from running multiple models, I used a Bonferroni-adjusted alpha level of .025 (.05/2). Table 6 shows the estimates of the predictors in both models.

Table 6

Estimates (Standard Errors) of Predictors in Cross-Level Interaction Models for the PWD Task

	Model 1		Model 2	
Level and variable	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**
Level 1				
Intercept (γ_{00})	0.19	0.02	0.66***	0.11
Sound (γ_{10})	1.16***	0.20	0.41*	0.16
Pretest (γ_{20})	0.76	0.37	1.19	0.66
Level 2				
EL status (γ_{01})	−0.01	0.03	−0.37*	0.14
Cross-level interaction				
Sound × EL status (γ_{11})	−0.68*	0.26	−0.22	0.20
Pretest × EL status (γ_{21})	0.87	0.67	0.11	0.90

Note. EL = English learner. The reference group for model 1 is control and model 2 is no sound.
*Regression coefficient is statistically significant at the Bonferroni-adjusted .025 level (two-tailed).**Regression coefficient is statistically significant at the .01 level (two-tailed).
***Regression coefficient is statistically significant at the .001 level (two-tailed).

Both models showed that EL status did not differentially affect students' pretest to posttest scores on the productive word definition task (model 1: $\gamma_{21} = 0.87$, $SE = 0.67$, $p = .37$; model 2: $\gamma_{21} = 0.11$, $SE = 0.90$, $p = .90$). Model 1 showed that EL status differentially affected students' productive word definition outcomes when comparing words taught with sound with control words that were not taught ($\gamma_{11} = -0.68$, $SE = 0.26$, $p = .011$), with non-EL students having higher growth in their scores than EL students. The mean difference score between sound words and control words was smaller for EL students (mean [M] = 0.53, $SD = 0.75$), with an effect size of $d = 1.00$, than for non-EL students ($M = 1.11$, $SD = 0.93$), with an effect size of $d = 1.72$. Model 2 showed that EL status did not differentially affect students' productive word definition outcomes when comparing sound words with no-sound words ($\gamma_{11} = -0.22$, $SE = 0.20$,

$p = .26$), indicating that EL students learned sound words better than no-sound words similarly to non-EL students.

Research Question 3: Lexical Information Growth

The third research question asked how teaching words with sounds impacted the lexical information that students provided on the productive word definition task. I was specifically interested in the lexical information compared across sound and no-sound words. To address this question, I calculated the difference scores between pretest and posttest in each lexical information category coded on the productive word definition task (synonym, gesture, instrument reference, conceptual relation, nuance, contextual example, and extension) for words taught with sound and no sound. Each information category difference score served as the dependent variable for seven, separate multilevel models. To compensate for potential Type I error conflation when running multiple models, I used a Bonferroni-adjusted alpha level of .007 (.05/7). The same multilevel model was used across categories:

$$\text{InformationCategoryDifferenceScore}_{ij} = \gamma_{00} + \gamma_{10}\text{NoSound}_{ij} + \gamma_{01}\text{ELStatus}_{j} + u_{0j} + e_{ij}$$

Each model nested instructional condition of taught words$_{ij}$ (sound and no sound) within students ($N = 52$) with random intercepts and fixed slopes. The model was constructed with the average information category difference scores as the dependent variable. Pretest scores did not have enough variation to function as a covariate for some of the information categories, so I constructed models with difference scores to account for the pretest. Instructional condition was dummy-coded as a level 1 predictor, and only sound and no-sound conditions were included in the model. Sound words served as the reference group, so the coefficient for the no-sound words (γ_{10}) compared the information category difference scores between the two conditions. Each

model had a level 2 covariate of EL status (γ_{01}) to detect language background differences in information category growth. Non-EL students served as the reference group in each model.

Figure 1 shows the difference scores across information categories for sound and no-sound words with coefficients. For words taught with sound, students made the largest growth from pretest to posttest in contextual examples, followed by synonyms, gestures, nuances, extensions, and instrument references. In contrast, no-sound words made the largest growth in synonyms, followed by contextual examples, nuances, and gestures. Comparing student growth between the sound and no-sound conditions and controlling for EL status, students showed positive, statistically significant growth in their knowledge of contextual examples for sound words compared with no-sound words ($\gamma_{10} = 0.23$, $SE = 0.06$, $p = .006$), with a medium Cohen's d effect size of 0.54 in favor of sound words. None of the other information categories reached statistical significance; however, gestural responses approached statistical significance in favor of sound words compared with no-sound words ($\gamma_{10} = 0.06$, $SE = 0.02$, $p = .02$), with a medium Cohen's d effect size of 0.43

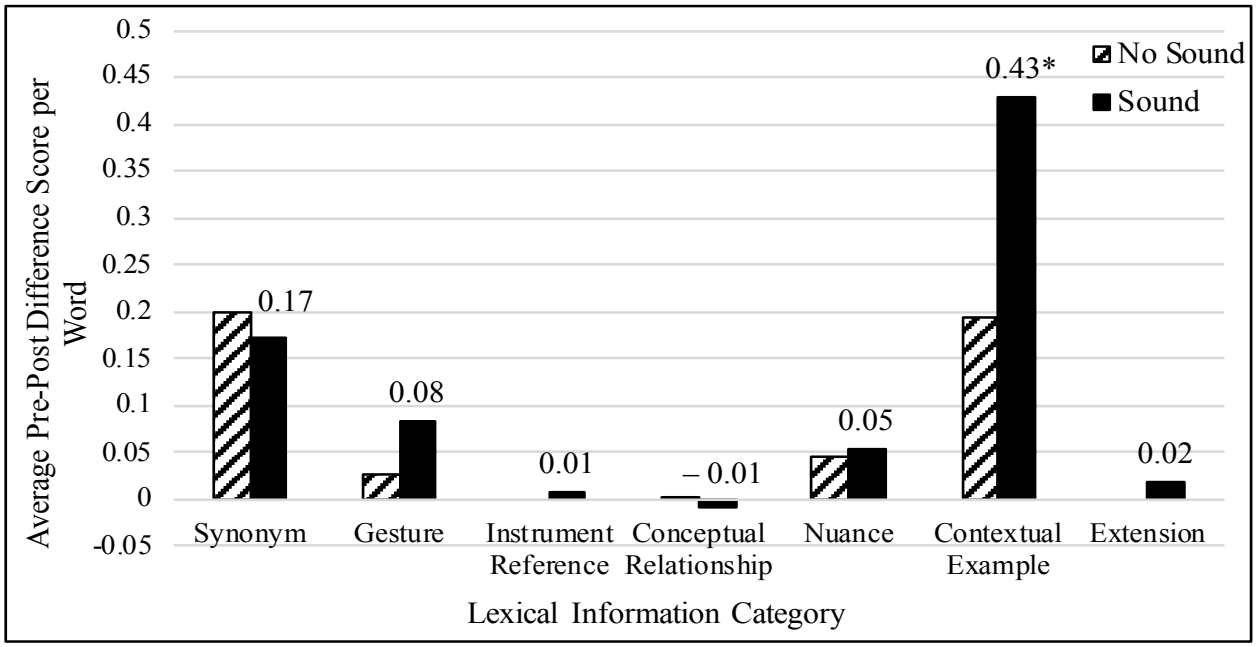

Figure 1. Average pretest to posttest difference scores by lexical information category code for sound and no-sound words. Scores above the bars represent the average difference score per word for sound words, and p-values indicate a statistically significant difference between sound and no-sound words for a given code. *p < .007.

Analyzing the effect of language background on information category difference scores, EL status was only a statistically significant predictor of contextual examples ($\gamma_{01} = 0.30$, $SE = 0.10$, $p = .007$). EL students provided more contextual examples for sound words compared with no-sound words, with a medium effect size of 0.39. However, descriptively, the number of contextual example responses was smaller for EL students than non-EL students, as seen in Table 7. On average, EL students provided 1.56 contextual example units for sound words, whereas non-EL students provided 4.20 contextual example units. EL status did not reach statistical significance for the other information categories; however, EL status approached statistical significance for synonyms ($\gamma_{01} = 0.13$, $SE = 0.05$, $p = .013$) in favor of no-sound words, with non-EL students tending to provide more synonyms than EL students.

Table 7

Means (Standard Deviations) and Effect Sizes of Growth in Lexical Information Categories by Condition and English Learner (EL) Status

	ELs (*n* = 32)			**Non-ELs (*n* = 20)**		
Lexical information category	**No-sound pretest–posttest gain *M* (*SD*)**	**Sound pretest–posttest gain *M* (*SD*)**	**Cohen's *d***	**No-sound pretest–posttest gain *M* (*SD*)**	**Sound pretest–posttest gain *M* (*SD*)**	**Cohen's *d***
Synonym	0.14 (0.22)	0.13 (0.19)	−0.05	0.29 (0.23)	0.24 (0.23)	−0.22
Gesture	0.01 (0.06)	0.09 (0.17)	0.66	0.05 (0.15)	0.07 (0.13)	0.12
Instrument reference	0.00 (0.00)	0.01 (0.03)	0.35	0.00 (0.00)	0.01 (0.04)	0.31
Conceptual relation	0.003 (0.03)	−0.01 (0.03)	0.37	0.004 (0.02)	−0.01 (0.04)	−0.41
Nuance	0.03 (0.09)	0.03 (0.09)	0.11	0.08 (0.09)	0.08 (0.11)	0.08
Contextual example	0.14 (0.17)	0.26 (0.42)	0.37	0.29 (0.23)	0.70 (0.67)	0.82
Extension	0.00 (0.00)	0.02 (0.07)	0.35	0.00 (0.00)	0.03 (0.08)	0.43

Note. *M* = mean; *SD* = standard deviation. Cohen's *d* effect sizes compare sound words with no-sound words. Positive effect sizes are in favor of the sound condition.

Discussion

Research has shown that word knowledge plays a critical role in later reading and academic success (Dickinson, Golinkoff, & Hirsh-Pasek, 2010). Because students with less initial school-valued vocabulary knowledge tend to fall behind in reading outcomes (Hoff, 2013), there is a need to consider new ways to foster vocabulary learning in the primary grades. Little is known about how sound effects can contribute to building rich lexical representations. Although nonverbal sounds have been used as a way to convey ideas in music for centuries (Tarasti, 2002), no research has considered how using nonverbal sounds to represent word meanings could impact word learning in young students.

Perfetti's (2007) lexical quality hypothesis posits that high-quality lexical representations are vital for reading comprehension. Specifically, one's knowledge about a word's form and meaning contributes to quick retrieval and integration of words during the reading process (Perfetti, 2007). Using Peirce's theory of signs helps us consider how multiple kinds of information related to a word's form and meaning are acquired during word learning. This semiotics frame highlights that experiences with various multimodal signs may help attune students into important features of words and assist in building and refining their lexical representations (Nöth, 2012, 2014).

The goal in the present study was to investigate the role of interactive, semantically related sound effects on first graders' word learning. I used a semiotics lens to consider what students learned about words after experiencing iconic nonverbal sound effects in combination with other word-related signs, such as verbal definitions, pictures, and book reading. Specifically, I considered whether incorporating sound effects in vocabulary instruction enriched

receptive, surface-level understanding of words, as well as depth of word knowledge as measured by a productive word definition task.

Intervention Effects

Instructional condition and task. Using sound effects as signs for teaching words helped students build lexical representations. Both receptive and productive definitional word knowledge significantly increased for all taught words compared with words not taught. Results on the receptive task showed large effects for words taught with sounds ($d = 1.12$) and moderately large effects for words taught with no sounds ($d = 0.70$) when compared with control words. There was not a statistically significant difference in receptive word learning between words taught with sound and words taught without sound. On the productive word definition task, results showed large effects for words taught with sound ($d = 1.21$) and no sound ($d = 1.28$) when compared with control words and a modest effect favoring words taught with sounds compared with those taught simply using verbal definitions and picture cards.

The lack of a difference between sound words and no-sound words on the receptive task suggests that semantically related sounds did not augment receptive learning that occurred when meanings were taught using pictures with definitions. The receptive task measured word learning through pictures, so I was only able to measure a student's ability to match words with a visual, picture sign but not a sound-based sign. It is therefore not surprising that adding sound effects to vocabulary instruction did not significantly improve receptive word knowledge. Although sound effects did not enhance receptive word knowledge compared with other taught words, I found that including sound effects did not impede receptive word learning for learners. This finding contrasts with previous research reporting that nonverbal visual supports can impede the

receptive word learning of young learners with various English-language proficiencies (Rowe et al., 2013). The difference in the findings may be a result of different instructional methods when using nonverbal supports to teach words. In Rowe et al.'s (2013) study, preschoolers were taught nonword labels for concrete objects in a non-book-reading context using semantically related, iconic visual signs, such as pictures and gestures, or no visual signs. When words were taught with visual signs, students were shown the matching gesture or picture, but they were not encouraged to replicate or produce the gesture or picture. In contrast, I asked first graders to actively select and perform the sounds used to represent words as they heard a story. Additionally, this study used more difficult, abstract words, which may account for additional differences in the results.

The finding of stronger growth in depth of word knowledge for sound words compared with no-sound words ($d = 0.40$) suggests that students acquired additional knowledge about word meanings for words taught with sound and were able to express that knowledge. This is consistent with my approach to word learning informed by Peirce's theory of signs because it suggests that in addition to acquiring lexical knowledge associated with information conveyed by the pictures, the newly acquired words also carried some meanings that were conveyed by the sound effects produced by musical instruments. Prior work has shown that vocabulary instruction that includes pictures and gestures is effective in teaching words (Hadley et al., 2016). What is novel is that this study directly contrasted learning with and without a nonverbal sign and demonstrated that when sound effects are used in the manner I employed, it functions as a sign and enriches students' word knowledge.

EL status. EL students displayed gains in their depth of word knowledge when words were taught with sounds, with higher mean gain scores for sound words ($M = 0.54$, $SD = 0.78$)

compared with no-sound words ($M = 0.32$, $SD = 0.41$). This finding indicates that teaching words with sounds benefited both EL and non-EL students. However, an interaction analysis showed that non-EL students did better than EL students on the productive word definition task when comparing sound and control words. One possible explanation for the difference between EL and non-EL students' scores is that the depth of word measure relied on students' language skills to communicate what they knew about words. Although I encouraged students to use gestures to share knowledge about words (Capone, 2007), the EL students may not have shared as much information as they knew because of language barriers. Previous work by Silverman and Hines (2009) reported that multimedia-enhanced vocabulary instruction in combination with shared book reading improved the English word learning of primary-grade ELs and closed the gap between EL and non-EL students' knowledge of taught words. However, students' word knowledge was measured with a yes/no vocabulary assessment that did not require an in-depth response about words. Future studies using depth measures, like the productive word definition assessment, with EL populations should consider encouraging dual-language assessments and other options that minimize language demands (see Mancilla-Martinez & Vagh, 2013).

Theoretical Implications

The results are consistent with Peirce's theory of signs (Chandler, 2017; Peirce, 1958) in that I found that words are learned more deeply when word learners experience multimodal signs related to a word (Nöth, 2012, 2014). Specifically, I found that making cross-modal links between word meanings and semantically related sound effects supported students' word learning. These results were statistically significant for the full sample, including EL students. Although students with a designated EL status provided less information about words compared with non-EL students, ELs still made larger growth for sound words compared with no-sound

words. I examined students' definitions to understand what type of lexical knowledge was acquired by coding for seven types of responses: synonym, gesture, instrument reference, conceptual relation, nuance, contextual example, and extension (see Appendix B for more details). I found that students' responses about words taught with sound tended to include more information related to gesture, instrument reference, nuance, contextual example, and extension compared with words taught with no sound. Among those categories, students provided significantly more contextual examples for words taught with sound compared with words taught with no sound, with sound words having approximately 2.20 times more contextual examples than words taught with no sound.

A number of the contextual examples referenced the other vocabulary supports used during the intervention. For instance, in response to *chaos*, some students described the picture used to introduce the word prior to the sound story reading (e.g., "When they throw papers, they play a lot. They mess up the whole classroom"). Several students referenced their sound experience during the sound story intervention (e.g., "When there is a lot of noise"). Still other students shared contextual examples that were never explicitly discussed during class (e.g., "When the dog is barking so loud, it won't even let you sleep"). These various examples demonstrated that asking students to actively select and perform sound effects with words not only signified word meanings but also brought attention to other relevant signs used during vocabulary instruction.

Students also used more gestures when defining sound words compared with no-sound words. Words taught with sound had 3.25 times more gestural responses than words taught with no sound. There was no statistically significant difference in the number of gestures produced by EL and non-EL students, lending support to the suggestion that measures of EL word learning

should include options to use nonverbal means of response. The increased use of gestures in students' responses is especially interesting because gestures were not explicitly taught, although the teacher sometimes used them to scaffold instruction. For instance, when guiding students to think about the direction of pitch that would be needed for the word *hoist*, the teacher moved his arms upward from low to high. Additionally, playing instruments may have helped students embody movements related to a word. For example, when performing the sound for *chaos*, students played their instruments in a wild motion. This movement may have transferred to gestural responses for *chaos* when children shook their hands back and forth.

The results support the notion that sound-based signs can enrich lexical representations. There are two possible reasons why words were learned better in the sound condition. One possibility that is consistent with the findings of prior research (for review, see Fritz et al., 2019) is that the sound condition increased attention and subsequent memory. Providing sounds for words and involving students in helping to select sounds to represent word meanings may have motivated students (Guthrie & Humenick, 2004) and pushed them to draw more deeply on contextual features in definitions, pictures, and gestures. As a result, I must acknowledge that simply hearing the sounds may have captured students' attention (Kutas & Federmeier, 2011) during vocabulary instruction, enabling students to better attend to information about words provided by picture and gestures and to make associations with their own prior experiences.

A second possibility that I feel is at the root of students' word learning in the sound story is that the sound condition not only increased their attention but also supplied additional semantic information that enhanced learning displayed on the productive word definition task but not the receptive task. Disentangling the attentional attributes from the semantic contributions of sound is difficult. However, Fritz et al. (2019) reported that the semantic relevance of music and

sound contributes to word learning. Fritz et al. found that semantically related music enhanced adults' word learning compared with semantically unrelated music, suggesting that the word-learning benefits of sound and music go beyond their ability to capture learners' attention. I argue that the increase in first graders' ability to display lexical knowledge of words taught with sound demonstrates that students learned semantic information conveyed through the sounds.

Additionally, I believe that the instructional methodology helped students attend to the semantic information embedded in the sound effects. Students were positioned as active participants in selecting sounds for words, which required them to make cross-modal links between verbal and nonverbal information sources. This process, known as transmediation, pushes students to reflectively think about the connections between different sign systems (Siegel, 1995). Siegel (1995) argued that transmediation can help enhance students' meaning making because they must consider and invent how to represent verbal information in a nonverbal modality. The current intervention encouraged students to transmediate verbal and visual semantic information about a word to a sound-based representation. This practice may have pressed students to think more deeply about word meanings and the semantic properties of sound and, in turn, helped build higher quality, multimodal lexical representations.

Limitations

The study only considered how sound effects could enhance the word learning of a limited number of words. The sound and no-sound conditions consisted of six words each and only included abstract nouns and verbs. Although I selected difficult words, future studies should consider whether sound stories can foster the word learning of a larger number of words and different word types. Furthermore, in the study, I was unable to control for language ability beyond students' initial knowledge of target words and school-designated EL status. Additional

measures of students' language ability in subsequent studies would provide further insight into how individual linguistic differences affect students' word learning when taught with sound effects.

The assessments used in the study provided students with different opportunities to share their word knowledge. However, none of the assessments measured students' learning and retention of nonlinguistic sound representations. Asking students to match sounds with words or specifically asking students to use sounds to depict word meanings may provide more insight into whether specific sound supports are retained in a lexicon.

Another concern is that the verbal and nonverbal supports may have included more lexical information for some words compared with others. A few of the verbal definitions had one of two information categories embedded in the definition: contextual examples (e.g., "like riding a bike" for *progress*) or nuances (e.g., "to chew a lot" for *gnaw*). These information categories were coded in the productive word definition task even if the information was included in a taught word's definition. To ensure that there was no bias for sound or no-sound words due to the definitions used in the study, I conducted an a posteriori analysis of the definitions in both conditions and found that there was an equal exposure to contextual examples and nuances in both the sound and no-sound conditions.

Additionally, the intervention used more instructional time (approximately 50 seconds) for sound words compared with no-sound words. This additional time for the instruction of sound words was used to set up instruments and discuss the sounds produced by instruments. It is possible that extra time allotted to sound words contributed to students' learning of words. Talk around the sound features of instruments during the instruction of sound words may have also impacted students' word learning. Students were asked to select the sound that best matched

the word's definition, so the music teacher guided students in thinking about how they could select sounds to represent meanings. Although I tried to equate the number of times students heard sound and no-sound word labels and definitions, the teacher's talk around sound features may have contributed to the statistically significant results. Future studies should compare the effects of using this type of instructional strategy with other nonverbal supports, such as gestures or pictures, to more clearly decipher the role of the instructional method in fostering deeper word knowledge.

The sound story intervention featured various instructional supports in combination with sound. Sounds were taught and used along with verbal definitions, picture supports, and a storybook narrative. The teacher guided students in thinking about how to represent word meanings through sounds and occasionally used gestures to convey ideas. Additionally, students actively selected sounds to represent words and were responsible for performing those sounds in the context of the story. Given the multistage teaching approach of the intervention, it is difficult to deduce which specific instructional features used when teaching sound words were responsible for the effects of the study. Future studies should consider parsing out these different instructional approaches when using sounds as nonverbal supports for words.

Educational Implications

The results of this study can help inform vocabulary instruction by expanding nonverbal supports to include sound effects. The sound story approach encouraged students to contemplate word meanings and decide which sounds best represented word meanings. Educators providing vocabulary instruction should consider engaging students in helping to select and use sounds associated with words. Additionally, the benefits associated with the use of sounds could have partly been the result of the discussion that accompanied the selection of the sounds. Therefore,

teachers might experiment with using the same approach with gestures or other nonverbal supports.

A unique implication of this study is that students' vocabulary knowledge was supported in a space outside the general classroom. As Nagy and Townsend (2012) noted, word learners need to engage in authentic contexts that allow them to experience words in different disciplines. Little research has considered how to foster rich word learning in special area classrooms, such as music. Music classrooms are particularly important to consider because music teachers have a wide-reaching instructional impact in school settings. Oftentimes, music teachers instruct each class from every grade level on a weekly basis. For instance, the music teacher in this study taught over 300 students every week. Music and other special area teachers are regularly asked to address literacy goals using traditional methods, such as read-alouds, and are sometimes pulled out of their classroom to teach literacy-related skills unrelated to music in the general classroom. The results suggest that there may be more benefit in allowing music teachers to use discipline-specific instructional techniques to support literacy goals, particularly word learning. The sound story implemented in the music class setting fostered deep word knowledge and was more effective than traditional approaches to teaching vocabulary through book reading.

Conclusions

The present study adds to the literature by investigating whether students can learn more information about words when taught with semantically related sound effects. I addressed the need to consider novel ways to extend and improve vocabulary instruction by considering the benefits of using nonverbal sound effects in a music class setting. In this study, I analyzed growth of surface-level and deep word knowledge and addressed differences in word learning between EL and non-EL students. I found that sounds may be an effective way to foster word

knowledge for first-grade students. Further research is needed to confirm the findings and assess whether sounds can be used to support word learning for more words and in other age groups.

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CHAPTER IV

SING IT OR SPEAK IT?: THE EFFECTS OF SUNG AND RHYTHMICALLY SPOKEN SONGS ON PRESCHOOL CHILDREN'S WORD LEARNING

Introduction

Early vocabulary knowledge is crucial for the comprehension of oral language and written text and can predict children's later reading success in formal schooling (Catts, Hogan, & Fey, 2003; Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Snow, Burns, & Griffin, 1998; Storch & Whitehurst, 2002). Although children from non-dominant groups, such as those from low socioeconomic backgrounds and language-minority learners, bring valuable linguistic knowledge to school (e.g. Moll, Amanti, Neff, & Gonzalez, 1992), they often have lower vocabulary knowledge in the dominant language valued in school compared to their monolingual peers from higher socioeconomic backgrounds (Hoff, 2013). As a result, disparities in academically-valued vocabulary outcomes are associated with socioeconomic and linguistic divides, making it challenging for children from diverse, minoritized backgrounds to comprehend school texts and sustain reading achievement in school (Hoff, 2013; Mancilla-Martinez & Lesaux, 2010; Páez, Bock, & Pizzo, 2011).

A number of vocabulary studies in early education aim to provide primary grade children from non-dominant groups access to the language of power (e.g., Ladson-Billings, 2011) by building children's knowledge about words that are privileged in formal schooling. However, these studies often limit their focus to direct, explicit instruction of words (Carlo et al., 2004; Cena et al., 2013; Gersten & Baker, 2000; Pollard-Durodola et al., 2018; Rowe, Silverman, & Mullan, 2013) and shared book reading contexts for vocabulary instruction (Beck & McKeown, 2007; Biemiller & Boote, 2006; Coyne, Simmons, Kame'enui, & Stoolmiller, 2004; Gonzalez, et

al., 2010; Pollard-Durodola, et al., 2011). While these vocabulary practices bolster children's word learning, privileging traditional approaches to vocabulary instruction limits our knowledge of potential contributions of other multimodal activities, such as music and songs, that children and teachers engage in throughout the school day. Songs as contexts for word learning have been underexplored in the research literature. Their melodic and rhythmic structures have the potential to promote children's memory of musical events, highlight target words used in song lyrics, and engage children in word learning activities (Crowder, Serafine, & Repp, 1990; Wallace, 1994).

This study expands upon current vocabulary research to examine how songs and the modality in which they are performed may contribute to minoritized children's vocabulary acquisition in preschool settings. Song modality refers to the mode in which songs are presented. For the current project, I focus on two song modalities: 1) songs that are sung with a structured melody, and 2) songs that are rhythmically spoken with no structured melody, similar to a rhyme or rap. Data are drawn from an intervention conducted in preschool classrooms. Analyses reported in the study address children's acquisition of lexical representations for words taught with sung songs plus picture cards, rhythmically spoken songs plus picture cards, and picture cards-only to determine if songs, and the mode of song performance, affect children's word learning.

Multimodal Word Learning

Multimodal experiences provide children with opportunities to learn words (Yu, Ballard, & Aslin, 2005). As children hear verbal stimuli, such as spoken word labels and definitions, in association with nonverbal stimuli, such as physical objects, actions, and sounds, they build initial lexical representations. The more multimodal encounters children have with words, the more opportunities they have to refine their understanding about a word's meaning, form, and

use in different contexts (McMurray, Horst, & Samuelson, 2012). Knowledge about the various forms and meanings of words, and the extent to which those knowledge components are interconnected, determines how readily children retrieve and interpret words in speech and text (Perfetti, 2007). As a result, lexical representations that are augmented by multimodal experiences may enhance the quality of the representation, resulting in improved ability to use these word meanings to comprehend text.

Songs as a Multimodal Context for Word Learners

Songs are multimodal; they embed words in a lyrical narrative that is presented with musical sound-structures, like rhythm and/or melody. The multimodality of songs offers a unique opportunity to foster word learning. The repetition, synchronization, and predictability of songs can assist children in learning unfamiliar vocabulary by engaging students in word learning events, drawing attention to words embedded in the song lyrics, and enhancing memory (Crowder et al., 1990; Wallace, 1994).

Engagement. Songs are fun, engaging, and familiar contexts for children's word learning. They are found in almost every society and culture (Patel, 2008), suggesting that all children, despite their cultural and linguistic background, can draw upon their funds of knowledge (Moll et al., 1992) to connect their prior musical experiences with songs used in the classroom. In addition to being a familiar context for learning, songs can evoke affective responses that may enhance attention and engagement (Fonseca-Mora, Toscano-Fuentes, & Wermke, 2011). Hearing songs activates our reward-senses and can result in a positive emotional response to musical events (Menon & Levitin, 2005; Gold, Zeighami, Benovoy, Dagher, &

Zatorre, 2019) that may increase motivation (Gold et al., 2019) and memory (Eschrich, Münte, & Altenmüller, 2008; Jäncke, 2008) in learning.

When extended to vocabulary instruction, children's familiarity with and positive emotional response to songs may increase their interest and motivation to attend to words. As Guthrie & Humenick (2004) note, student interest in a presented text can promote student motivation in literacy-based activities. Wolfe and Noguchi (2009) examined whether singing a story enhanced kindergarten children's ability to focus on the plot sequence compared to speaking the story. During the sung and spoken versions of the story, children were exposed to extraneous sound distractors to see if they were able to maintain interest in the story despite the noise. They found that in the presence of unrelated sound distractors, children followed the plot better when the text was sung compared to spoken. According to the researchers, students appeared to enjoy the songs regardless of distractors, with some children humming, moving, and trying to sing along. Their work provides preliminary evidence that songs promote attention and sustained engagement in literacy activities, supporting the notion that songs used to teach vocabulary may promote and sustain student engagement in word learning activities.

Attention-directing features. In addition to being familiar and engaging for students, songs feature inherent attention-directing musical properties that help children attend to words embedded in song lyrics. Similar to sentences heard in speech, songs consist of phrase structures that have designated lengths and stress patterns (see Wallace, 1994). Phrase structures convey two types of structural information that we perceive: temporal and pitch (Knösche et al., 2005; Koelsch, Rohremeier, Torrecuso, & Kentschke, 2013; Palmer & Krumhansl, 1987). When we hear music, underlying cognitive processes related to memory and attention are activated and enable us to focus on the beginning and ending of temporal and pitch phrase structures in music

(Knösche et al., 2005). Consequently, when words are positioned in musical phrases to form lyrics, the attentional focus triggered by music can assist listeners in attending to those words (see Wallace, 1994). The contiguity between the nonverbal musical phrase structures and the words in song lyrics may help direct children's attention to relevant information about words conveyed through songs (Chandler, 2017; Clark, 2003; Pierce 1931-1958), making them an effective tool for word learning.

Verbal memory. Concurrently hearing and attending to musical phrase structures and lyrics of songs enhances children's memory of words (Crowder, Serafine, & Repp, 1990). According to the dual coding theory (Paivio, 1986; Sadoski & Paivio, 2004), simultaneous processing of verbal and nonverbal information, such as musical sounds and words, increases one's ability to remember words and build higher quality lexical representations (see Lehmann & Seufert, 2018). As a result, songs are a powerful mnemonic aid for verbal memory. Songs that are rhythmically spoken with no melody enhance verbatim text recall, particularly when performed with a beat (Wallace & Rubin, 1988); however, sung songs featuring a melodic and rhythmic structure promotes better short-term (Chazin & Neuschatz, 1990; Knott & Thaut, 2018; McElhinney & Annett, 1996; Wallace, 1994; Wolfe & Hom, 1993) and long-term (Rainey & Larsen, 2002) memory of words for children and young adults than songs spoken in prose or with rhythmic phrasing. The benefits of singing also extend to adults and children learning words in a second language (L2) (Good, Russo, & Sullivan, 2014; Ludke, Ferreira, & Overy, 2013; Rukholm, Helms-Park, Odgaard, & Smyth, 2018), suggesting that songs that are sung promote verbal memory for dual language learners (DLLs) above songs that are rhythmically spoken.

The mnemonic advantage of singing a song may be affected by one's familiarity with the heard melody and rhythm (Purnell-Webb & Speelman, 2008; Wallace, 1994; Wolfe & Hom,

1993). Words sung to a novel tune require listeners to acquaint themselves with the unfamiliar melody and words. Consequently, the melody can be a distractor that impedes verbal memory (Wallace, 1994). Calvert and Billingsley (1998) found that preschool children better recalled telephone numbers when they were spoken compared to sung to an unfamiliar, original tune. Similarly, Wolfe and Hom (1993) reported that there was a negligible difference in the number of trials preschool children needed before recalling phone numbers when they were spoken or sung to an unfamiliar tune. However, Wolfe and Hom found that when teaching phone numbers with a familiar tune, preschool children required significantly less practice trails before being able to recall the number.

Repetition of a melody is also important in enhancing verbal memory (Calvert & Tart, 1993; Wallace, 1994). Hearing the rhythm and pitch sequence repeatedly enables a listener to become increasingly familiar with a song, making it more predictable and easier to encode. When investigating verbal memory of songs featuring either three verses or one verse, Wallace (1994) found differential effects for the modality of the song's performance. Young adults who listened to the song with three verses recalled more words when the verse was sung compared to spoken. However, those who listened to the song with one verse had better word recall when the verse was spoken opposed to sung. Wallace (1994) posits that the repetition of the melody highlights the pitch structure and increases familiarity of the tune, making it easier to process and recall words.

As evidenced by this prior research, hearing words in songs supports the recall of song lyrics despite song modality (i.e., sung or spoken). However, certain features of songs may impact verbal memory. Sung songs that have a familiar melody and repetitive musical phrases

may be more effective at enhancing recall compared to spoken songs, while sung songs that have an unfamiliar melody may distract listeners and be less effective.

Music Interventions Focusing on Language and Literacy

While there is ample research on songs and verbal memory, few studies consider the effectiveness of music in building children's word knowledge beyond word recall. Several studies have found that music programs support primary grade children's general word knowledge (Linnavalli, Putkinen, Lipsanen, Huotilainen, & Tervaniemi, 2018; Moyeda, Gomez, & Flores, 2006; Register, Darrow, Standley, & Swedberg, 2007; Yzejian & Peisner-Feinberg, 2009). Music programs refer to weekly music classes that use a researcher-designed music curricula in school settings. These programs often feature an array of music-based activities, such as performing instruments, singing and speaking songs, and learning early music notation. In a small sample of second grade students, Register et al. (2007) found that a music curriculum designed to support vocabulary, phonics, and story comprehension led to significant pre-to-post gains in children's word knowledge as measured by the Gates-McGinitie Reading Test compared to a control group that did not receive the music instruction. Word learning was supported in the music program using picture cards and asking children to define the meaning of the words. Linnavalli et al. (2018) reported similar findings for Finnish kindergarten children who participated in structured weekly musical play that featured singing, moving and playing instruments. They found that children in the musical play condition had significantly greater growth in their general definitional knowledge about words as measured by the WISC-IV than children who were not in the musical play condition.

The word learning benefits of implementing a music curriculum are also evident at the preschool-level. Working in Head Start classrooms, Yzejian & Peisner-Feinberg (2009) implemented a 26-week music and movement program where children sang, played percussive instruments (e.g., shakers, rhythm sticks) and performed movement activities. Songs were used as a vehicle to teach rhyming and vocabulary as children played along with songs and helped write additional song lyrics. Although researchers did not specify what type of words were targeted during the music and movement program, they found that it fostered children's general English receptive vocabulary. Moyeda et al. (2006) also studied the effects of a music intervention program, in which preschoolers performed, memorized, and read rhythmic and pitch patterns, on children's incidental word learning. They reported that the program significantly increased Spanish-speaking preschool children's general Spanish receptive vocabulary for those who participated in a music intervention program when compared to a practice-as-usual music class. Not enough information was provided about the practice-as-usual music class to determine differences in the type of music instruction that children received. While collectively these studies suggest that participation in music programs enhances children's knowledge of words, it is impossible to ascertain the extent to which specific music practices contribute to children's word learning.

Songs and song modality. There are several interventions that consider how songs in combination with extra vocabulary support, such as pictures, gestures, and/or word definitions, contribute to children's word learning. Schatz et al. (2018, April) found that words taught with picture cards, semantically related gestures, and definitions in a song context significantly increased receptive vocabulary and depth of knowledge of taught words for children from high poverty communities. Furthermore, they noted that songs were just as effective as books in

building preschool children's word knowledge. Although these findings are promising, it is unclear whether the melodic tune of the songs used was a necessary component in enhancing children's word learning.

No current studies measure the effects of song modality (i.e., sung or rhythmically spoken) on children's depth of word knowledge; however, there are mixed reports on whether sung songs foster young children's receptive and expressive word learning better than songs that are rhythmically spoken. Madsen (1991) explored whether first grade children learned word-referent associations better when gestures were used for target words during sung or spoken songs. She did not report the pre-to-post outcomes within the sung and rhythmically spoken conditions; however, when comparing across conditions, she found that children who learned the sung song with gestures learned to associate significantly more objects with target words than children who learned the rhythmically spoken song with gestures. Joyce (2011) reported conflicting results when investigating the effects of song modality during book readings with kindergarten students. While she found that simultaneously singing song lyrics and showing semantically related book illustrations enhanced kindergarten children's expressive vocabulary of target words, she did not find a significant difference between children's word learning when the lyrics were sung or spoken.

Working with non-native English speakers in kindergarten through second grade, Schunk (1999) explored whether the use of gesture during songs modulated the effects of song modality on children's word learning. Children were taught sung and spoken songs both with and without semantically related gestures for target words. Prior to performing the songs, children were introduced to the words using picture cards. All songs were taught and performed three times within a period of two weeks. Schunk found no significant difference in children's receptive

word learning between sung and spoken songs when they were performed with gestures. Children made significant gains in their receptive vocabulary for all songs despite song modality and the presence of gestures; however, sung and spoken songs that were performed with gestures resulted in significantly higher receptive vocabulary scores compared to the spoken song performed with no gestures. While there is evidence that music, and songs in particular, help children learn words, prior studies have not considered potential differential effects of songs and song modalities on word learning for students from various socioeconomic and linguistic backgrounds. The present study extends prior investigations by seeking to determine if linguistic and socioeconomic factors impact preschool children's learning when words are taught with sung and rhythmically spoken songs.

Semantically related nonverbal supports in songs. It is difficult to disentangle the active ingredients contributing to word learning in prior research with songs. All studies explicitly taught target words with picture cards (Joyce, 2011; Schatz et al., 2018, April; Schunk, 1999) and/or reinforced target words during songs with gestures (Madsen, 1991; Schatz et al., 2018, April; Schunk, 1999). Gestures and pictures are effective nonverbal aids in fostering primary grade children's word learning when combined with explicit instruction of words, especially for children with lower initial vocabulary knowledge and children learning words in a second language (Carlo et al., 2004; Cena et al., 2013; Páez et al., 2011; Rowe et al., 2013; Silverman, 2007; Silverman & Crandell, 2010). These nonverbal supports can direct children's attention to target words (Lawson-Adams & Dickinson, under review) and provide an additional representation of a word's meaning (Rowe et al., 2013). Consequently, the inclusion of gestures during song contexts may partially explain the word learning benefits associated with songs.

Picture cards also have been found to contribute to word learning. In a study on book reading, Pollard-Durodola et al. (2018) found that picture card-only instruction was as effective in bolstering the English receptive and expressive vocabulary of preschool-aged Dual Language Learners (DLLs) as combined picture card and book reading instruction. These findings highlight the importance of considering whether song contexts that include picture card instruction yield additional word learning benefits beyond picture card-only instruction. The present study examines patterns in children's word learning when words are taught with a combination of songs and picture cards, as well as picture cards-only, and considers whether word learning varies based on children's socioeconomic and linguistic backgrounds.

Purpose of Study

This study sought to determine whether teaching words with songs and picture cards builds vocabulary knowledge for preschool children from different socioeconomic and linguistic backgrounds. Specifically, I wanted consider how the modality in which a song is performed (i.e., sung or rhythmically spoken) impacts children's quality of lexical representations for taught words. I hypothesized that song instruction, despite modality, would enhance children's word knowledge compared to picture card-only instruction. Furthermore, I hypothesized that the melodic structure of sung songs would draw increased attention to information about words and word meanings embedded in song lyrics and picture cards used during a song's performance compared to rhythmically spoken songs. As a result, I posited that rhythmically spoken songs would not foster children's word learning to the same degree as sung songs.

The following questions are addressed:

1. Did preschool children's receptive and productive definitional word knowledge for target words increase when words were taught with sung and rhythmically spoken songs compared to control words that were not taught?
2. How did preschool children's receptive and productive definitional word knowledge for target words compare for words taught with sung songs, rhythmically spoken songs, and picture cards-only?
3. Did preschool children learn different types of information about words when they were taught with sung songs, rhythmically spoken songs, and picture card-only instruction?
4. Were there differential effects on children's receptive and productive definitional word learning through sung songs, rhythmically spoken songs, and picture card-only instruction based on student factors, including pretest scores, dual language learner (DLL) status, and maternal education?

Methods

Sample

Participants. Participants were recruited from four preschool classrooms within the same school district. Two of the preschool classrooms were housed in the same school building, while the other two preschool classrooms were in separate schools. I recruited 61 total students at the start of the project; however, one student did not want to be tested and four students did not return a completed parent report, which resulted in missing data. These students were excluded from the final analyses, so the final sample consisted of 56 students (mean age = 57.57 months).

Each preschool served a high number of children from traditionally non-dominant groups. Table 1 lists demographic information for the sample by classroom.

Table 1

Demographic Information

Demographic Factors	Number of Participants N = 56 (100%)	Preschool Classes, n (percentage)			
		Class 1 n = 16	**Class 2** n = 10	**Class 3** n =15	**Class 4** n =15
Sex					
Male	27 (48.2)	6 (37.5)	5 (50)	7 (46.7)	7 (46.7)
Female	33 (58.9)	10 (62.5)	5 (50)	8 (53.3)	8 (53.3)
Dual Language Learner (DLL) status					
DLL	25 (44.6)	12 (75)	8 (80)	2 (13.3)	3 (20)
Non-DLL	31 (55.4)	4 (25)	2 (20)	13 (86.7)	12 (80)
Home language					
English	31 (55.4)	4 (25)	2 (20)	13 (86.7)	12 (80)
Spanish	8 (14.2)	2 (12.5)	4 (40)	1 (6.7)	1 (6.7)
Arabic	3 (5.4)	2 (12.5)	0 (0)	1 (6.7)	0 (0)
Kurdish	2 (3.6)	2 (12.5)	0 (0)	0 (0)	0 (0)
Igbo	2 (3.6)	0 (0)	2 (20)	0 (0)	0 (0)
Uzbek	2 (3.6)	2 (12.5)	0 (0)	0 (0)	0 (0)
Other	8 (14.2)	4 (25)	2 (20)	0 (0)	2 (13.3)
Individualized Education Plan (IEP)					
Yes	6 (10.7)	1 (6.3)	0 (0)	3 (20)	2 (13.3)
No	50 (89.3)	15 (93.8)	10 (100)	12 (80)	13 (86.7)
Race and/or ethnicity					
White/Caucasian	11 (19.6)	7 (43.8)	1 (10)	2 (13.3)	1 (6.7)
Black/African American	28 (50)	0 (0)	5 (50)	11 (73.3)	12 (80)
Hispanic/Latino	6 (17.9)	1 (6.3)	4 (40)	1 (6.7)	0 (0)
Asian/Pacific Islander	2 (3.6)	2 (12.5)	0 (0)	0 (0)	1 (6.7)
Middle Eastern	3 (5.4)	2 (12.5)	0 (0)	1 (6.7)	0 (0)
Multiracial	3 (5.4)	2 (112.5)	0 (0)	0 (0)	1 (6.7)
Maternal education					
High school or less	15 (26.8)	2 (12.5)	5 (50)	4 (26.7)	4 (26.7)
GED	1 (1.8)	0 (0)	0 (0)	1 (6.7)	0 (0)
Some college/vocational degree	18 (32.1)	4 (25)	2 (20)	4 (26.7)	8 (53.3)
Bachelor's degree	13 (23.2)	7 (43.8)	2 (20)	3 (20)	1 (6.7)
Graduate degree	9 (16.1)	3 (18.8)	1 (10)	3 (20)	2 (13.3)

Note. Class 3 and 4 were different classrooms in the same school.

Music instructor. I served as the music specialist for all four preschool classrooms. Having the same music specialist across classrooms helped minimize variability in the delivery of the intervention. I am a certified PreK-12 music teacher with six years of experience in leading primary grade music activities and I felt that I was best suited to lead the music sessions and follow the protocols of the study. Since my role as both the researcher and music specialist had the potential to introduce researcher bias, all of the music sessions were video-recorded and coded by research assistants to ensure I was consistent across conditions in my affect and fidelity of implementation.

Measures

Vocabulary. Children's vocabulary knowledge of 24 target words was measured using two assessments (receptive and productive word definition) at two time points (pretest and posttest). Children were tested individually for each measure.

Receptive task. Receptive knowledge of words was measured using a researcher-created task modeled after the Peabody Picture Test of Vocabulary fourth edition (Dunn & Dunn, 2007). During testing, a child was shown four picture images and asked to select the image that depicted the target word. The target images were similar, but not the same, as the images used as part of the instructional activities. The three images that did not match the target word were related to the word by concept, theme, or phonological form.

Productive word definition. Depth of word knowledge was measured using a researcher-created productive word definition (PWD) task adapted from Hadley et al. (2016). In the PWD, individual children were asked to share what they knew about specific words (e.g., What is

texture? Can you tell me or show me more about *texture*?). All responses were video-recorded and coded using nine information categories: definition, antonym, gesture, contextual example, conceptual relationship, perceptual quality, part/whole, super/subordinate, and function (see Appendix C for category descriptions, point values, and example responses). The PWD task was coded by research assistants, and 20% of the assessments were randomly selected and double-coded to ensure interrater reliability. The overall percent agreement was 99.5% with a mean Cohen's Kappa value of .96.

Student characteristics. Pretest scores and parent questionnaires were used to collect data on children's socioeconomic and linguistic backgrounds. Children's socioeconomic background was accounted for using parent reports of the highest level of maternal education. Children's linguistic background was accounted for using two separate variables: (1) children's pretest scores from the vocabulary assessments, and (2) children's DLL status. Children were identified as a DLL based on parent reports of whether a language other than English was spoken at home. No reports indicated that children were exposed to more than two languages.

Song and Word Selection

The study used two songs: "Lucy Goose" and "Purple Pete." Both songs could be sung to a familiar children's American/English folk tune or rhythmically spoken, like a rhyme (see Appendices E and F). The lyrics of "Lucy Goose" were created to follow the tune of "She'll Be Comin' Around the Mountain," and the lyrics of "Purple Pete" were created to follow the tune of "London Bridge." The songs were used in a previous study on preschool children's word learning. Analyses of data collected as part of a prior study showed that the songs did not yield

significantly different effects on preschool children's word learning (γ_{20} = -0.15. SE = 0.064, *p* = 0.30), suggesting that it was appropriate to compare across the songs in the current study.

Twenty-four words were selected. All words were used in prior vocabulary studies with primary grade children and came from the T6 category of the Biemiller (2010) word list, meaning they were high-priority words and familiar to 40–80% of students by the end of grade 6 (Silverman & Hartranft, 2015). Only T-6 category words were used to ensure that the words were equal in their difficulty-level and likely to be unfamiliar to preschool-aged children. The selected words featured three word types (concrete nouns, abstract nouns, and verbs) that were equated across conditions with two of each word type per condition (see Appendix D). Two of each word type were randomly assigned to each song ("Lucy Goose" and "Purple Pete"), picture card-only condition, and control conditions for a total of six words per condition. Out of the 12 words randomly assigned across the songs (six words per song), eight words had existing verses for both songs that were created in a prior vocabulary study. New song lyrics were created for the remaining four words.

Materials

Picture cards. Picture cards were created to teach words in the two song conditions and the picture card-only condition. All images were selected by a group of researchers to make sure the images semantically represented the target words. Picture cards were printed in color on 8.5 by 11-inch cardstock to ensure that children could clearly see the images.

Songs. Each verse in the songs was dedicated to one target word (one verse = one word). The verse provided a narrative context for the word and explicitly stated the word two times. Four versions of the song lyrics were professionally recorded by a female vocal artist: 1) "Purple

Pete" sung, 2) "Purple Pete" spoken, 3) "Lucy Goose" sung, and 4) "Lucy Goose" spoken. The sung versions the songs included an acoustic guitar accompaniment, while the spoken versions of the songs had a simple drum beat similar to a metronome. See Appendices E and F for song lyrics, key, and tempo details.

Research Design

This project used a within-subjects design to allow children to function as their own controls. All classrooms were taught words in three activities during the music sessions: 1) picture card-only instruction, 2) picture card instruction followed by "Purple Pete" and 3) picture card instruction followed by "Lucy Goose." No children were taught the six control words. Each instructional activity contained six target words, so children were taught a total of 18 words during the music sessions. The modality of the two songs' performance (i.e., whether the songs were sung or rhythmically spoken) was counterbalanced across classrooms. As a result, "Purple Pete" and "Lucy Goose" were sung in some classrooms and spoken in others. Additionally, the order in which the songs were presented to children varied between classrooms. Table 2 lays out this research design. The counterbalance of the modality of the songs' performance and the order of their presentation to students helped minimize potential bias from these features.

Table 2

Assignment of Songs to Sung or Spoken Condition

Classroom #	Sung Condition	Spoken Condition	Music Session Order
1	"Lucy Goose"	"Purple Pete"	1) Picture Card Only 2) Sung 3) Spoken
2	"Lucy Goose"	"Purple Pete"	1) Picture Card Only 2) Spoken 3) Sung
3	"Purple Pete"	"Lucy Goose"	1) Picture Card Only 2) Spoken 3) Sung
4	"Purple Pete"	"Lucy Goose"	1) Picture Card Only 2) Sung 3) Spoken

Instructional Procedures

Each preschool class participated in three 15-minute sessions during a two-week period. Previous studies have shown that children and adults can recall words from a song after hearing it three or four times (Calvert & Billingsley, 1998; McElhinney & Annet, 1996). Our own previous work with songs showed significant growth in preschool children's word learning when songs were heard two or four times (Schatz et al., 2018, April). As a result, it was decided that hearing the songs three times throughout the intervention was appropriate. Each session featured three instructional activities. At the start of each activity, children were introduced to a puppet who had special words for the children to learn.

Picture card-only instruction. Children first experienced the picture card-only activity in each session. They were introduced to a puppet named Ollie O and taught six target words. During the picture cards-only activity, students were shown a picture card, given a child-friendly definition, and asked to repeat the word. Each target word was spoken by the teacher four times.

Song plus picture card instruction. Following the picture card-only activity, children participated in one of the two song activities (i.e., "Purple Pete" or "Lucy Goose" either sung or rhythmically spoken). After meeting the associated puppet (Purple Pete or Lucy Goose), students were shown a picture card, given a child-friendly definition, and asked to repeat the word for all six target words. Unlike the picture card-only activity, the teacher only said each target word two times when introducing words through picture cards. Following the introduction of the words, children reviewed movements to the chorus of the song. The movements included stomping their feet and clapping their hands. Children then listened to the song and were encouraged to sing or speak along with the chorus depending on the assigned song modality. During the verses, the teacher held up the picture card that matched the target word. In total, children heard each target word four times in the song activity: twice during the picture card introduction and twice in a verse. The process was repeated for the final instructional activity using the remaining song and song modality.

Fidelity of Implementation and Bias Check

The music sessions were video recorded and coded for fidelity of implementation and researcher affect. Two coders coded the music session videos and double-coded 30% of the videos. For fidelity of implementation, coders assessed whether the researcher followed the intervention protocol. Interrater reliability was 1.00 and revealed that the intervention was delivered with 99.6% fidelity.

The affective behaviors of my instruction were coded using a 3-point rating scale: 3 = behavior frequently occurred (seen for 5-6 of the words), 2 = behavior sometimes occurred (seen for 2-4 of the words), and 1 = behavior rarely occurred (seen for 0-1 of the words). For behavior during the picture card word introduction in each activity, coders rated my use of gestures (i.e.,

providing hand movements to express a word), overt facial expressions (i.e., raising eyebrows and making eye contact with student), and intonation/pitch (i.e., using a child-friendly, engaging voice). For behavior during song performances (sung and rhythmically spoken), coders rated the my use of beat gestures (i.e., clear and distinct body movements to the beat) and overt facial expressions (i.e., raising eyebrows and making eye contact with students). The coders had perfect interrater reliability and results revealed that my affect during the delivery of the intervention was 100% consistent across instructional activities within and between music sessions.

Results

Analytic Approach

I conducted tests of kurtosis and skewness using z-scores of the residuals on the receptive and PWD tasks to confirm the assumption of normality (Corder & Foreman, 2014). On the receptive task, z-scores for kurtosis (z = -0.46) and skewness (z = 0.27) fell between -1.96 and +1.96, passing the normality assumption for α = 0.05. On the PWD task, z-scores for kurtosis (z = 4.36) and skewness (z = 2.12) were not in the desired range for α = 0.05; therefore, the PWD scores violated the assumption of normality. Normality violation was confirmed using a density plot (see Appendix G).

To analyze the results of the receptive task, I conducted multilevel models with instructional condition$_{ij}$ (sung, rhythmically spoken, picture cards-only, and control) nested within children$_j$ using a normal distribution. The two-levels of the model allowed me to account for the nesting structure of the within-subject design since every child experienced all four instructional conditions (Snijders & Bosker, 2012). For the PWD task, I used a generalized linear

mixed effects model (GLMM) to nest instructional condition$_{ij}$ within children$_j$ using a tweedie distribution. The tweedie distribution was selected due to the distribution properties of children's PWD scores, which resembled zero-inflated count data. See Appendix G for more information. All models were conducted using R statistical software. Table 3 shows the means, standard deviations, and effect sizes for each condition on both vocabulary assessments.

Table 3

Means, Standard Deviations, and Effect Sizes for Vocabulary Tasks by Condition

Vocabulary Task/Condition	**Pretest M (SD)**	**Posttest M (SD)**	**Pre-to-Post Gain M (SD)**	**Cohen's *d* Effect Size for Pre-to-Post**
Receptive				
Sung	0.29 (0.20)	0.38 (0.24)	0.080 (0.35)	0.41
Rhythmically Spoken	0.29 (0.20)	0.40 (0.22)	0.11 (0.27)	0.52
Picture Card-Only	0.27 (0.19)	0.38 (0.21)	0.11 (0.28)	0.55
Control	0.25 (0.17)	0.23 (0.17)	- 0.015 (0.23)	- 0.12
Productive word definition				
Sung	0.003 (0.022)	0.22 (0.32)	0.21 (0.32)	0.96
Rhythmically Spoken	0.007 (0.046)	0.27 (0.33)	0.26 (0.32)	1.12
Picture Card-Only	0.009 (0.038)	0.14 (0.27)	0.14 (0.28)	0.72
Control	0.001 (0.011)	0.013 (0.063)	0.012 (0.064)	0.27

Preliminary Analyses of Song Lyrics and Order

To determine if the "Purple Pete" and "Lucy Goose" song lyrics and order of song presentation affected vocabulary outcomes, I collapsed the posttest scores for all song conditions (sung and rhythmically spoken) and ran the following preliminary model for the receptive and PWD tasks controlling for pretest:

$$\text{PosttestSongs}_{ij} = \gamma_{00} + \gamma_{01}\text{SongOrder}_{ij} + \gamma_{02}\text{SongLyrics}_{ij} + \gamma_{03}\text{Pretest}_{ij} + u_{0j} + e_{ij}$$

There were no significant effects for song order (γ_{01} = 0.020, *SE* = 0.051, *p* = .85; γ_{01} = - 0.50, *SE* = 0.33, *p* = .14) and song lyrics (γ_{02} = -0.061, *SE* = 0.051, *p* = .23; γ_{01} = -0.24, *SE* = 0.15, *p* =

.10) on the receptive and PWD tasks, respectively. As a result, I did not include song order or song lyrics in the final analytic models.

Research Question 1: Songs Compared to Control

The first research question asked whether preschool children learned words that were taught with sung and rhythmically spoken songs compared to control words that were not taught. I ran the following model for the receptive and PWD tasks with control words set as the reference group:

$$\text{Posttest}_{ij} = \gamma_{00} + \gamma_{10}\text{Sung}_{ij} + \gamma_{20}\text{Spoken}_{ij} + \gamma_{30}\text{PictureCard}_{ij} + \gamma_{40}\text{Pretest}_{ij} + \gamma_{01}\text{DLLstatus}_{j} + \gamma_{02}\text{MaternalEd}_{j} + u_{0j} + e_{ij}$$

Posttest scores were used as the dependent variable and conditions were dummy coded as Level 1 predictors. Pretest scores were included as Level 1 covariate, and DLL status and maternal education were included as Level 2 covariates. Table 4 presents the parameters of each model for both vocabulary assessments. On the receptive task, controlling for pretest (γ_{40} = 0.024, *SE* = 0.071, *p* = .76), DLL status (γ_{01} = -0.043, *SE* = 0.038, *p* = .26), and maternal education (γ_{02} = 0.011, *SE* = 0.008, *p* = .16), results indicated that preschool children correctly answered more items for words taught with a sung song (γ_{10} = 0.14, *SE* = 0.035, *p* < .001) and rhythmically spoken song (γ_{20} = 0.17, *SE* = 0.035, *p* < .001) compared to control words that were not taught. Cohen's *d* calculations of pre-to-posttest difference scores indicated medium effect sizes for words taught with a sung song compared to control words (*d* = 0.32) and a rhythmically spoken song compared to control words (*d* = 0.50).

Similarly, on the PWD task, controlling for pretest (γ_{40} = 0.041, *SE* = 0.061, *p* = 0.79), DLL status (γ_{01} = -0.73, *SE* = 0.27, *p* = .01), and maternal education (γ_{02} = 0.23, *SE* = 0.061, *p* <

.001), results showed that preschool children provided more information about target words taught with a sung song ($\gamma_{10} = 2.78$, $SE = 0.45$, $p < .001$) and rhythmically spoken song ($\gamma_{20} = 3.03$, $SE = 0.45$, $p < .001$) compared to control words that were not taught. Cohen's *d* calculations of the pre-to-posttest difference scores yielded large effect sizes for words taught with a sung song compared to control words ($d = 0.86$) and a rhythmically spoken song compared to control words ($d = 1.07$).

Table 4

Parameter Estimates for Multilevel Models by Vocabulary Task.

	Receptive task	**PWD task**
Variable	**Estimate (*Standard error*)**	**Estimate (*Standard error*)**
Fixed Effects		
Intercept	0.20 (0.051)**	-2.90 (0.54)**
Level-1 Sung (γ_{10})	0.14 (0.035)**	2.78 (0.45)**
Level-1 Rhythmically Spoken (γ_{20})	0.17 (0.035)**	3.03 (0.45)**
Level-1 Picture Card-Only (γ_{30})	0.15 (0.035)**	2.35 (0.46)**
Level-1 Pretest (γ_{40})	0.024 (0.071)	0.041 (0.061)
Level-2 Dual language learner status (γ_{01})	-0.043 (0.038)	-0.73 (0.27)*
Level-2 Maternal education (γ_{02})	0.011 (0.008)	0.23 (0.061)**
Random Effects		
Level-1 residual variance ($\hat{\sigma}_e^2$)	0.034	2.04
Level-2 residual variance ($\hat{\tau}_{00}$)	0.011	0.50

*Regression coefficient is significant at the .01 level (two-tailed).**Regression coefficient is significant at the .001 level (two-tailed).

Research Question 2: Sung, Rhythmically Spoken, and Picture Card-Only

The second research question asked if children learned words better when they were taught with a sung song, rhythmically spoken song, or picture cards-only. I planned three comparisons a priori: 1) sung vs. picture cards-only, 2) rhythmically spoken vs. picture cards-

only, and 3) sung vs. rhythmically spoken. The conditions were compared by testing linear contrasts of the models used for the first research question. Table 5 shows the effect sizes of difference scores across the conditions for each vocabulary task. I found no significant differences between children's receptive scores for words taught with a sung song compared to picture cards-only (p = .79), rhythmically spoken song compared to picture cards-only (p = .68), and sung song compared to rhythmically spoken song (p = .49). On the PWD task, children provided significantly more information for words taught with a sung song compared to picture cards-only (p = .04) with a Cohen's d of 0.23. Children also provided significantly more information about words taught with a rhythmically spoken song compared to picture cards-only (p = .001) with a Cohen's d of 0.40. There was no significant difference in PWD scores between words taught with sung and rhythmically spoken songs (p = .19).

Table 5

Cohen's d Effect Sizes Comparing Difference Scores Across Conditions for Vocabulary Tasks

	Control 1	**Sung 2**	**Rhythmically Spoken 3**	**Picture Card-Only 4**
Receptive				
1. Control	-			
2. Sung	0.32***	-		
3. Rhythmically Spoken	0.50***	0.10	-	
4. Picture Card-Only	0.49***	0.09	0	-
Productive word definition				
1. Control	-			
2. Sung	0.86***	-		
3. Rhythmically Spoken	1.07 ***	0.16	-	
4. Picture Card-Only	0.63 ***	-0.23*	-0.40**	-

Note. Effect sizes compare condition in row to condition in column. *p < .05, **p < . 01, ***p < .001

Research Question 3: Information Learned

The third research question asked what types of information children learned about words when taught with a sung song, rhythmically spoken song, and picture card-only instruction. I analyzed student responses on the PWD measure to identify the types of information children provided when asked to share what they knew about target words. Responses on the PWD were coded for nine information categories: definition, antonym, gesture, contextual example, function, perceptual quality, part/whole, super/subordinate, and conceptual relationship. Figure 1 shows children's average pre-to-post difference score across all information categories. For each category, children provided more responses when words were taught with a sung or rhythmically spoken song than words taught with picture cards-only. Descriptively, children made the most growth in the definition and contextual example categories for songs and picture cards-only. Cohen's *d* calculations of pre-to-posttest growth for responses with definitions indicated large effects sizes for sung songs ($d = 0.86$), rhythmically spoken songs ($d = 0.90$), and picture cards-only ($d = 0.76$). Growth in contextual examples yielded medium effect sizes for sung songs ($d = 0.67$), rhythmically spoken songs ($d = 0.70$), and picture cards-only ($d = 0.50$).

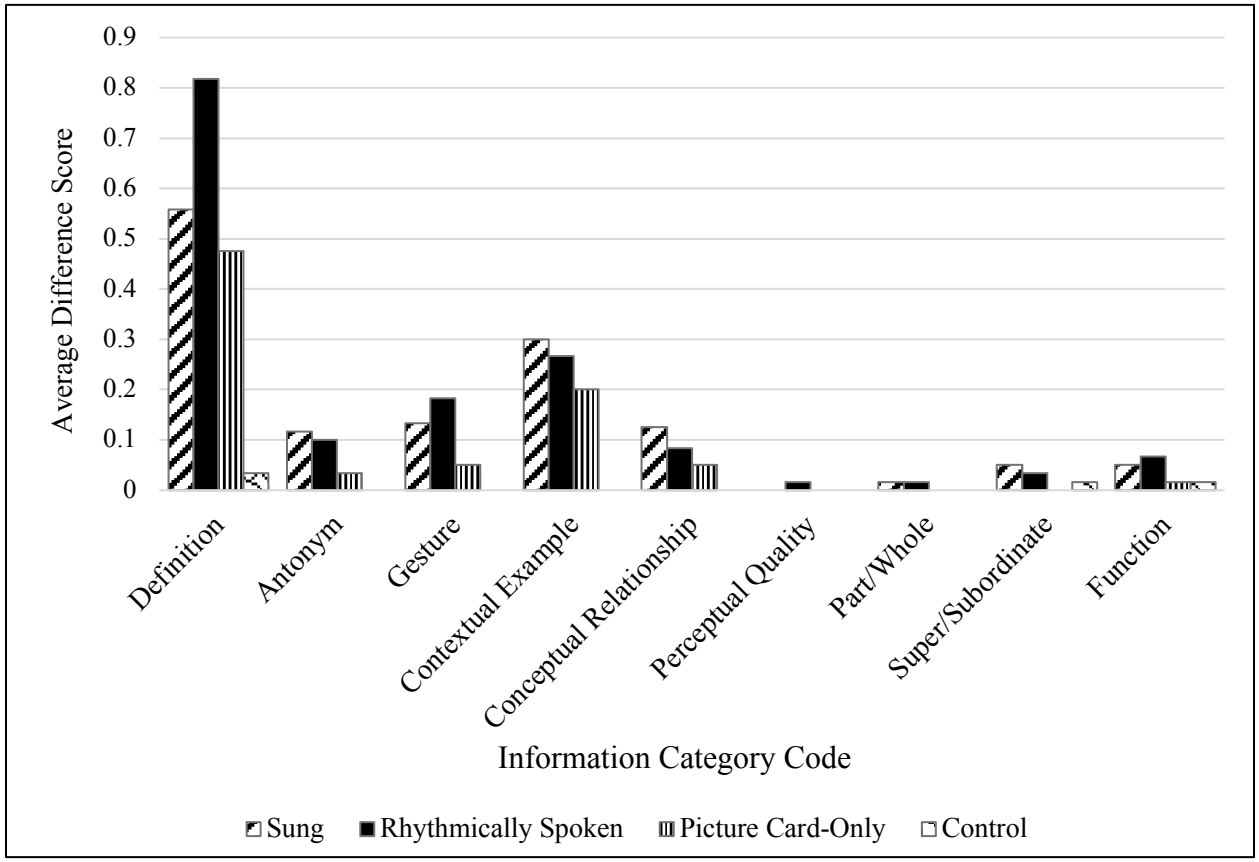

Figure 1. Average pre-to-post difference score by lexical information category code for all conditions

Research Question 4: Differential Effects of Songs

The final research question sought to determine whether student characteristics (pretest scores, DLL status, and maternal education) affected children's word learning outcomes. I was unable to run full, nested interaction models for the receptive and PWD tasks because the models were too complex and would not converge using available data. As a result, for the receptive task, I conducted three models that tested interactions between student characteristics and one of the conditions of interest: (1) sung, (2) rhythmically spoken, and (3) picture-card only. Each model was structured similarly to the model used in the first research question, but included interaction terms. Since I ran three separate unplanned interaction models a posteriori, I used the Benjamini-Hochberg (B-H) procedure (Benjamini & Hochberg, 1995) to handle potential Type I

errors. Original p-values are reported and results reflect whether predictors met the significance threshold with a false discovery rate (FDR) of 0.05, 0.10, and 0.20. I found no significant interactions between words taught with a sung song and children's pretest scores ($p = 0.15$), DLL status ($p = 0.051$), or maternal education ($p = 0.83$). There were no significant interactions for words taught with a rhythmically spoken song and children's pretest scores ($p = 0.54$), DLL status ($p = 0.10$) and maternal education ($p = 0.14$). For words taught with picture cards-only, there were no significant interactions with children's pretest scores ($p = 0.75$), DLL status ($p = 0.45$), and maternal education ($p = 0.35$).

For the PWD task, I was unable to test any interactions in the model because the addition of random effects was too complex for the GLMM. Due to this limitation, I ran three separate, restricted models for each condition of interest (sung, rhythmically spoken, and picture-card only) using only the scores of the specified condition and control condition. Each model was structured with posttest as the dependent variable, condition and pretest as Level 1 predictors, and DLL status and maternal education as Level 2 predictors. The B-H procedure was used to control for the FDR due to potential Type I errors as a result of running multiple models. Results show whether predictors met the significance-threshold when the FDR was set at 0.05, 0.10, and 0.20. Original p-values are reported. For words taught with a sung song, pretest ($p = .76$) was not a significant predictor of posttest, but maternal education ($p = .021$) and DLL status ($p < .001$) were significant. For words taught with a rhythmically spoken song, pretest scores ($p = .13$) and DLL status ($p = .61$) were not significant predictors of posttest scores for words taught with a rhythmically spoken song. Maternal education ($p = .032$) was not significant when the FDR was set at 0.05, but was significant when the FDR was set to 0.10 and 0.20. For words taught with picture cards-only, pretest ($p = .58$) was not a significant predictor of posttest scores, while

maternal education (p = .001) and DLL status (p = .004) were significant when the FDR was set at 0.05, 0.10, and 0.20. In all conditions, higher levels of maternal education and being identified as a non-DLL corresponded with higher PWD scores.

Discussion

The present study sought to determine the effects of songs and their modality of performance in fostering preschool children's word knowledge. I focused on the ability of songs to build preschool children's surface-level understanding of word meanings through a receptive task, as well as their deeper knowledge about words through a productive word definition task. I analyzed whether songs bolstered children's word learning better than picture card-only instruction and control words that were not taught, and I sought to ascertain whether children learned words better when a song was sung compared to rhythmically spoken. Additionally, I addressed whether student characteristics, including prior knowledge of taught words, DLL status, and maternal education, differentially impacted children's word learning through songs.

Word Learning through Songs

Teaching words with songs enhanced children's receptive and productive definitional knowledge of target words. Children had significant pre-to-posttest growth on the receptive task when words were taught with a sung song (d = 0.41) and when words were taught with a rhythmically spoken song (d = 0.52). Results from the PWD task similarly showed significant large pre-to-posttest growth for words taught with a sung song (d = 0.96) and a rhythmically spoken song (d = 1.12). These findings provide initial evidence that combining songs with explicit vocabulary instruction supports receptive and productive definitional word knowledge for preschool children.

I found no significant difference between the two song modalities (sung vs. rhythmically spoken) in fostering children's receptive or productive definitional word learning. These findings correspond with Schunk's (1999) work that found no difference in the receptive learning of children in kindergarten through grade 2 for sung and rhythmically spoken songs when words were introduced with picture images and reinforced with semantically-related gestures during the song's performance. While children did not perform gestures in the present intervention, they did see picture cards of target words before and during the songs. The use of the picture cards may have nullified any receptive and productive definitional word learning differences between the song modalities. I could not find any previous vocabulary studies that measured children's depth of knowledge for words taught through songs, making this the first study to find that songs, despite modality, foster deep knowledge about taught words.

Songs Compared to Picture Card-Only Instruction

No significant differences were found in children's receptive knowledge for words taught with either song modality compared to picture cards-only. These findings align with prior work by Pollard-Durodola et al. (2018) who found that combining explicit picture card instruction with book reading did not enhance children's receptive word knowledge beyond picture card-only instruction. The receptive task requires children to identify the picture image that best matches the target word, but it does not assess additional knowledge children may have about words and may underestimate the extent to which songs build lexical representations (Lawson-Adams & Dickinson, under review).

The PWD task offered more insight into whether songs helped children build deeper knowledge compared to picture card-only instruction. Children displayed significantly more depth of knowledge for words taught with sung ($d = 0.23$) and rhythmically spoken songs ($d =$

.40) compared to picture cards-only. Prior vocabulary interventions have reported that picture card instruction combined with book reading enhances children's productive definitional knowledge of words (Dickinson et al., 2019; Hadley et al., 2016); however, this is the first study to account for the contribution of picture card instruction in building children's depth of knowledge when used in combination with a contextual support. These findings indicate that teaching words with songs using either modality augments children's depth of word knowledge beyond picture card-only instruction. Similar to books, songs provide an engaging context for teaching vocabulary.

The use of pictures during the song in conjunction with the musical components of the songs may have helped direct children's attention to semantic features depicted in the images, as well as the semantic information in the lyrical content. For example, when children heard the verse for *devour* in "Purple Pete" (see Appendix E), they saw an image of a man messily eating a bowl of spaghetti while simultaneously hearing lyrics about how Purple Pete is hungry and eats lots of pies and cakes. Children's responses showed that they attended to this information (e.g., "you eat something like spaghetti faster" and "you eat a lot of sugar"). The background drum in the spoken condition and guitar in the sung condition may have heightened children's interest in the image and verse, and the ability of songs to enhance verbal memory may have increased children's retention of the semantic information.

Categories of Information Learned through Songs

Across all conditions, the target words were defined and used the same number of times (four), but for the song conditions two of those occasions of use occurred as the songs were sung or spoken. To ascertain the type of information learned during the songs and picture card-only instruction, I examined children's responses about words on the PWD task. Definitions were the

response type that was commonly used by students across conditions. On average, children provided 1.55 more definition responses for words taught with a spoken song and 1.05 more for words taught with a sung song compared to words taught with picture cards alone. Definition responses included information about words that was directly shared with children during the intervention through didactic instruction. In both song conditions, children were verbally given definitional information about words before and during the song performance. Additionally, picture cards were used to explicitly teach words prior to hearing the song and to serve as visual reference for words during the song's performance. The direct and repeated exposure to visual and verbal representations of words in combination with rhythmic and/or melodic musical elements of the songs may have bolstered children's attention to and memory of word meanings in song modalities. This aligns with the DCT (Paivio, 1986; Sadoski & Paivio, 2004) which argues that merging verbal and nonverbal sources, such as lyrics, pictures, and music, can help children better process and retain semantic information about words.

Children also showed improvement in their use of contextual examples, which involved providing descriptions of meaningful contexts related to a word. Unlike definitions, student responses with contextual examples often included information about words that was not explicitly taught during the intervention. On average, children provided 1.36 more contextual examples for rhythmically spoken songs and 1.5 more contextual examples for sung songs compared to picture cards-only. Children's contextual examples for words taught with both song modalities sometimes included a reference to the content of the song lyrics, but more often featured an example of a context not discussed during the intervention. For instance, for the word *texture,* children sometimes referenced the song lyric about fluffy clouds (e.g., "it can feel fluffy") but more frequently extended the word meaning to a new situation (e.g., "something

feels bumpy or smooth"). These responses demonstrate that children were able to extrapolate contextual information from songs and that songs may have helped children bridge taught information about words with their other experiences, resulting in higher quality lexical representations.

Differential Effects Across Students

Receptive knowledge increased for children when words were taught with songs regardless of their pretest scores, DLL status, and reported maternal education. However, on the productive definitional task, I found differential effects for DLLs and reported maternal education. While children provided more information about words taught with songs compared to picture cards-only regardless of maternal education, higher reported levels of maternal education corresponded with larger pre-to-posttest growth on the productive definitional task. Children's DLL status may partially explain why I found higher, but not significant productive definitional word growth for rhythmically spoken songs compared to sung songs. DLL status affected children's word learning in the sung song and picture card-only conditions. DLLs had small pre-to-posttest growth in their productive definitional knowledge for words taught with a sung song ($M = 0.059$, $SE = 0.11$) and picture cards-only ($M = 0.020$, $SE = 0.010$), suggesting that these instructional conditions did not foster deep word knowledge for bilingual learners. However, the results showed that rhythmically spoken songs were as effective in fostering depth of knowledge for DLLs as monolingual, native speakers. DLLs had similar pre-to-posttest growth on the productive definitional measure ($M = 0.25$, $SE = 0.35$) as their monolingual peers ($M = 0.27$, $SE = 0.33$).

DLL status may partially account why children displayed more, although not significantly more, depth of word knowledge for words taught with a rhythmically spoken song

compared to words taught with a sung song. I found evidence that DLLs' musical engagement may have varied upon hearing both song modalities. During the sung songs, children tried to hum and sing-along with the melody before listening to or learning the song lyrics. However, during the rhythmically spoken songs, children did not try to speak-along with the instructor and therefore were attending to the lyrics. Wallace (1994) argued that the melodic structure of sung songs may distract learners as they focus more on the sound of the lyrics than the lyrics themselves. This may be particularly true for bilingual children from homes where English is not the dominant language, because they may find it easier to attend to the melody rather than lyrics in their non-dominant language. As a result, their attention to the lyrics may be somewhat reduced compared to native speakers.

Additionally, DLLs' attention to the melody instead of the words may have been further augmented if they were not familiar with the tunes of the folk songs used in the study. Previous work suggests that children may not recall words as readily when hearing an unfamiliar melody compared to spoken text (Calvert & Billingsley, 1998; Wolfe & Hom, 1993). It is possible that the melodies of the American/English folk songs used in the study were unfamiliar to children from homes where a language other than English was spoken. As a result, DLLs may have focused more on learning the melody rather than attending to the words embedded in the song lyrics for sung songs. This distraction may have been eliminated when songs were rhythmically spoken, allowing children to listen attentively to the semantic information in the songs. I did not find any vocabulary studies on song modality that analyzed the effect of children's DLL status on learning words through songs, but the results provide preliminary evidence that children from homes where they are exposed to a language other than English may benefit more from rhythmically spoken songs than sung songs when learning English vocabulary.

Theoretical Implications

Children's school-valued vocabulary knowledge at school-entry predicts their later reading comprehension (Dickinson & Porche, 2011; Hoff, 2013; Storch & Whitehurst, 2002). Since vocabulary is critical for reading success, it is pertinent to examine ways to support children's learning of school-valued vocabulary in preschool. Songs are commonly used in preschool settings (Gillespie & Glider, 2010) and can augment verbal memory of words in song lyrics (Chazin & Neuschatz, 1990; Knott & Thaut, 2018; McElhinney & Annett, 1996; Wallace, 1994; Wolfe & Hom, 1993). However, there is limited evidence regarding whether songs, and their modality of performance, affect word learning for young children from different linguistic and socioeconomic backgrounds.

The ability to simply recall a word from a song is not a sufficient indicator for whether songs help build high quality lexical representations that contribute to the ability to comprehend text and speech. Perfetti's (2007) lexical quality hypothesis argues that closely intertwined knowledge about both a word's form and meaning allows readers to readily and flexibly retrieve and apply their word knowledge to read or spoken text. This theoretical perspective suggests that, in addition to associating word forms with explicit definitional meanings, lexical knowledge can be enriched with the addition of other semantic dimensions that can be supplied through nonverbal channels. Songs are multimodal and engage learners, promote memory of words, and direct attention to vocabulary supports, such as narratives in song lyrics and supplemental material like picture cards. The combination of nonverbal musical structures with verbal lyrical narratives has the potential to help children attend to words and build deeper semantic knowledge. The present study's findings support this notion and demonstrate that sung and rhythmically spoken songs can foster preschool children's word knowledge. Additionally, the

results highlight that familiarity with melodic structure in sung songs may be important to enhance word learning, especially for language-minority learners.

Educational Implications

The results hold several implications for teaching vocabulary through songs in preschool settings. First, songs provide an effective context for word learning when used in combination with picture card instruction of words. Specifically, songs help provide more contextual support for building deeper word knowledge than can be achieved with picture card instruction alone. Preschool classrooms use songs throughout the school day (Gillespie & Glider, 2010), and the findings suggest that teachers can leverage songs to help foster children's vocabulary knowledge.

Second, teachers do not have to spend a large amount of instructional time to support word learning through songs. Each song activity (sung and rhythmically spoken) took approximately five minutes. Children in the present study experienced the song activities three times, meaning 15 minutes of vocabulary instruction across two weeks led to significant growth in word knowledge. Songs provide a quick, effective approach to supporting vocabulary in the preschool classroom and occur during an activity period that is common in many classrooms but typically not used to intentionally foster vocabulary learning.

Third, the modality in which songs are performed does not significantly affect children's word learning; however, rhythmically spoken songs may better enhance depth of word knowledge for DLLs. These findings are promising for classroom teachers who may vary in their comfort with singing songs in the classroom. Teachers enter the classroom with different levels of musical experience (Dogani, 2008; Siebenaler, 2006). Although music and singing may be commonplace in their daily routines, preschool teachers often report a lack of confidence in their ability to sing (Ehrlin & Wallerstedt, 2014). The results provide initial evidence that teachers can

support vocabulary through rhythmically spoken songs that do not involve singing, allowing teachers the flexibility to use a song modality that is most comfortable for them.

Limitations

There were several limitations in the current study. The intervention featured four total conditions (sung, rhythmically spoken, picture card-only, and control) and 24 words. Although children were taught a variety of word types, the number of words and word types in each condition were relatively small. Future studies should consider a longer-term intervention with multiple iterations of each condition to measure children's learning of more words and word types through songs.

While the analyses accounted for socioeconomic and linguistic factors, such as maternal education, DLL status, and children's initial knowledge of words at pretest, they did not account for children's general language ability. They also did not account for children's self-regulatory ability, which is a characteristic found to affect learning from vocabulary interventions (Dickinson et al., 2019). Including additional cognitive and language measures would identify whether additional factors differentially affect children's word learning during sung and rhythmically spoken songs. Additionally, although the study had a linguistically and culturally diverse sample, I did not collect data on children's familiarity with the tunes used for both songs. A measure of song familiarity would help us determine whether familiarity impacted the effectiveness of songs in building children's lexical knowledge.

While the findings indicate that songs may be an effective vocabulary support in the classroom, it is important to note that instruction was provided by the researcher, who is trained as a music educator. She is comfortable singing and speaking songs and is an energetic and

engaging performer. Others may be less comfortable using these techniques and may be less effective.

In the intervention, children were exposed to three repetitions of the instructional conditions. Prior studies indicate that hearing a song three times is sufficient for word learning; however, having more repetitions may have fostered better word learning for preschool children. Future studies should consider examining the effects of hearing songs more than three times. Additionally, all three instructional activities were delivered back-to-back during the music sessions. As a result, children were taught a total of 18 words within a 15-minute time-frame, which may have overburdened their cognitive load and affected their word learning. Spacing out instruction may further enhance children's word learning outcomes.

Lastly, vocabulary gains on the receptive and productive word definition measures were relatively small. I selected difficult words, including abstract nouns, and used didactic approaches to teaching vocabulary. I also limited children's talk about words and did not engage in responsive discussions about word meanings, which has been shown to be an effective approach to vocabulary instruction (Beck & McKeown, 2007). The small, but significant, gains children made in their vocabulary knowledge is notable given the difficulty of the words, the didactic instructional approaches, and limited amount of instructional time I utilized. Future studies should explore the benefits of longer instructional time that would allow for more repetitions of the songs and child talk around words to see if these instructional strategies promote larger gains in word knowledge.

Conclusions

The current study adds to the literature by analyzing whether songs, and different song modalities, support children's learning of difficult, school-valued vocabulary. I address the need

to consider the effectiveness of multimodal contexts outside of book reading and traditional explicit vocabulary instruction in fostering children's word knowledge. This study examines children's receptive and productive definitional learning of words taught through songs and picture card-only instruction, and I analyze differential effects in word learning through songs based on socioeconomic and linguistic factors. The results from this study demonstrate that songs are effective contexts for vocabulary instruction in preschool settings.

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Appendix A

Sound Words, Definitions, and Sound Choices Given to Students

Word	Word type	Definition	Matching Sound (correct sound)	Contrasting Sound (incorrect sound)
chaos	abstract noun	A time when everyone and everything is out of control	All instruments playing wildly	No instruments/ silence
gnaw	verb	To chew on something a lot	Crunchy sound using cabasas and/or guiros	Ringing triangles
hoist	verb	To lift up something big	Going from low to high on bass/alto xylophones	Going from high to low on bass/alto xylophones
inspire	verb	To make someone want to do something well	Gently ringing hand bells (Do, Mi, So)	Clapping sand blocks together
progress	abstract noun	When you get better at something, like riding a bike	Drums transition from unsteady/mismatched beat to playing steady beat together	Drums playing an unsteady/mismatched beat that never becomes steady
texture	abstract noun	How something feels when you touch it, like smooth or rough	Scraping sand blocks (rough)	Ringing triangles (smooth)

Appendix B

Examples of Student Responses and Information Categories Assigned on Productive Word Definition (PWD) Measure

Information Category	**Definition of Category**	**Student Response**	**Word**
Synonym	A word or short phrase that defines the word	"something loud"	*clamor*
Gesture	A gesture, movement, or facial expression that shows knowledge of word	waves arm around wildly	*chaos*
Instrument Reference	A description of the instrument/sound taught with the word	"like the bells! I learned how to play the bells"	*inspire*
Conceptual Relationship	A typical association that shows little understanding of word	"food"	*gnaw*
Nuance	A specific detail (or nuance) about a word meaning	"[*to burn something*] until it's all black"	*char*
Contextual Example	A description that provides an example of the word	"like a heavy box you gotta pick up with hundreds of decks in there!"	*hoist*
Extended Response	A list of multiple, related examples for a word	"like the wall is soft or paper is soft or something is soft like the door"	*texture*

Note. Brackets [] indicate a part of the response that received a different information category code

Appendix C

Productive Word Definition (PWD) Information Categories with Descriptions and Examples of Student Response

Information Category	Definition of Category	Student Response	Word
Definition (2 points)	Repeating the two parts of the taught definition: (1) word or short phrase that defines the word, and (2) example used to teach the word	"(1) you hold tight (2) like a teddy bear"	*clutch*
Antonym (1 point)	A word that is opposite of the word being explained	"when you are not careful"	*strategy*
Gesture (1 point)	A gesture, movement, or facial expression that shows knowledge of the word	moves fingers quickly	*scurry*
Contextual Example (1 point)	A description that provides an example of the word that was not explicitly taught and shows deeper understanding	"playing a trumpet too loud"	*nuisance*
Conceptual Relationship (0.5 point)	An association that shows little understanding of the word	"kitchen"	*devour*
Perceptual Quality (1 point)	*For concrete nouns only.* A description of the properties of an object, like how it looks, smells, feels, or sounds.	"a plastic [boat]"	*vessel*
Part/Whole (1 point)	*For concrete nouns only.* A description pf a part of the object or the whole that the object is part of	"[a snake] with poison"	*serpent*
Super/Subordinate (1 point)	*For concrete nouns only.* A description of a lower or higher category of an object	"some kind of creature"	*rodent*
Function (1 point)	*For concrete nouns only.* A description of the process, purpose, or use of an object	"[a can], you open it"	*canister*

Note. Brackets [] indicate a part of the response that received a different information category code

Appendix D

Words, Taught Definitions, Word Type, and Level of Difficulty by Condition

Condition	Words	Taught definitions	Word type	Difficulty rating[a]
"Purple Pete" (sung or spoken)	*baffle*	to confuse someone, like a child trying to use a new camera	verb	T6
	devour	to eat food very fast, like this person eating a bowl of spaghetti	verb	T6
	progress	when you get better at something, like learning to ride a bike	abstract noun	T6
	sapling	a baby tree, like this one that is growing	concrete noun	T6
	serpent	a snake, like this one hunting for food	concrete noun	T6
	texture	how something feels, like how rough bricks feel	abstract noun	T6
"Lucy Goose" (sung or spoken)	*clutch*	to hold something very tightly, like these children holding a teddy bear	verb	T6
	nuisance	something that is annoying, like when someone is snoring real loudly	abstract noun	T6
	rodent	an animal that chews on things, like a mouse	concrete noun	T6
	scurry	to move with quick little steps, like these crabs on the beach	verb	T6
	tempo	the speed of something, like this cheetah that is running fast	abstract noun	T6
	vessel	a boat, like one that floats on the water	concrete noun	T6

Picture Card-Only	*abdomen*	the belly, which is a part of your body	concrete noun	T6
	burrow	a hole in the ground where animals live, like this hole in the field	concrete noun	T6
	char	to burn something until it turns black, like this burnt grass	verb	T6
	mutter	to say something quietly when you are unhappy, like this grumpy teenager	verb	T6
	source	where something comes from, like a banana that grows on a banana tree	abstract noun	T6
	strategy	a careful plan, like when you are trying to win a game	abstract noun	T6
Control (not taught or performed)	*alter*	n/a	verb	T6
	blunder	n/a	abstract noun	T6
	canister	n/a	concrete noun	T6
	knoll	n/a	concrete noun	T6
	perch	n/a	verb	T6
	preference	n/a	abstract noun	T6

Note. T6 = words known by 40-80% of students by end of grade 6
[a]Biemiller (2010).

Appendix E

"Purple Pete" Lyrics

Tempo: Bpm = 88, Key: D Major, Range: D4 to A4
(to the tune of *London Bridge is Falling Down*)

Refrain (repeats after every verse):
Walking down the windy street
Clap your hands, stomp your feet
Look! Who's that?! It's Purple Pete!
What's he doing/saying?

---

1. He's running from a SERPENT's nest
   Where all the snakes go to rest
   Lots of snakes in the serpent's nest
   Oh snakes do scare him

2. He's DEVOURING lots of food
   Pies and cakes, he's a hungry dude
   He even devoured my food too
   Pete ate so quickly!

3. He feels this TEXTURE it's so soft
   Like a piece of cloud fell off
   This TEXTURE is fluffy to the touch
   Like a fluffy pillow

4. He sees a SAPLING in the grass
   A small tree that will grow and last!
   He helps the sapling in the grass
   With time, sunshine, and water

5. This puzzle is BAFFLING you and me
   It's harder than it ought to be
   This puzzle baffled you and me
   It's confusing!

6. He's making PROGRESS tying his shoes
   He's getting better, yes it's true
   So much progress with tying his shoes
   He practiced until he aced it!

Appendix F

"Lucy Goose" Lyrics

Tempo: Beats per minute (bpm) = 108, Key: F Major, Range: C4 to C5
(to the tune of *She'll Be Comin' 'Round the Mountain*)

Oh I came to town to search for Lucy Goose (x2)
Refrain (repeats after every verse):
I hear stomping, I hear clapping
I see feathered wings a'flapping
Oh what's she doing now, that Lucy Goose?

---

1. Oh she found a RODENT hiding in her shoe
   Yes it has big teeth and uses them to chew
   Oh it went straight for the cheese without even saying please
   Yes she found a rodent hiding in her shoe

2. Oh she's in a rush and SCURRYING away
   Taking short, fast steps because she cannot stay
   Oh she's rushing right on past, and her steps are short and fast
   Oh she's in a rush and scurrying away

3. Oh she hears the TEMPO of her favorite song
   Yes, she feels the beat and starts to move along
   First it's fast then it's slow, listen closely and you'll know
   When she hears the tempo of her favorite song.

4. Oh she's in a VESSEL floating in the sea
   Yes she's in a boat as happy as can be
   Oh the boat is made of wood, and it's floating like it should
   Yes she's in a vessel floating in the sea

5. Oh she's CLUTCHING onto something soft and light
   She can make a fist to hold it very tight
   Oh it's Lucy's favorite puppet, and she doesn't want to drop it
   So she's clutched her favorite puppet very tight

6. This cat's a NUISANCE and gets on Lucy's nerves!
   All he does is scratch, meow, and cough up fur!*bleh*
   Oh he really is annoying, she wishes he'd be boring
   He's a NUISANCE and gets on Lucy's nerves!

Appendix G

Productive Word Definition (PWD) Task: Normality Concerns and the Tweedie Distribution

The usual linear mixed-effects regression model assumes that, conditional on the predictors included in the model, the residuals follow a normal distribution. This assumption is likely to be violated when observed scores are highly non-normal, which will jeopardize the accuracy of inferences made about the data. Normal quantile-quantile (q-q) plots are a helpful diagnostic for checking this assumption and can be easily generated using the car package in R (Fox and Weisberg, 2019). Figure G1 shows theoretical quantiles of a normal distribution, plotted against the residuals from the following model for the PWD task:

$$\text{Posttest}_{ij} = \gamma_{00} + \gamma_{10}\text{Sung}_{ij} + \gamma_{20}\text{Spoken}_{ij} + \gamma_{30}\text{PictureCard}_{ij} + \gamma_{40}\text{Pretest}_{ij} + \gamma_{01}\text{DLLstatus}_{j} +$$

$$\gamma_{02}\text{MaternalEd}_{j} + u_{0j} + e_{ij}$$

The following plot shows a large amount of skewness in the distribution of residuals for the PWD task, suggesting violation of the normality assumption is a concern.

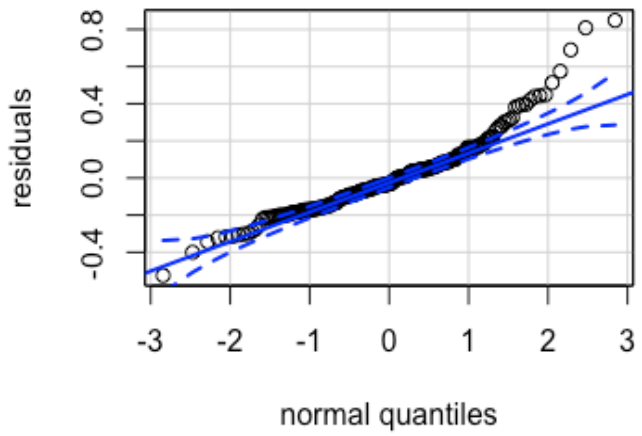

Figure G1. Normal quantile-quantile plot of residuals from a linear mixed-effects model for the PWD task, showing large amounts of positive skewness in the distribution of residuals.

The observed distribution of scores on the PWD is strictly non-negative, with a large number of zero values. This suggests the data may be effectively modeled by a compound Poisson distribution, also known as a Tweedie distribution (Jorgenson, 1987), a member of the family of exponential dispersion models. Generalized linear mixed models using Tweedie distributions can be fit using the cplm package in R (Zhang, 2013). Figure D2 shows a kernel density estimate of

the distribution of observed scores, overlaid with a Tweedie distribution whose parameters were estimated from the data.

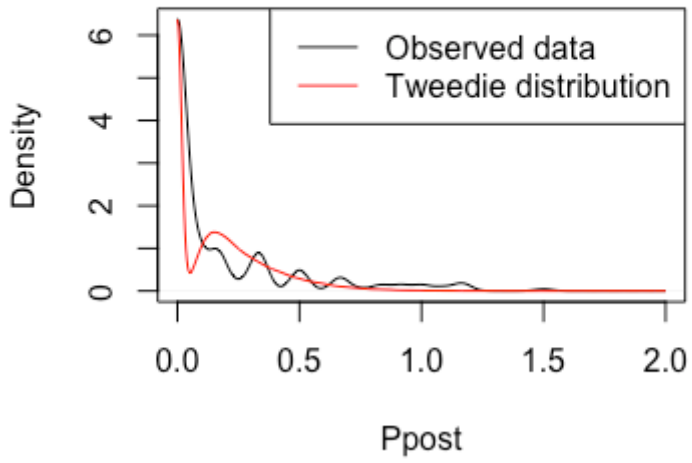

Figure G2. Kernel density estimates of the observed distribution of PWD scores and of random values generated from a fitted Tweedie distribution.