INFORMING VOCABULARY INTERVENTIONS USING PRINCIPLES FROM THE SCIENCE OF WORD LEARNING

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ABSTRACT

Vocabulary knowledge is essential for children's reading success (Dickinson & Porche, 2011; Ouellette, 2006). Unfortunately, even before formal schooling begins, glaring differences in language ability exist between children from disadvantaged backgrounds and their more advantaged peers (Hart & Risley, 1995, Golinkoff et al., 2018; Fernald, Marchman, & Weisleder, 2013). Despite efforts to redress differences in vocabulary knowledge, previous interventions have made little progress (Wasik et al., 2016). Researchers have suggested that the translation of knowledge from the science of word learning to literacy research may be one way to increase the effectiveness of vocabulary instruction (Hassinger-Das et al., 2017).

The current study is a vocabulary intervention for preschoolers that employs, and expands upon, principles from the psychology of word learning (that deep word knowledge can be built through semantic networking and through category formation) used in previous projects (Neuman et al., 2011; Neuman & Kaefer, 2018). Specifically, this project assesses if participants who are provided with an *advanced organizer* that aims to provide a foundation upon which to build richly-connected word knowledge show enhanced learning from the intervention. Results from this dissertation demonstrate that, when comparing two groups who received equivalent vocabulary instruction, the addition of an advanced organizer did not lead to enhanced depth of target word knowledge, categorization ability, or induction ability. However, overall, children in the study made significant gains on categorization ability and depth of target word knowledge. This study offers a first step into how vocabulary researchers might incorporate a foundational component to improve upon interventions.

DEDICATION

This dissertation is dedicated to all the children who participated in intervention studies that I helped conduct throughout my time in graduate school.

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CHAPTER 1

INTRODUCTION

"Words stand for things. To possess a wide vocabulary without wide knowledge is a thing that has never existed and never will" (Hirsch, 1999).

Vocabulary knowledge is critical for children's academic outcomes, especially reading success. Without a strong understanding of the words children read on a page, comprehension suffers (Wexler, 2019; Willingham, 2017; O'Reilly, Wang, & Sabatini, 2019; Schneider, Körkel, & Weinert, 1989). This is likely why vocabulary knowledge is strongly tied to reading ability (Snow, 1991; Cunningham & Stanovich, 1997; Dickinson & Porche, 2011; Scarborough, 2001). Moreover, vocabulary knowledge is linked to such outcomes as math achievement, self-regulation, and executive function (Pace et al., 2017; LeFevre et al., 2010; Morgan, Farakas, Hillemeier, Hammer, & Maczuga, 2015; Cole, Armstrong, & Pemberton, 2010; Schmitt, Purpura, & Elicker, 2019).

Unfortunately, research shows that economically advantaged caregivers tend to talk more, use more diverse vocabulary, and engage in higher quality language interactions with their children compared to lower-income caregivers (Gilkerson et al., 2017; Golinkoff, Hoff, Rowe, Tamis-LaMonda, & Hirsh-Pasek, 2018; Rowe, 2008; Hart & Risley, 1995; Hoff, 2013). Moreover, researchers often document stark differences in language ability between children from disadvantaged backgrounds and their more advantaged peers before the age of three (Hart & Risley, 1995, Golinkoff et al., 2018; Fernald, Marchman, & Weisleder, 2013).

Much of this work highlights a difference in *breadth* of vocabulary knowledge, or the number of words children know. However, many language researchers also recognize the great importance of *depth* of vocabulary knowledge. Depth can be described as the extent to which a word resides in a rich web of interconnected knowledge, allowing the child to use the word in multiple contexts and distinguish the word between closely related words (Perfetti, 2007; Silverman & Hartranft, 2015; Hadley & Dickinson, 2018). A child who knows that an *orange* is a fruit that comes in different varieties, provides important vitamins and minerals, grows in a warm climate, and has seeds likely has deep semantic knowledge of the term *orange*.

Depth of word knowledge is especially important for children as it is a critical predictor of reading ability (Ouellette, 2006). Research demonstrates that strong content knowledge, which can be viewed as a proxy for vocabulary knowledge in young children (Hirsch, 2003), is crucial for reading comprehension (O'Reilly et al., 2019; Recht & Leslie, 1988; Schneider et al., 1989). If a child knows a lot about trees, for example, they likely have strong comprehension of the words *branch*, *jungle*, and *root*. Knowledge about this wide variety of words will assist that child's reading comprehension ability.

For instance, in one study, Schneider and colleagues (1989) tested children on both their verbal ability and amount of soccer knowledge. After participants read a story about soccer, the researchers tested children's comprehension and found that the amount of background knowledge in soccer was more important for comprehending the passage than were verbal skills. If a child does not have an adequate threshold of knowledge on a topic, no amount of 'reading skill' will likely help their comprehension on that particular topic (O'Reilly et al., 2019).

In an effort to build children's vocabulary, especially in those who experience a paucity of language input, many researchers conduct school-based vocabulary interventions. Some studies focus on building children's breadth of word knowledge, feeling an urgency to "fill a quantitative gap" (Biemiller, 2005; Biemiller & Boote, 2006). These interventions typically use a shared book reading approach while introducing children to short definitions of selected vocabulary words as they read through a story (Whitehurst et al., 1994; Biemiller & Boote, 2006; Lever & Sénéchal, 2011). Other studies, however, aim to build young children's depth of word knowledge (Wasik & Bond, 2001; Beck & McKeown, 2007; McKeown & Beck, 2014; Coyne, McCoach, & Kapp, 2007; Neuman, Newman, & Dwyer 2011; Hadley, 2017). These researchers utilize various pedagogical methods to increase children's richness of knowledge. For instance, in addition to providing definitions of words provided in shared book reading sessions, McKeown and Beck (2014) prompted kindergarteners to distinguish between examples and non-examples of vocabulary words and asked children to create and explain contexts for the words.

Unfortunately, a majority of vocabulary interventions have made little progress in increasing children's word knowledge (Wasik, Hindman, & Snell, 2016; Dickinson, Freiberg, & Barnes, 2011). Not only do children generally learn fewer than 25% of taught words in some of the most well-cited interventions (Wasik et al., 2016), but a recent meta-analysis of shared book reading interventions found that these studies demonstrate a near-zero effect on children's language skills, including vocabulary, when active control groups are used (Noble et al., 2019).

In response to these poor outcomes, some early childhood researchers suggest that the field utilize findings from the word learning literature in psychology as a foundation to build vocabulary interventions (Hassinger-Das, Toub, Hirsh-Pasek, & Golinkoff, 2017). And in recent intervention studies, this call has been heeded. Most notably, the *World of Words* (WOW) program (Neuman et al., 2011; Neuman & Kaefer, 2018) is a vocabulary intervention that targets children's depth of word knowledge. WOW is aimed at young children from disadvantaged backgrounds and is based on findings that strong content knowledge is crucial for reading comprehension (O'Reilly et al., 2019; Recht & Leslie, 1988; Schneider et al., 1989).

To increase the richness of children's vocabulary knowledge, the WOW program takes advantage of findings in the word learning literature. Specifically, the program uses the principles that deep word knowledge can be built through *semantic networking* and through *category formation*. A semantic network can be thought of as a "web" of interconnected lexical knowledge that children possess. For instance, the web surrounding the word *pen* might include words like *write, ink,* and *pencil.* Neuman and colleagues (2011) build children's semantic networks by teaching words like *edible, celery,* and *balanced* in relation to the word *vegetable.*

Additionally, in an effort to support conceptual development, WOW also teaches words through taxonomic category formation. This is done by grouping objects based on shared properties. For instance, *circles, squares,* and *hexagons* all fall under the category of *shapes.* Neuman and colleagues (2011) use categories to teach vocabulary because children can use their category knowledge to make inferences and generalizations about words (Gelman & Markman, 1986; Gelman & O'Reilly, 1988; Gelman, 2003). Consider a child who has learned about the category of birds (e.g., that they have wings and feathers, can fly through the air to move, and lay eggs). That child may not yet know the term, *sparrow,* but upon learning that it is a bird can infer all those pieces of knowledge about a sparrow.

These two principles, which stem directly from the psychological literature, and the way in which WOW incorporates these principles, are discussed in detail in the next section. While the principles utilized in WOW are directly in line with how children learn language, oftentimes children do not exhibit substantial learning gains. For instance, in one iteration of the project, children only learned an average of 4.2 out of 40 words taught per unit (Neuman et al., 2011). And while the effect sizes of this intervention are impressive (*d*'s = 0.44, 0.56, 0.86), the results might not be practically significant. It is imperative that this lack of progress, even in interventions that aim to arm preschoolers with a rich network of knowledge, be addressed as children require a strong vocabulary in order to tackle formal schooling (Neuman & Dwyer, 2009).

This dissertation implements and evaluates an intervention study that employs the principles from the psychology of word learning that are utilized in WOW interventions. However, in an attempt to improve both the methodologies and outcomes of vocabulary interventions, the current study provides children from disadvantaged backgrounds with a foundation upon which to build richly-connected word knowledge.

Principles from the Science of Word Learning: Semantic Networks

One of the principles used in WOW is teaching words through semantically-related concepts and structures in an effort to deepen children's understanding of taught words. This pedagogical technique is taken from findings highlighting the importance of semantic networks. These networks are composed of a web of words and each word is considered a node within the web. Nodes are connected to, via semantic relatedness, other words and concepts (Steyvers & Tenenbaum, 2005; Hills, Maouene, Maouene, Sheya, and Smith, 2009; Collins & Loftus, 1975). Nodes that are next to each other are considered neighbors (e.g., *shoe* and *laces*). A semantic neighborhood can be defined as a subgroup of words that consist of a single word (e.g., *shoe*) and all of its neighbors (e.g., *laces, walk, heel*) (Steyvers & Tenenbaum, 2005).

Recent research has examined what the structure of a semantic network looks like. Beckage, Smith, and Hills (2010) provide a good explanation of this structure: A mature semantic network contains two vital elements – 1) high local structure, and 2) global access. High local structure means that there are clusters of densely connected words linked together. For example, *shoe* might be linked to *laces*, *walk,* and *heel*. Importantly, these dense clusters also have global access, or connections to words in other distant clusters (a group of words that are semantically different from the first cluster). These connections allow for easy movement from one cluster to the next. For instance, the cluster containing the term *shoe* might have access to clusters of clothing (e.g., *shirt, jeans, hat*) through a shared node of *sock*. Researchers posit that these two elements of semantic networks allow for efficient semantic processing and word retrieval (Hills et al., 2009; Beckage et al., 2010).

Moreover, Beckage, Smith, and Hills (2011) found evidence for this hypothesis. The researchers studied the semantic network structure of children who displayed typical or delayed vocabulary development. Participants with delayed vocabulary had networks that were less connected compared to the networks of children with typically developing vocabularies. More specifically, their networks did not have as much high local structure and global access, the two vital elements of an efficient semantic network. This result supports the idea that the connectivity of a child's semantic network plays a role in their lexical acquisition.

Growth in the semantic network is likely one mechanism children use to increase their depth of word knowledge. In the process of semantic network building, a child learns how a word is related to other entries in their lexicon, encodes the connections between the new word and existing entries, and fits these words together (Wojcik, 2018; Henriksen, 1999). Evidence demonstrates that children do not build these networks through simply hearing, and then storing, words from their environment. Rather, the structure of the child's current semantic network plays a large role not only in what words that child will learn next, but also the ease with which they will learn new words.

For example, one study conducted with 2-year-olds examined how the density of a child's semantic network might affect their word learning (Borovsky, Ellis, Evans, and Elman, 2016). The researchers hypothesized that children would learn words that are connected to dense semantic networks more effectively than words with fewer semantic neighbors, positing that cohesive semantic structure prompts networks to recognize and map similarities from existing nodes onto new words. Using data collected from the MacArthur-Bates Communicative Development Inventories (MCDBI; Fenson, 2007), researchers were able to evaluate how much word knowledge each child had within the following noun categories: animals, clothing, vehicles, body-parts, fruits and drinks. If a child had more knowledge within a certain category than other categories (as measured by the proportion of words they were reported to say), they were considered to have 'high' knowledge for that category. The authors found that children learned novel word meanings more effectively in the semantic categories for which they had more knowledge, indicating that they are harnessing the power of their existing semantic network to learn new vocabulary words. Therefore, when a child is acquiring more and more information about a word (acquiring depth of knowledge), we can posit that their semantic network surrounding that word is in turn becoming denser, creating more connections.

The WOW vocabulary intervention utilizes these findings on growth in a child's semantic network by teaching semantically-related concepts and structures in an attempt to deepen children's understanding of taught words (Neuman et al., 2011; Neuman & Kaefer, 2018; Hadley et al., 2018). These intervention studies connect semantically-related words through taxonomies (Neuman et al., 2011; Neuman & Kaefer, 2018). For instance, in a recent iteration of WOW, Neuman and Kaefer (2018) supported young children's knowledge of science concepts by teaching words like *whale* and *manatee* under the taxonomic category of *marine mammals*.

Principles from the Science of Word Learning: Knowledge Building through Categorization

Teaching vocabulary through taxonomic categories is the second principle from the science of learning that WOW utilizes and is based on work demonstrating the inductive potential of categories (Gelman & Markman, 1986; Gelman & O'Reilly, 1988; Gelman, 2003). That is, once we know that something is an animal, for example, we can induce that it has a heart and a brain. The WOW program takes advantage of children's ability to draw inferences from categories. For example, Neuman and colleagues (2011) taught the category of *tools* to Head Start preschoolers. After the intervention, at post-test, the researchers tested children's ability to generalize their new category knowledge of tools to novel exemplars. Children were presented with an image of a vise (never seen before) and prompted with, "This is a vise, it's a tool. Can you use this to cook things?" Results showed that children who participated in the WOW program, compared to children in a control group, scored significantly higher in using the categories they learned to identify the meaning of new words.

Why might categories, and the inductive potential of categories, be important for increasing children's word knowledge? When it comes to the relationship between language learning and concept building, some researchers proposed the idea that words serve as invitations to form categories and that there's an implicit link between a child's linguistic and conceptual development (Waxman, 2003; Brown, 1956). In fact, using an adult sample, a recent study found that linguistic labels were significantly more potent in influencing participants' ability to categorize objects compared to other cues such as numbers or symbols (Gervits, Johanson, & Papafragou, 2016).

Even before children produce language themselves, linguistic labels assigned to objects support children's repertoire of object categories (Althaus & Westermann, 2016). For example, category labels have been shown to play a constructive role in 10-month-old infants' category formation. A study by Althaus and Westermann (2016) demonstrated that infants who viewed a set of images in silence of a novel animal whose features slightly varied (on a morphed continuum) integrated those features into a single category representation. However, in a different set of infants, when two labels were strategically provided during the viewing of this novel animal, 10-month-olds formed two exclusive categories. This finding indicates that preverbal infants use labels to assist in category formation. Similarly, Nazzi and Gopnik (2001) found that 20-month-old babies can use labels to form novel object categories, even when those objects do not share perceptual similarities (e.g., when a yellow, wooden trapezoid and a silver, metal doorknob are both called a *tib*).

Moreover, labels can give children the ability to identify subordinate individuals (e.g., *oranges, apples, grapes*) within superordinate categories (e.g., *fruit*) (Waxman, 2003). For example, giving distinct objects different labels has been shown to highlight object individuation (Xu, 1999). Children also demonstrate the ability to go beyond mapping a single word to just one individual object and can extend that word systematically to other members of the same category (Waxman & Booth, 2000). Children expect, for example, that count nouns (e.g., a *dog*, a *parrot*) refer to categories of objects (Jaswal & Markman, 2001).

Similarly, there is evidence that information in the form of generic sentences (e.g., "cows have sticky tongues") transmits category, or inductive, knowledge compared to information conveyed in non-generic sentences (e.g., "these cows have sticky tongues") (Cimpian & Markman, 2008). In the former generic statement, *sticky tongues* refers to all cows. Moreover, Hollander, Gelman, & Raman (2009) found evidence in 4- and 5-year-old children that using generic wording when teaching a novel animal (e.g., "Kevtas have two humps") effectively guided their extension of new knowledge to another exemplar compared to the use of non-generic wording (e.g., "This kevta has two humps").

Furthermore, it appears that language facilitates children's categorization not just through basic labeling, but also through the teaching of facts about objects. Johanson and Papafragou (2016) demonstrated that 4-year-old children could use both observable facts (e.g., "this one has a long beak") and unobservable facts (e.g., "this one drinks milk") to correctly categorize perceptually ambiguous natural kinds.

How might children go about using their category knowledge to learn new vocabulary items? The work of Susan Gelman (Gelman & Markman, 1986; Gelman & O'Reilly, 1988; Gelman, 2003) demonstrates that the inductive potential of categories is likely a powerful way to facilitate vocabulary learning. In a study by Gelman and Markman (1986), researchers tested young children's ability to make category-based inductions. The authors presented 4-year-olds with sets of three images, for example, a tropical fish, a dolphin, and a gray shark (a fish). Although the shark and dolphin are similar in appearance, the shark shares category membership with the fish. Children were told, "this fish stays underwater to breathe" and "this dolphin pops above the water to breathe". Researchers then showed children the shark and told them it was a fish. Children were then asked if the shark stayed underwater to breathe like the fish or went above water to breathe like the dolphin. Participants based 68% of their inferences on category membership, despite the perceptual similarity between the shark and dolphin. This percent was significantly above chance.

These findings indicate that young children have the ability to draw novel inferences from one category member to another, based on properties that category members share. Therefore, if children are taught a novel vocabulary word that represents an entire category of objects, the natural inductive potential of categories can help leverage the learning of many other subordinate words in that particular category. This could serve as a powerful tool for children from disadvantaged backgrounds because, when armed with category knowledge, they can utilize the inductive potential of their known categories to learn new words and concepts.

Work has also examined children's ability to make inductive generalizations about novel animals based on either causal cues (e.g., "this spits out goo at animals that try to get it") or on non-causal clues (e.g., "this has blue stripes on the bottom") (Booth, 2014). Booth (2014) found that when causal cues were used, or when conceptual support was provided in the description, those labels were significantly better at helping children generalize their new knowledge compared to when non-causal cues were employed. This indicates that providing children with conceptual information in regards to category knowledge is likely a critical way to promote inductive generalizations in children.

It has also been found that children's ability to use categories to generalize knowledge likely improves as children's semantic knowledge advances (Fisher, Godwin, Matlen, and Unger, 2015; Nazzi & Gopnik, 2001). A study by Fisher and colleagues (2015), for example, attempted to relate category-based induction ability to children's semantic knowledge of animals. To measure children's ability of semantic differentiation, the researchers had participants place animals similar in kind (e.g., *crocodile-alligator, chick-hen, whale-dolphin*) close together and ones that are not similar farther apart on a game board. The researchers also gave children a category-based reasoning task which had children generalize novel property knowledge to new categories (consisting of artifacts, inanimate natural kinds, and animate natural kinds). They found that younger children in their sample had more immature placements on the semantic differentiation task, meaning that they were just as likely to place the alligator as close to a crocodile as to a fish or a grasshopper.

Older children, on the other hand, typically put the alligator closer to a crocodile than to a fish or a grasshopper. This shows that children's semantic differentiation of animals likely increases with development. Moreover, their results showed that for their preschool-aged participants, there was a significant correlation between children's scores on the semantic differentiation task and the category-based reasoning task suggesting that children's ability to generalize based on category knowledge likely emerges as a result of improvement in children's semantic organization. Relatedly, a study by Nazzi and Gopnik (2001) demonstrated that 20-month-old children's name-based categorization ability was significantly correlated with the size of their productive vocabulary. Importantly, this study found that there was no relation between toddlers' vocabulary and their ability to categorize objects based solely on visual similarities. Rather, the correlation existed only for the ability to categorize based on a shared novel label, indicating that a child's vocabulary size likely influences their ability to use language to categorize objects.

Is Language Experience Related to Category Knowledge?

Given the evidence that language appears to be important for building category knowledge (Cimpian & Markman, 2008; Waxman & Markow, 1995; Fisher et al., 2015; Booth, 2014), there is reason to believe that children who are exposed to less language or lower quality language interactions may categorize concepts in their world in a way that is less mature compared to children who experience rich language exposure. Some researchers have formulated the hypothesis that children from disadvantaged backgrounds may not have the richness of category knowledge necessary to successfully learn from taxonomically-organized interventions (Neuman, personal communication, March 21, 2019). Children who come from environments characterized by fewer adult-child interactions and less word exposures on a daily basis (Gilkerson et al. 2017; Golinkoff et al., 2018) may have less opportunity to differentiate their semantic networks through category knowledge.

During parent-child shared book reading, for example, parents pass category knowledge to their children by pointing out taxonomic and thematic relations presented in readings (Gelman et al., 1998). Children who are not often engaging in rich communicative interactions, like shared book reading, could have lexicons that consist of isolated islands of knowledge. Their semantic networks may not be as interconnected as their peers' who live in environments characterized by richer language exchanges.

Might it be beneficial to preface a vocabulary intervention that teaches words through taxonomies with what we term an *advanced organizer*? Before children can be "taught" through a taxonomic approach, or one that differentiates between items that exist *within* a category, it could be advantageous to introduce low-language experience children to the concept that knowledge can be organized and delineated into categories. In other words, this advanced organizer would attempt to teach the concept that new words can be connected to current words and concepts that already exist in the child's semantic network.

The advanced organizer could serve as an opportunity to encourage differentiation of children's semantic networks and set the stage for the teaching of more sophisticated knowledge about one category in particular. For example, in the intervention currently being proposed, the advanced organizer will provide children with a base of connected knowledge of living things, as children's existing semantic networks surrounding the concept of living things (e.g., plants and animals) may not be strongly organized or connected. In existing programs like WOW, researchers teach through taxonomies from the outset of the intervention by having children watch a content video about a prototype of a category. Children are then asked questions such as, "Where does a katydid live?" and "What is an insect?" Moreover, the category of insects gets introduced to children by teaching words like *antennae, wings, katydid,* and *segments.* However, children from environments characterized by limited language exchanges likely do not have a strong, connected base of content knowledge that may be needed to establish connections with novel and arguably difficult concepts. This could be one of the reasons why children in this intervention only learned an average of 4.2 out of 40 words taught per unit. That is, while the effect sizes of this intervention are impressive (*d*'s = 0.44, 0.56, 0.86), the results might not be practically significant.

The advanced organizer in this study is a series of shared book readings that utilize principles derived from the work of Dedre Gentner and colleagues (Gentner, 1983; Gentner & Namy, 1999; Christie & Genter, 2010; Shao & Gentner, 2016). The first principle is the importance of comparison in category learning. Gentner's (1983) *Structure Mapping Theory* reveals how comparison highlights commonalities and differences between representations. For instance, comparing a desk and a chair reveals how they both share of the category of furniture, but serve different functions. The second principle used in the creation of the advanced organizer is the importance of highlighting multiple cases. Gentner and Namy (1999) found that conceptual understanding is enhanced when children are given 2 exemplars, as opposed to 1. They theorize that providing only 1 exemplar may encourage children to solely focus on perceptual similarities. This could discourage children from grasping more meaningful concepts that underlie exemplars.

Finally, Gentner's studies on analogical comparisons always use pictorial supports. Therefore, every example in the advanced organizer contains pictorial representations.

Research Questions and Hypotheses

The current intervention study attempts to lay a base of knowledge for children through an advanced organizer *before* teaching words through a taxonomy so that the taxonomic intervention is more effective. This project is a WOW-inspired, shared book reading intervention for preschoolers from disadvantaged backgrounds and is composed of 2 phases. In phase 1, children are placed into one of two conditions: either in a control group or a group in which they experience the advanced organizer. In phase 2, all children experience shared book reading sessions that teach vocabulary through the taxonomy of fish. There are 3 research questions:

Question 1: Do children who experience the advanced organizer outperform children in the control condition on a measure of categorization ability?

Hypothesis 1: Participants who experience the advanced organizer will outperform participants in the control condition. This is because the advanced organizer should convey the idea that living things (e.g., plants and animals) can be organized into categories.

Question 2: Do children who experience the advanced organizer outperform children in the control condition on a measure of expressive word knowledge?

Hypothesis 2: Participants who experience the advanced organizer will outperform participants in the control condition on a measure of expressive word knowledge. This is because the advanced organizer should help appropriately arrange children's semantic networks and transmit the idea that knowledge is organized into categories. These children should therefore be better prepared to learn advanced vocabulary words through a taxonomy.

We utilize an expressive measure of children's vocabulary knowledge as it captures depth of word knowledge (Hadley et al., 2018; Hadley & Dickinson, 2018). Children are prompted to tell the researchers everything they know about the target vocabulary words in this expressive task. Receptive vocabulary measures are often used in interventions, such as ones that have children point to or label an image a word (Hadley & Dickinson, 2018). However, these receptive measures do not allow for insight into the richness of knowledge a child might have about particular words.

Question 3: Do children who experience the advanced organizer outperform children in the control condition on a measure of induction ability?

Hypothesis 3: Participants who experience the advanced organizer will outperform participants in the control condition on a measure of induction ability. This is, in part, because of Hypothesis 2. If children who experience the advanced organizer gain greater depth of knowledge of target words, then their ability to make inferences and generalizations based on their knowledge of these target words should be heightened compared to children in the control condition.

CHAPTER 2

METHODOLOGY

This dissertation project was a vocabulary intervention for Head Start and Pre-K Counts preschool students. At the start of this study, families who enrolled their children in Head Start could earn up to 100% of the federal poverty level (a gross income of $25,750 for a family of 4 in 2019) (U.S. Department of Health & Human Services, Office of the Assistant Secretary for Planning and Evaluation, 2019). Families who enrolled their children in Pre-K Counts could earn up to 300% of the federal poverty level (a gross income of $77,250 for a family of 4 in 2019) (HHS, ASPE, 2019). Head Start and Pre-K Counts are both free preschool programs for families.

The study is novel as it was the first to lay a base of foundational knowledge in preparation for teaching words through a taxonomy. The intervention used a mixed-effects design, both between- and within-subjects. Half of the study classrooms were randomly assigned to experience the advanced organizer and the other half were assigned to experience a control condition. Learning from pre- to post-test was the within-subjects variable. All experimental protocols in this study were approved by the Temple University Institutional Review Board.

Participants

Before children participated in the study, parents gave consent for their child's participation and video recording. Parents also filled out a questionnaire that gathered information such as maternal and paternal education and home literacy behaviors. A total of 69 typically developing 3-, 4-, and 5-year-old children were originally signed-up for the intervention. Participants who were either given an Individualized Education Plan (IEP), left the school throughout the course of the study, could not be tested at either time point, or were absent for more than half of the intervention sessions were removed. The final sample consisted of 54 participants (*Mean age* = 51.45 months; *SD* = 7.04; 28 females). The sample size was determined for each research question based on power analysis and study design.

Children were from the Head Start and Pre-K Counts programs of the Montgomery County Intermediate Unit (MCIU). The study sample was 33.33% Black or African American, 22.22% Hispanic, 18.52% White Caucasian, 9.26% Asian, 1.85% mixed-race (Black and White), 11.12% identified as "Other", and 3.70% did not to report race and ethnicity information. Many children in the project came from homes in which a language other than English was spoken. However, all children enrolled in the study who spoke a language other than English had been previously deemed English-proficient by school staff members. In order to meet this English-proficient criteria, these children must have been enrolled in the MCIU preschool for at least one year prior to the start of the 2019 school year. Spanish was spoken in the home of 22.22% of children, and a language other than English or Spanish was spoken in the home of 24.05% of participants.

Conditions were assigned at the classroom level. Four classrooms (28 children) experienced the advanced organizer condition and 3 classrooms (26 children) experienced the control condition. All children in the study experienced the phase 2 intervention shared book readings.

Materials

Advanced Organizer Book Readings

Before the target vocabulary items were taught in the intervention, a subset of children experienced the advanced organizer. This was comprised of a series of 6 shared book readings that contained information children were likely already familiar with. However, the advanced organizer stressed the idea that this knowledge can be organized into categories. Specifically, the book readings contained an introduction to the concepts of living things and wild environments (Appendix A). The differences and similarities between various animals and plants were described as well as the environments in which these living things exist. The topic of living things was chosen as the advanced organizer topic most appropriate to preface an intervention surrounding the taxonomy of fish and other aquatic life. We also attempted to connect the content of the advanced organizer to children's lives.

The head researcher crafted 2 books that offered selections from *Creaturepedia* and *Plantopedia* by Adrienne Barman. The books were renamed to *The Exciting World of Animals* and *The Exciting World of Plants.* The order of presentation of these books was counterbalanced by classroom. Book 1 featured comparisons of various plants, the various habitats that plants can inhabit, the different sizes and colors of plants, and the needs of all plants (e.g., water and sunlight). Book 2 featured different types of animals, the habitats these animals live in, the different sizes and movements of animals, and the needs of all animals (e.g., water and food). The research assistant also asked the class questions during these book readings such as, "can you think of some other big animals?", "where have you seen flowers before?", "can we think of some other plants we might eat from a garden?", and "what other animals can we think of that live in a hot place?" The final 2 readings included a discussion of how plants and animals are different and similar to one another (Appendix A). In no part of the advanced organizer was fish or other aquatic life mentioned.

Control Condition Book Readings

To ensure that participants in the control condition received the same amount of researcher attention as participants in the advanced organizer condition, these children were presented with 6 book readings that were unrelated to the content presented in the advanced organizer or the intervention. The presentation of these books was counterbalanced by classroom. These book readings were comprised of 2 narrative books: *Pumpkin Soup* by Helen Cooper and *Pearl's New Skates* by Holly Keller. The researcher shortened the length of each book to ensure that the text length and reading time were roughly equivalent to each other and to the books presented in the advanced organizer. The amount of questions presented in these book readings was equivalent to the amount of questions posed in the advanced organizer readings. Some of these questions included: "what smell is coming from the house?", "why did duck leave?", "what do we think Pearl will use her new gift for?", and "why is Pearl upset?"

Vocabulary Words

The intervention book readings taught 15 words through the taxonomy of fish (see Table 1). This particular taxonomy is akin to the other series of categories taught in previous studies that teach words through taxonomies (e.g., *vegetables, flowers,* *geometric shapes, pets*) (Hadley et al., 2018; Neuman et al., 2011). We were unaware of any previous interventions that taught words through the taxonomic category of fish, however.

As seen in other studies that have taught through taxonomies (Neuman et al., 2011; Hadley et al., 2018), some of these target words were not a member of the taught category, but rather associated words that assist in creating a more comprehensive semantic network (e.g., *scales, fins*) surrounding the category. Four control words were also utilized in this study, but never presented to children. Target and control words were considered difficult for preschool children to ensure they did not learn the words outside the intervention setting. The difficulty of words was verified using Beck, McKeown, and Kucan's (2013) Tier system, Biemiller's (2010) Words Worth Teaching list, and CHILDFreq (MacWhinney, 2014). Many previous intervention studies utilized these criteria (Hadley, Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2016; Toub et al., 2018; Hopkins & Scott et al, in prep). Nouns, adjectives, and verbs were taught.

The Merriam-Webster online dictionary was used to look up definitions for all words. Definitions were then all shortened and modified to be suitable for preschoolers. Each target word was also paired with a gesture that the researcher used and encouraged children to mimic during intervention book readings (Appendix B).

Vocabulary words were presented through the shared book reading of 2 informational texts (*Coral Reefs* by Sylvia Earle and *Wonders of the Sea* by Louis Sabin). Words were split evenly across these 2 texts (8 target words in one book, 7 target words in the other). The particular target words were chosen based on the original text and illustrations of these texts. For example, if the book featured a page about seahorses, this word was verified using our difficulty criteria and then added to the target word list. The text surrounding the target words, though, was typically altered and shortened to accommodate our preschool participants.

Table 1

List of Vocabulary Words

Target Words	Control Words
Carnivorous (adj.)	Armadillo (n.)
Coral (n.)	Develop (v.)
Eel (n.)	Femur (n.)
Enormous (adj.)	Repulsive (adj.)
Fins (n.)	Udder (n.)
Gills (n.)	
Grouper (n.)	
Mackerel (n.)	
Parrotfish (n.)	
Propel (v.)	
Respire (v.)	
Seahorse (n.)	
Seaweed (n.)	
Snorkel (v.)	
Tropical (adj.)	

The book scripts were modeled on a successful vocabulary intervention called the *Language for Reading* project (Hopkins & Scott et al., in prep) which was created in collaboration with education and literacy development experts. The length of the two books was comparable and the order in which the books was read was counterbalanced across classrooms. All target words had equal exposure in the readings.

Words Taught through the Taxonomy of Fish

Target words were related to the category of fish. As seen in other studies that taught vocabulary through taxonomies (Neuman et al., 2011; Hadley et al., 2018), some of the target words were not members of the taught category (e.g., *gills* and *fins*) but rather support words that assist in creating a more comprehensive semantic network surrounding the category. In teaching the target words, the following were highlighted: taxonomy membership, information about how words relate to the larger category, perceptual features, and conceptual and functional information. Word supports such as gestures and illustrations from the book were also used. All target words had equal exposure in the readings. Prior to the reading of each book, the researcher engaged in a picture-card review activity to get the children familiarized with the target words for that day. Colored images of each target word were displayed on 8.5 x 11 cardstock paper and presented while the definition and gesture of a word was reviewed.

Control Words

Control words were only heard during assessment at pre- and post-test and not incorporated into any of the book readings. These words were not related to the category of fish. Control words were used to ensure that children's learning of the target words was due to the effect of the intervention and not simply due to maturation.

Procedure

Table 2 highlights the design and timeline of when the advanced organizer, control condition book readings, and intervention book readings were conducted.

Advanced Organizer Procedure

There were 3 sessions of advanced organizer book readings, each containing 2 book readings per session. There was one session per week. Every classroom heard each book read a total of 3 times. Before the project started, 2 undergraduate research assistants were trained in the book reading procedure. These research assistants proctored every book reading and were blind to study hypotheses. The head researcher was blind to classroom condition assignment and was not present for any of the readings. Teachers stayed in the room while the research assistant read the book and teachers engaged solely in classroom behavior management. Teachers were asked not to provide any assistance during the book readings.

The research assistant read whichever book was assigned for that particular day. Book order was counterbalanced by classroom. For example, one classroom may have received *The Exciting World of Animals* first and then *The Exciting World of Plants* second, while another classroom received *The Exciting World of Plants* first and then *The Exciting World of Animals* second. During each reading session, the research assistant allowed time for children to answer the prescribed questions in the text. All advanced organizer readings took approximately 15 minutes.

Table 2.

Study Design and Timeline

Condition	Week	Activity
Advanced Organizer	1, 2, 3	*The Exciting World of Animals / The Exciting World of Plants*
Control	1, 2, 3	*Pumpkin Soup / Pearl's New Skates*
Advanced Organizer AND Control	4	*Wonders of the Sea*; Read 1 or *Coral Reefs*; Read 1
Advanced Organizer AND Control	5	*Wonders of the Sea*; Read 2 or *Coral Reefs*; Read 2
Advanced Organizer AND Control	6	*Wonders of the Sea*; Read 3 or *Coral Reefs*; Read 3
Advanced Organizer AND Control	7	*Wonders of the Sea*; Read 1 or *Coral Reefs*; Read 1
Advanced Organizer AND Control	8	*Wonders of the Sea*; Read 2 or *Coral Reefs*; Read 2
Advanced Organizer AND Control	9	*Wonders of the Sea*; Read 3 or *Coral Reefs*; Read 3

Note: At week 7, children received their first reading of whichever book was not read in weeks 4 through 6.

Control Condition Procedure

There were 3 sessions of control condition unrelated book readings, each containing 2 book readings per session. Classrooms heard each book read a total of 3 times. The same research assistants that proctored the advanced organizer readings were also trained in and administered the control condition book readings. Teachers were given the same instructions that the teachers in the advanced organizer classrooms received. Book order was counterbalanced by classroom such as that one classroom may have received *Pearl's New Skates* first and then *Pumpkin Soup* second, while another classroom received *Pumpkin Soup* first and then *Pearl's New Skates* second. The research assistant allowed time for children to answer questions posed in the book's text. All control condition book readings took approximately 15 minutes.

Intervention Book Reading Procedure

Children in all classrooms experienced the intervention book readings. These book reading sessions began 5 weeks after the advanced organizer and control condition book readings ended. Children received one book reading a week for 6 weeks. It is important to note that dosages and lengths of vocabulary interventions vary immensely. For instance, some interventions are conducted 5 times per week for anywhere from 2 weeks (Biemiller & Boote, 2006), to 3 weeks (McKeown & Beck, 2014), to 4 weeks (Hargrave & Sénéchal, 2000). Some intervention sessions take place 2 times per week for anywhere from 8 weeks (Lever & Sénéchal, 2011) to 15 weeks (Wasik & Bond, 2001). Hadley and colleagues (2018) conducted their intervention 4 times per week for 2 weeks, while yet another study lasted a total of 20 sessions over 10 weeks (Justice, Meier, & Walpole, 2005).

The length and dosage of the current study is most similar to that of the *Language for Reading* project, a vocabulary intervention that included units comprised of 1 book reading session per week for 4 weeks (in addition to 1 play session per week) (Hopkins & Scott, in prep). In the current project, the preschool classrooms of MCIU had limited availability for our researchers to conduct the intervention. For instance, 2 of the classrooms spent 2 days a week at a local high school engaged in a mentoring program. Moreover, volunteers from throughout the local community read to all the classrooms during numerous points throughout the week. The undergraduate research assistants read to classrooms on Mondays (to 3 classrooms) and Fridays (to 4 classrooms). These classrooms were located within 4 different buildings throughout the county.

It is also crucial to note that the WOW program seen in Neuman and colleagues (2011) was a supplemental curricular intervention implemented daily throughout the entire academic year. We consider this dissertation study "inspired" by the WOW program's use of teaching words through taxonomies. However, WOW includes elements such as videos, problem-solving and journal activities, and take-home information books. The current intervention hones in the on WOW's pedagogical use of teaching through categories.

The presentation of books in the current study was counterbalanced by classroom. Three classrooms received *Coral Reefs* for the first 3 readings and 4 classrooms received *Wonders of the Sea* for the first 3 readings. Trained undergraduate research assistants administered these book reading sessions. To begin each session, the research assistant went through a picture card review activity where she showed children an image of each target word, gestured each word, and encouraged the class to verbally repeat and gesture each word. Then she began the book reading. The sessions were scaffolded to challenge children to provide more information about target words as the intervention progressed.

During the first reading session of a book, when a target word appeared in the text, the research assistant provided the definition of the word and modeled the gesture. She then asked children to repeat the word and the gesture. In the second reading, the research assistant provided the target word's definition and prompted students to provide the word. Then, she reiterated the word to the class, provided the gesture, and asked the class to repeat the word and the gesture. During the final reading of the book, the research assistant provided the target word and prompted children to provide the definition. She then reiterated the word, provided the gesture, and asked the class to repeat the word and gesture.

Testing Procedure

Before students received the advanced organizer or control condition book readings, children's knowledge of target vocabulary items, ability to make inferences based on category knowledge, and categorization ability was measured. In the pre-testing session, children were first given the semantic space task which assesses children's ability to categorize plants and animals. An inferences measure was then proctored, which measures children's ability to make categorical generalizations and inductive inferences. An expressive measure of word knowledge was the final assessment proctored to participants. Children were tested on the 15 target words and the 5 control words. Every child received a sticker for their participation after pre-testing.

After the intervention book readings ended, a post-test was administered to participants. The same measures were given to children in the same order during this session, however, participants were also given the Woodcock-Johnson IV Picture Vocabulary Test (WJ-PVT) (Schrank, Mather, & McGrew, 2014) as the fourth and final assessment. Every child received a sticker for their participation after post-testing.

Assessments

Semantic Space Task

The categorization measure was adapted from a semantic space task previously used in the literature (Fisher, Godwin, Matlen, & Unger, 2015; Vales, States, & Fisher, 2018) and assessed children's ability to categorize plants and animals. Eighteen black and white line drawings printed on 5x5cm cards representing 9 plants and 9 animals were used with a game board that contained a 10x10 grid of 6.3cm squares (See Figure 1, 2). Within the 9 plants, there were 6 flowers (*hibiscus, hydrangea, rose, sunflower, tulip, lily*) and 3 trees (*beech tree, palm tree, fir tree*). Within the 9 animals, there were 6 mammals (*kangaroo, fox, dolphin, camel, rabbit, cow*) and 3 birds (*chickadee, chicken, egret*). Within each of these categories, stimuli were deliberately chosen not to be perceptually similar to each other in order to probe children's ability to categorize based on kind.

Children were told that the goal of the game was to organize the board so that items that are the same kind of thing are placed close together and items that are not the same kind of thing are placed far apart. The researcher demonstrated the task with practice items before children began the task. While the stimuli were unique to this study, the procedure (including the practice items) was taken directly from Vales and colleague's (2018) procedure. However, one caveat must be noted. The researchers in Vales and colleagues (2018) labeled each card as they presented them to participants (e.g., "Here is a *butterfly*"). Instead, the researcher in the current study remained silent during this part and asked children to label the cards after they filled their board. This was to collect data that could be used for future analyses.

After children completed the task, an image of the child's completed board was taken. After the intervention was conducted, a coder used the 10x10 grid as a coordinate plane and coded the coordinates of each card on the game board as seen in Vales and colleagues (2018). Note that in Vales and colleagues (2018) a second coder verified the accuracy of the coordinates, but given the time constraints of the current study, a second coder did not verify the accuracy of coordinates. Then, from those coordinates, a researcher calculated the distance scores for all pairs of items of interest by computing the Euclidian distance between the points specified by the coordinates of each card of a pair. Smaller distance scores represent items that were placed closer together. Same-category items should have smaller distances between them (e.g., 2 cards representing trees) whereas different category items (e.g., 2 cards, one representing a mammal and one representing a flower) should have larger distances between them.

A composite measure of children's scores was created for both pre- and post-test time points. Distances for all same-category items and different-category items were averaged. For each participant, the average of same-category item pairs was subtracted from the average of different category item pairs to create the composite score. A higher score indicates better performance on this measure (e.g., a child who has a larger average for different-category item pairs and a smaller average for same-category item pairs will end up with a high composite score).

Figure 1

Line Drawings Representing Birds, Mammals, Flowers, and Trees

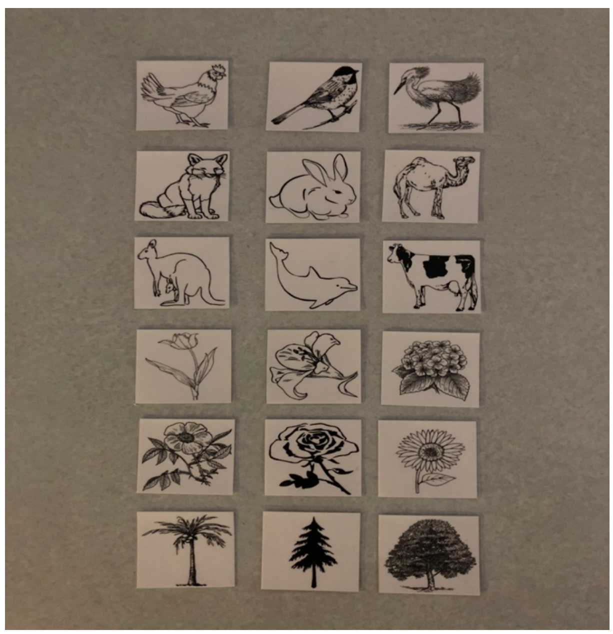
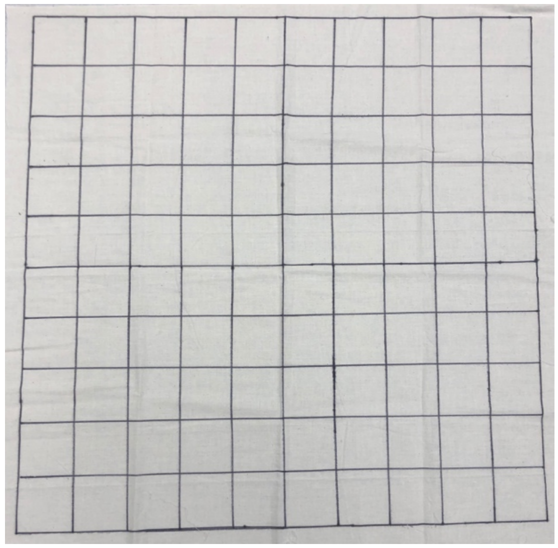


Figure 2

Grid for the Semantic Space Task



Inferences Task

To measure children's ability to make categorical generalizations and inductive inferences based on known concepts applied to novel words, children were given an inferences and generalization task (Neuman et al., 2011). Ten novel vocabulary words (e.g., *lamprey, gurnard, cerianthus*) related to the category of fish were assessed. All of the 10 sea creatures chosen for this task did not look like stereotypical fish in order to encourage children to use their conceptual knowledge of the category and not rely on the perceptual cues of the animal.

Half of these objects were appropriate to the object's category and half were not. For example, children were shown an image of a turbot and asked, "This is a *turbot*, it's a kind of fish. Does a *turbot* move its head above water to breathe?" At post-test, children should have been able to use their newly learned category knowledge of fish to appropriately answer the questions. Correct responses on this measure were tallied and a total score for each child was given. Responses were tallied by a trained undergraduate research assistant. A total score of 10 was possible on this measure.

Expressive Measure of Vocabulary Knowledge

An expressive measure of target and control word knowledge was assessed using the New Word Definition Task-Modified (Hadley et al., 2018). This is considered to be a measure of depth of word knowledge (Hadley & Dickinson, 2018). In this measure, children are asked to say everything they know about the word they are verbally prompted with. For each word, the child is asked, "What is (a) ___?" and then the follow-up question, "Can you show me or tell me anything else about ___ ?" Children's responses were coded and the types of information units children provided were coded for category information, perceptual qualities, object function information, part/whole, synonyms, gestures, meaningful context, and basic context.

Each information unit was worth 1 point except for basic context, which was only worth 0.5 points. The first four coding categories were used for nouns only. This measure was coded by a master coder and trained research assistants. Coders' reliability was assessed for this measure. Twenty percent of the expressive tests were randomly selected and checked for reliability against a master coder after every four tests were coded. The coder was not allowed to continue coding without further training if reliability fell under 90%. Overall percentage agreement averaged 95%.

Woodcock-Johnson IV Picture Vocabulary Test (WJ-PVT)

To assess generalized vocabulary knowledge, children were given the *Woodcock-Johnson IV Picture Vocabulary Test* (Schrank et al., 2014). This assessment prompts children to verbally label items that the researcher points to. The difficulty level of words tested increases as children go through the measure. The *Woodcock-Johnson IV Picture Vocabulary Test* is demonstrated to be highly correlated other measures of oral language ability (e.g., with the *Peabody Picture Vocabulary Test-Fourth Edition* (Dunn & Dunn, 2007)), demonstrating its validity (Schrank et al., 2014). Moreover, the assessment is reliable, with reported levels of .89 and higher (Schrank et al., 2014). This measure will be referred to as the WJ-PVT from this point forward.

The WJ-PVT was utilized because were interested in using children's general vocabulary knowledge as a covariate in our analyses. While the WJ-PVT was administered at post-test, our team had originally planned to give this measure in the middle of the intervention in an effort to avoid over-testing at both pre- and post-test time points. However, during the course of the intervention, both undergraduate research assistants were conducting the shared book readings 2 days a week and did not have more time to dedicate to testing. Therefore, we proctored the WJ-PVT at post-test on the assumption that scores on this generalized language measure were unlikely to change over the course of this brief study. Moreover, in WOW, Neuman and colleagues (2011) found no change in children's WJ-PVT scores over the course of the academic year. This result gave us confidence in utilizing WJ-PVT as a covariate, even though it was given at the end of the study. Note that we report children's raw WJ-PVT scores.

Data Analysis

A 2x2 mixed-model, repeated measures multivariate analysis of covariance (MANCOVA) was run to analyze children's scores on the measure of expressive word knowledge, semantic space task, and inferences task. The between-subjects variable was condition (advanced organizer vs. control condition) and the within-subjects variable was time (pre- vs. post-test). MANCOVA was used in order to control for covariates. WJ-PVT was used a covariate to ensure that our findings were not simply due to the effect of general language ability. Age was used as a covariate because we had children 3- through 5-years-old in the study, and therefore needed to control for age. Finally, the effect of classroom was examined before the full model was run. Since classroom and condition are confounding variables, a repeated-measures ANCOVA was implemented to ensure there were no classroom differences in learning before running the MANCOVA.

CHAPTER 3

RESULTS

Before the data was analyzed, it was coded by the head researcher and two undergraduate research assistants who were blind to study hypotheses. Information about the coding process for the measures is highlighted in the Assessments section of Chapter 2. The results are framed around the three hypotheses of this dissertation study. We hypothesized that children who experienced the advanced organizer prior to beginning the intervention would outperform children who received control condition book readings prior to starting the intervention on 3 measures: 1) a semantic space task which assessed participants' ability to categorize living things, 2) an expressive measure of target word knowledge, and 3) a measure of induction ability which assessed children's ability to make inferences based on knowledge of the category of fish.

Table 3 provides the descriptive statistics of the full sample. Table 4 provides bivariate correlations between study variables and Table 5 shows the partial correlations between variables.

Table 3.

Full Sample Descriptive Statistics

Measure	Pre-Test Mean	Post-Test Mean
Expressive, AO	1.92 (3.76)	8.36 (7.53)
Expressive, C	2.88 (4.18)	12.46 (8.56)
Inferences, AO	5.20 (1.14)	5.50 (1.22)
Inferences, C	5.31 (.97)	5.50 (1.45)
SST, AO	1.08 (1.67)	2.41 (2.90)
SST, C	1.27 (1.84)	2.22 (3.16)
WJ-PVT, AO (one time point)		18.57 (3.18)
WJ-PVT, C (one time point)		18.73 (2.74)
Age at pre-test, AO	51.45 mos. (7.04)	
Age at pre-test, C	51.60 mos. (6.76)	

Note: Standard deviations are in parentheses. AO = Children who were in the advanced organizer condition. C = Children in the control condition. SST = Semantic space task. N = 54.

Table 4.

Bivariate Correlations between Outcome Variables and Covariates

Variable	1	2	3	4	5	6	7	8	9
1. Age	-	.02	.41**	.17	.32*	.09	-.12	.27*	-.22
2. Condition		-	-.05	-.16	-.25	-.09	.00	-.11	.06
3. WJ-PVT			-	.36**	.47**	.05	-.17	.24	-.27*
4. Exp_Pre				-	.55**	-.10	.06	.03	-.08
5. Exp_Post					-	-.09	-.08	.24	-.29*
6. Inf_Pre						-	-.09	-.01	-.11
7. Inf_Post							-	-.02	.03
8. SST_Pre								-	-.88**
9. SST_Post									-

Note: WJ-PVT = Woodcock-Johnson Picture Vocabulary Test, Exp_Pre = Expressive pre-test score, Exp_Post = Expressive post-test score, Inf_Pre = Inference pre-test score, Inf_Post = Inference post-test score, SST_Pre = Semantic Space Task pre-test score, SST_Post = Semantic Space Task post-test score. **p* < .05. ** *p* < .01.

Table 5.

Partial Correlations between Variables

Variable	1	2	3	4	5	6	7
1. Condition	-	-.11	-.26	-.09	-.01	-.10	.05
2. Exp_Pre		-	.50	-.12	.13	-.07	.03
3. Exp_Post			-	-.14	.01	.12	-.17
4. Inf_Pre				-	-.08	-.03	-.09
5. Inf_Post					-	.03	-.03
6. Comp_Pre						-	-.88
7. Comp_Post							-

Note: Partial correlations with Age and WJ-PVT as covariates are presented. WJ-PVT = Woodcock-Johnson Picture Vocabulary Test, Exp_Pre = Expressive pre-test score, Exp_Post = Expressive post-test score, Inf_Pre = Inference pre-test score, Inf_Post = Inference post-test score, SST_Pre = Semantic Space Task pre-test score, SST_Post = Semantic Space Task post-test score. *$p < .05$. ** $p < .01$.

Before we ran our proposed MANCOVA analysis, we examined any possible age or WJ-PVT differences between the two conditions. The covariate of age did not differ between children in the two conditions in this study ($t(52) = .15$, $p = .89$). WJ-PVT scores did not differ between the two conditions, either ($t(52) = .35$, $p = .73$). Next, we wanted to examine if there were any WJ-PVT or age differences between the classrooms. There was no age difference between the classrooms ($F(6,47) = 1.68$, $p = .15$), however there was a significant difference in WJ-PVT scores ($F(6,47) = 2.78$, $p = .02$). Therefore, we ran an ANCOVA, controlling for WJ-PVT and age, to determine if there were classroom differences on any of the outcome measures. This repeated-measures ANCOVA indicated no significant classroom differences in learning on any of the tasks (expressive: $F(6,45) = .99$, $p = .45$; inferences: $F(6,45) = .19$, $p = .98$; semantic space task: $F(6,45) = 1.85$, $p = .11$). There were also no condition differences on any of the pre-test measures (expressive: $t(52) = .89$, $p = .38$; inferences: $t(52) = .64$, $p = .52$; semantic space task: $t(52) = .79$, $p = .44$).

We also ensured that the data met the assumptions for a MANCOVA analysis. The data met the requirements for homogeneity of variances and normality. It is important to note, though, that the skewness and kurtosis statistics for the expressive pre-test scores were high (2.53 and 6.75, respectively). This is because a majority of children scored a 0 on this measure, indicating they had no knowledge of the target words before the intervention began. Removing the 10 scores that SPSS considered outliers (scores above 5 points) created a normal distribution for this measure. However, the data were run with both the outliers included and excluded from the data set and the results did not significantly change the results of the planned analyses. Therefore, we kept those 10 data points in the pre-test expressive scores data set to preserve power.

We used the standard 1.5 x IQR rule for discerning outliers, which utilizes the interquartile range of data. For each measure, the interquartile range was calculated and then multiplied by the constant to detect outliers, 1.5. This value was then added to the third quartile and subtracted from the first quartile to retrieve any outliers found. Using this method, there were no outliers found in the expressive post-test scores or inferences post-test scores. One outlier was detected in the inferences pre-test scores, however, removing this outlier did not significantly change the results of the planned analyses. Therefore it was kept in the data. There was one data point in both the semantic space task pre- and post-test scores that was an outlier and did change the results of the planned analyses. Therefore, it was removed from the data set.

To assess each of the 3 research questions in one model, a 2x2 mixed-model repeated measures MANCOVA was run. This analysis allowed us to examine the main effect of time (learning from pre- to post-test), the effect of condition (do children in the advanced organizer do better on the 3 outcome measures compared to children in the control condition?), and to see any potential impacts of the covariates of WJ-PVT and children's age. Table 6 outlines estimated marginal means and standard errors for the outcome measures stemming from the MANCOVA. The results are presented in order of the research questions.

Table 6.

Estimated Marginal Means and Standard Errors

Measure	Pre-Test Score EMMs	Post-Test Score EMMs
Expressive, AO	1.99 (.71)	8.53 (1.35)
Expressive, C	2.82 (.74)	12.28 (1.40)
Inferences, AO	5.11 (.22)	5.49 (.24)
Inferences, C	5.31 (.23)	5.51 (.24)
SST, AO	.93 (.31)	2.55 (.54)
SST, C	1.25 (.32)	2.26 (.56)

Note: Standard errors are in parentheses. AO = Children who were in the advanced organizer condition. C = Children in the control condition. SST = Semantic space task.

Research Question 1

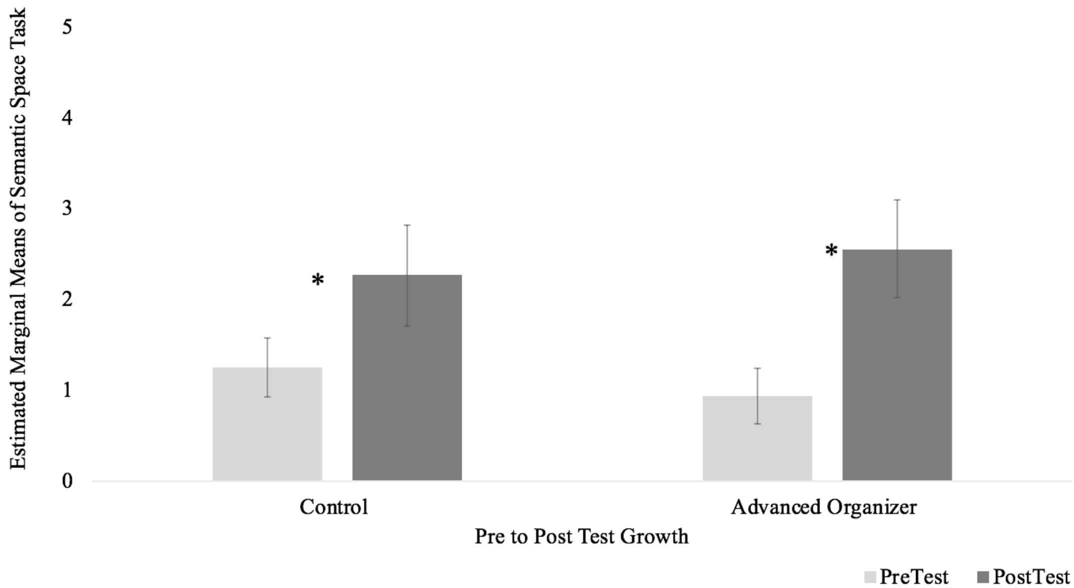
Our first question asked: Do children who experience the advanced organizer outperform children in the control condition on a measure of categorization ability (the semantic space task)? We expected that children who got the advanced organizer prior to the intervention would do better on this task as the advanced organizer should convey the idea that living things (e.g., plants and animals) can be organized into categories.

The MANCOVA revealed a significant main effect of time (pre- to post-test growth) on the semantic space task measure ($F(1,50) = 5.91$, $p = .02$, $\eta_p^2 = .12$) (Figure 3), indicating that regardless of condition, children made significant gains from pre- to post-test. There was no interaction between time and age ($F(1,50) = 1.20$, $p = .28$ $\eta_p^2 = .02$) or between time and WJ-PVT score ($F(1,50) = 1.75$, $p = .19$, $\eta_p^2 = .03$). Finally, there was no significant interaction between time and condition ($F(1,50) = .26$, $p = .61$, $\eta_p^2 = .01$), indicating that children in the advanced organizer condition did not outperform control condition children on the semantic space task measure.

To probe the main effect of time on children's semantic space task score growth, a linear regression was conducted. The variables of condition, WJ-PVT score, semantic space task pre-test score, and a condition by WJ-PVT score interaction were used as predictors. Only children's semantic space task pre-test score was a significant predictor of post-test score ($B = -1.50$, $t(53) = -11.70$, $p = .00$).

Figure 3.

Growth from Pre- to Post-Test on the Semantic Space Task



Note: Children in both conditions grew significantly from pre- to post-test. There was no condition difference on this measure. *p < .01.

Research Question 2

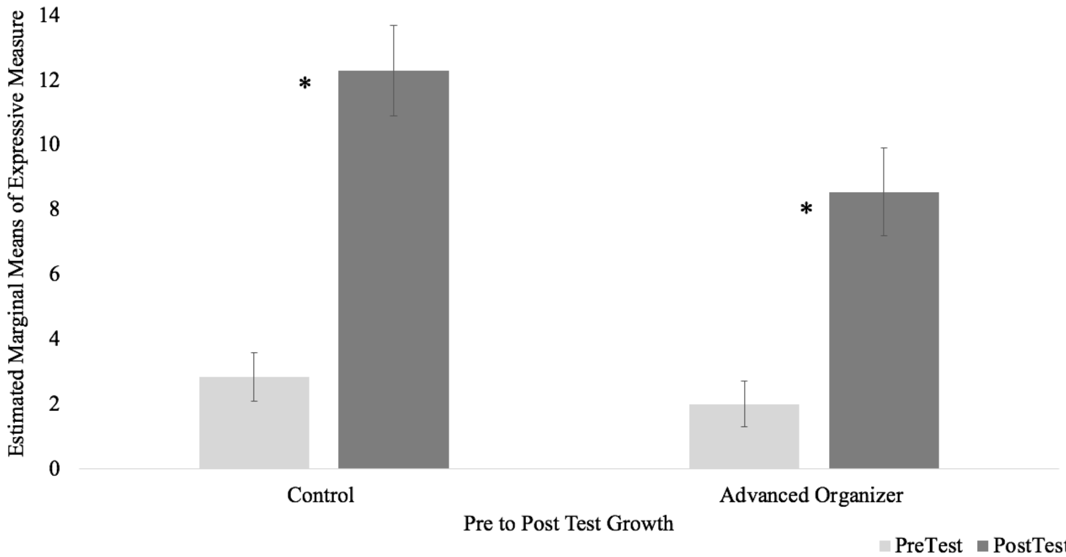
Our second research question was: Do children who experience the advanced organizer outperform children in the control condition on a measure of expressive word knowledge? We hypothesized that since the advanced organizer should transmit the idea that knowledge can be organized into categories, children who experience this condition (compared to those in the control condition) should be better prepared to learn advanced vocabulary words through a taxonomy. The MANCOVA revealed no significant main effect of time on the expressive measure ($F(1,50) = 2.64$, $p = .11$, $\eta_p^2 = .05$). However, a pairwise comparison of the pre- to post-test estimated marginal means revealed that children gained a significant amount of expressive knowledge throughout the course of the study ($p < .01$). Therefore, regardless of condition, children improved on this measure (Figure 4).

The analysis also revealed that there was no time by age interaction ($F(1,50) = 1.40$, $p = .24$, $\eta_p^2 = .03$). There was also no significant time by condition interaction ($F(1,50) = 2.97$, $p = .09$, $\eta_p^2 = .06$), demonstrating that children in the advanced organizer condition did not outperform those in the control condition on this measure. There was, however, a significant time by WJ-PVT interaction ($F(1,50) = 4.04$, $p = .05$, $\eta_p^2 = .08$). To probe this interaction, a linear regression controlling for age, condition, and expressive pre-test score was run. This analysis showed that WJ-PVT score significantly predicted children's expressive post-test score ($B = .24$, $t(53) = 1.98$, $p = .05$).

This finding indicates that children with higher generalized vocabulary ability scored higher on the expressive measure of target word knowledge at post-test. However, a regression also showed that the *interaction* between condition and WJ-PVT score did not significantly predict children's expressive post-test scores ($B = -.18$, $t(53) = -1.64$, $p = .11$), meaning that it wasn't children in the advanced organizer condition (or the control condition) with better general vocabulary ability that scored higher at post-test.

Figure 4.

Growth from Pre- to Post-Test on the Expressive Measure



Note: Children in both conditions grew significantly from pre- to post-test. There was no significant effect of condition. *$p < .01$.

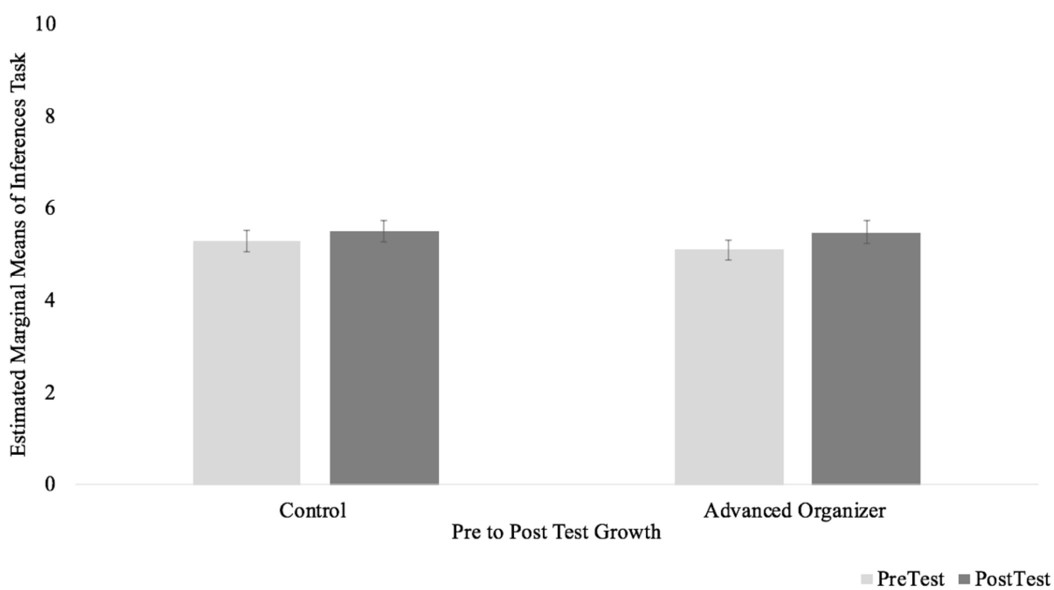
Research Question 3

Our final research question asked: Do children who experience the advanced organizer outperform children in the control condition on a measure of induction ability? We hypothesized that children who experienced the advanced organizer before the intervention book readings would gain greater depth of word knowledge (as seen in research question 2). Therefore, their ability to make inferences and generalizations based on their knowledge of the target words should be heightened compared to children in the control condition.

The MANCOVA revealed that there was no significant main effect of time ($F(1,50) = 1.76$, $p = .19$, $\eta_p^2 = .03$), meaning that regardless of condition, children did not make significant gains from pre- to post-test on this outcome measure. There was no time by age interaction ($F(1,50) = .39$, $p = .53$, $\eta_p^2 = .01$) and no time by WJ-PVT interaction ($F(1,50) = .47$, $p = .50$, $\eta_p^2 = .01$). The analysis also showed that there was no time by condition interaction ($F(1,50) = .13$, $p = .72$, $\eta_p^2 < .01$) (Figure 5), indicating that children in the advanced organizer condition did not outperform children in the control condition on this measure.

Figure 5.

Growth from Pre- to Post-test on the Inferences Measure



Note: There is no significant effect of time or condition.

Exploratory Analyses

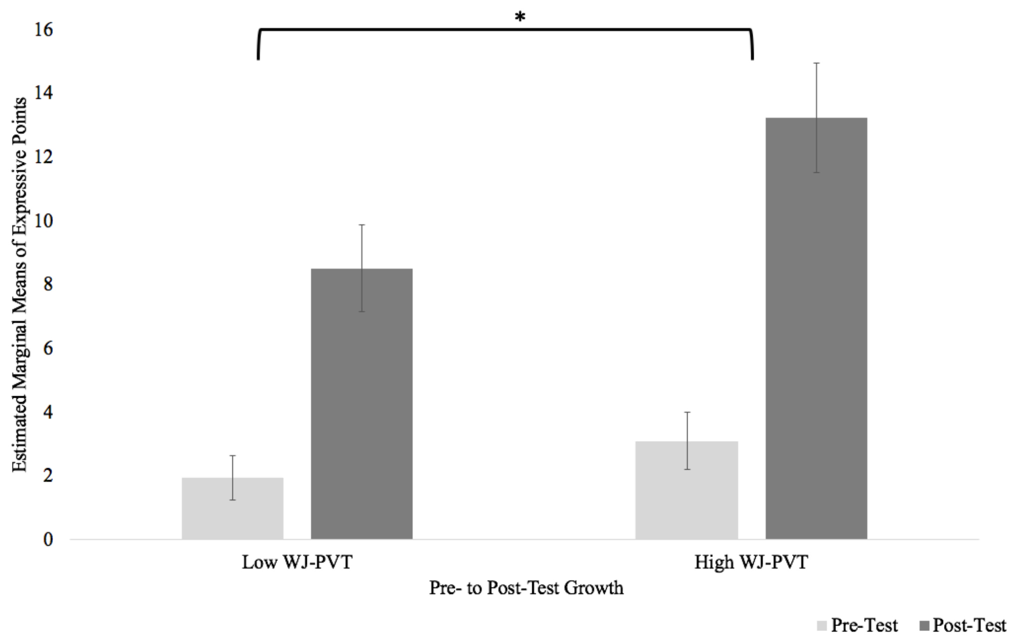
After conducting the preplanned MANCOVA, we were interested in examining how much of the variance the covariates accounted for in the model. Step-wise regressions were run with condition entered as the first step, WJ-PVT score entered as the second step, and age entered as the final step. Condition nor age accounted for any significant portion of the variance on any of the outcome measures, at pre- or post-test. WJ-PVT score did not account for a significant portion of the variance for the inferences measure nor the semantic space task, at pre- or post-test. However, WJ-PVT score did account for 11% of the variance in children's expressive pre-test scores ($t(53) = 2.72$, $p = .01$) and 24% of the variance in expressive post-test scores ($t(53) = 3.80$, $p < .01$).

To further explore the effect of WJ-PVT score on children's learning in this study, we conducted a median-split of WJ-PVT scores. This allowed us to see how children with high and low generalized vocabulary knowledge performed on our measures. WJ-PVT score became a dichotomous variable and was entered into the MANCOVA (with age still entered as a covariate). This analysis revealed no interaction between time and WJ-PVT group for the inferences or the semantic space task measures.

However, there was a marginally significant time by WJ-PVT group interaction for the expressive outcome ($F(1,51) = 3.70$, $p = .06$, $\eta_p^2 = .07$). Children in the high WJ-PVT group gained an average of 10.21 expressive points from pre- to post-test, while children in the low scoring WJ-PVT group gained an average of 6.56 points (Figure 6). This finding indicates that children with higher general vocabulary ability gained more target word knowledge compared to children with less general vocabulary ability.

Figure 6.

Children's Gains on the Expressive Measure by WJ-PVT Group



Note: Children in the high WJ-PVT had a mean pre-test score of 3.09 points (*SE* = .89) and a mean post-test score of 13.22 (*SE* = 1.72). Children in the low WJ-PVT group had a mean pre-test score of 1.94 points (*SE* = .70) and a mean post-test score of 8.50 points (*SE* = 1.36). Children in the high WJ-PVT group gained marginally significantly more expressive points on this measure compared to the low WJ-PVT group. **p* =.06.

To investigate the effects of the intervention without the covariates in the model, further post-hoc exploratory analyses were conducted. Dropping WJ-PVT scores, specifically, allowed us to examine the study outcomes without the variance of this generalized language measure impacting the model. A 2x2 repeated measures MANOVA was run which allowed us to assess the impact of condition for all 3 outcome measures, without the covariates in the model.

Exploratory Analyses on the Semantic Space Task

Seventeen out of the 26 participants in the control group improved from pre- to post-test on the SST measure (65%). Twenty out of the 28 children who got the advanced organizer grew on this measure (71%). Participants in the control group gained an average of .95 points on the semantic space task from pre- to post, while children in the advanced organizer condition gained an average of 1.33 points. However, results from the exploratory analyses went on to reveal that this difference was not significant.

The MANOVA revealed a significant main effect of time ($F(1,52) = 4.67$, $p = .04$, $\eta_p^2 = .08$), as did the previous MANCOVA we ran. This showed that regardless of condition, children gained significantly from pre- to post-test on their ability to categorize living things. However, the analysis demonstrated that there was no time by condition interaction ($F(1,52) = .35$, $p = .56$, $\eta_p^2 = .01$). Therefore, children in the advanced organizer condition did not outperform children who received the control condition book readings.

The exploratory MANOVA also revealed there was no effect of gender on gains in this task ($F(1,50) = .04$, $p = .84$, $\eta_p^2 < .01$). There was also no effect of language status (monolingual vs. bilingual speaker) on children's growth in categorization ability ($F(1,50) = .04$, $p = .84$, $\eta_p^2 < .01$).

Exploratory Analyses on the Expressive Measure of Target Word Knowledge

Twenty-four out of the 26 children in the control group improved from pre- to post-test (92%), while 20 out of the 28 children in the advanced organizer improved over time (71%). Children in the control condition gained an average of 9.58 points and those in the advanced organizer gained an average of 6.44 points. Our exploratory analysis went on to reveal that this condition difference was marginally significant. This finding is in opposition to our hypothesis.

The MANOVA revealed a significant main effect of time ($F(1,52) = 78.59$, $p = .00$, $\eta_p^2 = .60$) and a marginally significant condition by time interaction ($F(1,52) = 3.04$, $p = .09$, $\eta_p^2 = .06$). This interaction indicates that children in the control condition gained marginally significantly more target word expressive knowledge compared to children who experienced the advanced organizer. The exploratory MANOVA also revealed there was no effect of gender ($F(1,50) = .01$, $p = .94$, $\eta_p^2 = .00$) nor language status ($F(1,50) = .00$, $p = .99$, $\eta_p^2 = .00$) on expressive target word knowledge gains.

Exploratory Analyses on the Inferences Task

Ten out of 26 children in the control group improved on the inferences measure (38%), while 17 out of the 28 children who experienced the advanced organizer improved on the task (61%). Children in the control condition gained an average of .19 points from pre- to post-test, while children in the advanced organizer condition gained an average of .30 points. The exploratory analysis revealed that this difference was not significant, though.

Results from the MANOVA showed that there was no main effect of time ($F(1,52) = 1.49$, $p = .23$, $\eta_p^2 = .03$) and no time by condition interaction ($F(1,52) = .18$, $p = .68$, $\eta_p^2 < .01$). This means that regardless of condition, children did not make significant gains in their ability to make inferences from pre- to post-test, and children in the advanced organizer condition did not outperform children in control condition on this measure. Results from the analysis also showed there were no gender differences on gains on the inferences measure ($F(1,50) = .00$, $p = 1.00$, $\eta_p^2 < .01$). There was also no effect of language status on gains made on this measure ($F(1,50) = 2.72$, $p = .11$, $\eta_p^2 = .05$).

Performance on Target vs. Control Words

At the expressive pre-test, no participants scored points on any of the 5 control words. Children scored an average of 2.97 points at pre-test on the 15 target words. Participants scored significantly more points on target words at post-test (an average of 10.13 points) compared to the control words (an average of 0.05 points) ($t(59) = 10.49$, $p < .001$).

CHAPTER 4

DISCUSSION

Vocabulary knowledge is essential for children's reading success (O'Reilly et al., 2019; Schneider et al., 1989; Dickinson & Porche, 2011). Literacy researchers often try to bolster the vocabulary ability of children from disadvantaged backgrounds through the use of various pedagogical methods. More specifically, many attempt to increase children's depth or richness of word knowledge (Beck & McKeown, 2007; McKeown & Beck, 2014; Neuman et al., 2011; Hadley, 2017), as this aspect of vocabulary is a crucial predictor of reading ability (Ouellette, 2006). Recent work, however, shows that these interventions haven't made robust progress in increasing children's outcomes (Wasik et al., 2016; Dickinson et al., 2011).

Some researchers recommend that interventionists use findings from the behavioral science of word learning to craft vocabulary interventions (Hassinger-Das et al., 2017). The *World of Words* (WOW) study (Neuman et al., 2011; Neuman & Kaefer, 2018) is one project that does just that. WOW recognizes that rich semantic knowledge can be built through *semantic networking* and through *category formation*. These principles are in line with how children acquire language, yet, learning outcomes have not been impressive. This dissertation study attempted to improve the methodologies and outcomes of an intervention that utilizes these two tenets. Specifically, we studied the impact of an advanced organizer, or a foundation upon which participants could later build richly-connected word knowledge.

We hypothesized that children who received this advanced organizer prior to receiving a series of book readings that taught words through a taxonomy, compared to a control group, would demonstrate enhanced gains on three outcome measures: a semantic space task, an expressive measure of target word knowledge, and an inferences task. Our hypotheses were not confirmed. Our participants who received the advanced organizer did not outperform those in the control group on their ability to categorize living things, on their gains in expressive target word knowledge, nor in their ability to make inferences based on categorical knowledge.

Ultimately, this study lacked the intensity of dosage and length of treatment that might be required to make the intervention successful. Both the advanced organizer and control condition took place over the course of 3 weeks, with 2 book readings occurring during 1 day per week. While an advanced organizer has not been attempted in previous studies, any future pedagogical approach that attempts to lay a foundation of categorical knowledge prior to a vocabulary intervention likely needs to be stronger. Moreover, children in both conditions experienced 6 weeks of the book reading intervention that taught words through the taxonomy of fish. In contrast, the WOW intervention takes place over the course of an academic year and incorporates many more components such as post-reading activities, videos, journaling, and take-home information texts. Additionally, a majority of vocabulary interventions are longer than 6 weeks and engage with children more than 1 day per week. Therefore, it is possible that the portion of the intervention that taught words through a taxonomy was also lacking in strength.

Below, we break down the discussion of findings by each of the 3 research questions and highlight a few unexpected findings that our analyses revealed.

Research Question 1: Do children who experience the advanced organizer outperform children in the control condition on a measure of categorization ability as demonstrated on the semantic space task?

We hypothesized that children who received the advanced organizer would outperform children in the control condition as the advanced organizer should convey that living things (e.g., plants and animals) can be organized into categories. Results from the MANCOVA showed that this hypothesis was not supported, with no time (pre- to post-test) by condition interaction found. However, both the MANCOVA and exploratory MANOVA indicated a significant effect of time, revealing that regardless of condition, children performed significantly better at this task at post-test compared to pre-test. This implies that children's categorization ability improved over time. This may simply be due to children's maturation over the course of the school year.

Oddly, semantic space task pre-test score was negatively correlated with semantic space task post-test score. While 37 out of the 54 children improved from pre- to post-test on this measure, there were 16 who performed worse at post-test (1 child performed the same). This likely explains the negative correlation found. Moreover, a negative correlation existed between children's semantic space task post-score and expressive post-test score (and WJ-PVT score). These findings suggest that the semantic space task measure may not be the most appropriate way to examine preschooler's categorization ability. Indeed, in their study of children's categorization ability using the semantic space task, Fisher and colleagues (2015) tested preschoolers, kindergarteners, and first-graders. They found that half of their preschool sample had composite scores equal or lower than

1, showing that little to no differentiation between same- or different-category items took place.

This could be what occurred in our sample as well. However, we collected pilot data on this semantic space task with preschool-aged children in our laboratory prior to the start of the intervention. This pilot data revealed that children were appropriately discriminating between same- and different-category items. Moreover, at pre-test, while many participants showed room for improvement on the task, there was no indication that the children in our intervention did not understand the goal of the task. It is possible, though, that this particular semantic space task may not be a suitable method of capturing children's bourgeoning, but fragile, semantic space and categorization ability.

Fisher and colleagues (2015) note the possibility that instead of placing items of like kind together (e.g., putting all the flowers next to each other), children may use thematic relations to organize their boards. For instance, they may place animals that belong in the same habitat together (e.g., placing the birds next to the trees). In fact, there is evidence to support this notion. In a semantic fluency task where children were asked to free list animals, Crowe and Prescott (2003) found that all participants in their sample clustered their responses by habitat.

While we instructed the children in this study to place all the items that were alike close together and items that were not alike farther apart, the real purpose of this study was not to explore the various types of relations children could be using to categorize their boards. Rather, the goal was to assess if children could categorize based on like and different kinds. The next step with this data set is to code each child's grid to determine if thematic relations may have been a grouping heuristic. Since we videotaped children completing the semantic space task and took photographs of their completed boards, we can examine this possibility. Additionally, if this task is used in the future with children in this young age group, it would likely be beneficial to add a component where children practice the task before completing the "real" board. This would help ensure that children understand the goal of the semantic space task.

Research Question 2: Do children who experience the advanced organizer outperform children in the control condition on a measure of expressive word knowledge?

We predicted that children who got the advanced organizer would outperform children in the control condition on the measure of target vocabulary word knowledge. The advanced organizer was intended to bolster children's category knowledge, and thus, these participants should have been better prepared to learn vocabulary items through a taxonomy. Results from the MANCOVA revealed that there were no significant condition differences on expressive word learning and no main effect of time. However, the exploratory MANOVA showed a significant main effect of time, meaning that regardless of condition, children offered significantly more information on the expressive post-test compared to at pre-test. Additionally, this analysis revealed a marginally significant condition difference in learning gains: children in the control condition gained an average of 9.58 points while children who got the advanced organizer only gained an average of 6.44 points. This result did not support our hypothesis.

The finding that children in the control condition gained more target word knowledge than children who experienced the advanced organizer allows us to draw a few possible conclusions. The first is that the advanced organizer simply did not foster children's categorical knowledge of living things, and therefore did not bolster their ability to gain deeper knowledge of words in the intervention. However, it's important to recognize that the sessions of the advanced organizer only lasted 3 weeks and were one day per week (2 readings in one session). This was due to certain constraints of the study.

The head researcher needed to stay blind to condition, therefore, the trained undergraduate research assistants had the responsibility of reading to the participants. These research assistants were only available to travel to the 7 classrooms (located in different 4 communities) 2 days per week. It was crucial that we asked teachers if their students were accustomed to receiving more than 1 book reading in a single sitting. Many teachers reported often reading 2 books to children during classroom story-time. Therefore, our team decided to move ahead with 2 advanced organizer readings per session. Moreover, the advanced organizer took place in the weeks preceding a 4-week winter break for the research assistants. It did not seem ideal to have a 4-week break in the delivery of the advanced organizer. We therefore thought it prudent to finish the advanced organizer before winter break began for the preschoolers. While there is no precedent in the literature for how long an advanced organizer needs to be, it is quite likely that there needed to be more sessions of the advanced organizer to detect its impact.

It is also important to note that a significant time by WJ-PVT interaction existed, with a regression revealing that general vocabulary ability significantly predicted children's expressive post-test score. To probe this interaction, we broke WJ-PVT scores into 2 groups (participants with low general vocabulary ability and those with high vocabulary ability). Results showed that children in the high scoring group gained marginally significantly more points (p = .06) on the expressive test compared to the low scoring group. This finding indicates that children with higher vocabulary skill tended to learn more about words that the intervention taught. This is often referred to as the Matthew effect (Stanovich, 1986); however, this effect must be interpreted with caution as the analysis did not reach full significance.

Research Question 3: Do children who experience the advanced organizer outperform children in the control condition on a measure of induction ability?

We hypothesized that children who experienced the advanced organizer would outperform children in the control condition on the measure of induction ability because they should have acquired deeper target word knowledge. Therefore, their ability to make inferences based on their knowledge of the target words should have been enhanced compared to children who experienced the control condition. Results from the MANCOVA showed that children did not perform better from pre- to post-test on this outcome, nor did performance differ by condition. The exploratory MANOVA revealed the same outcome.

Not only did the analyses not support our hypothesis, but the finding that children's ability to make inferences based on their knowledge of fish *did not* improve over time was striking. All children in the study, regardless of condition, received 6 weeks of intervention book readings that taught words through the taxonomy of fish. Therefore, in theory, children's ability to make inferences should have significantly improved. Indeed, research demonstrates that preschool-aged children have the ability to make category-based inductions (Gelman and Markman, 1986; Neuman et al., 2011).

For instance, in the WOW vocabulary intervention, Neuman and colleagues (2011) taught the category of *tools* to Head Start preschoolers. After the intervention, at post-test, the researchers tested children's ability to generalize their new category knowledge of tools to novel exemplars. Participants who experienced the WOW program, compared to children in a control group, scored significantly higher in using the category they learned to identify the meaning of new words. This result may be due to the fact that the teachers in WOW engaged students in a "sorting" task that encouraged children to think about what may or may not constitute category membership (e.g., asking participants if a bat is an insect).

It is important to highlight, though, the features of the inferences measure - both in this dissertation study and in the WOW intervention. In the current study, there were a total of 10 yes/no questions on this measure, therefore, children who received a score of 5 performed at chance. At pre-test, children in advanced organizer condition averaged a score of 5.20 and children in the control condition average a score of 5.31. Children in both conditions had an average post-test score of 5.50. In their intervention, Neuman and colleagues (2011) used the inferences task only at post-test and gave children 6 yes/no questions. They reported that children in the treatment group got an average of 58% correct, while children in the control group got about 50% correct (note that the difference was statistically significant).

In both the current study and in the WOW program, children appear to be hovering around chance on this measure. In fact, in this study, the main researcher noted that a fair number of participants gave the same response for all 10 of the questions. Why might this be the case? One explanation is that children simply did not build enough category knowledge throughout the course of the study to succeed on the inferences task. Another idea could be, perhaps, that children of this preschool age might answer these types of neutral questions in a rather ‘noisy’ way. For instance, research shows that in various circumstances where yes/no questions are being asked, children have a tendency to be biased toward responding with “yes” (Peterson, Dowden, & Tobin, 1999; Steffensen, 1978). Other studies found, though, that children demonstrate a “no” response bias when being asked these questions (Peterson & Biggs, 1997).

In one study, Fritzley and Lee (2003) were interested in examining children’s yes/no responses to questions about various objects (e.g., a fuse, a baster) that contained words that were beyond children’s comprehension (e.g., “Is this for opening ancs?”). The 4- and 5-year-old participants in their study showed a significant “no” bias. The researchers posit that children may respond “no” to questions that contain words they do not understand because they have never heard adults use them. Therefore, children may infer that the object in question likely has nothing to do with the nonsense word and conclude that “no” is potentially the right answer.

These findings may shed light on the inferences task. For instance, the task in the current study asked questions such as, “This is a *gurnard*, it has tiny scales that protect its body. Is a *gurnard* a fish?” The gurnard fish was deliberately chosen as it is unfamiliar to preschoolers. We wanted to probe children’s ability to infer using their newly learned category knowledge. However, as research shows, utilizing unknown words in yes/no questions may create a bias in children’s responses. Therefore, future work should examine a way to probe children's ability to make categorical inferences *without* using novel vocabulary words. Moreover, it will be useful to explore if there were either a "yes" or "no" bias in how children in the current study responded in our inferences task.

Finally, it must be acknowledged that the preschoolers in this study are not independent from one another as they are clustered within classrooms. It is possible that there is shared variance within the students of each classroom. Therefore, it may be prudent to run multilevel linear model on the data, instead of a MANCOVA. However, given the limited sample size (n = 54), this analysis would likely be underpowered.

Future Directions

This dissertation was an intervention study that aimed to arm children from disadvantaged backgrounds with a foundation of categorical knowledge, or what we call an advanced organizer, before learning vocabulary words through a taxonomy. Our hypotheses were not confirmed. We found that this advanced organizer did not improve children's ability to categorize living things, although regardless of condition assignment, children's categorization ability did improve over time.

Future work must examine how we can accurately capture the categorization ability of preschool aged children. Both the current study and Fisher and colleagues (2015) found that children this young likely have difficulty demonstrating a differentiation between same- and different-category items on the semantic space task grid. Alternatively, researchers could ensure that participants appropriately comprehend the instructions by having them complete the task with practice cards. It is especially important to study how we can appropriately capture young children's categorization skills if we are to study socioeconomic differences in this realm. For instance, we cannot accurately test the possibility that the lexicons of children from disadvantaged backgrounds may not be as connected as their peers' who live in homes characterized by richer language exchanges if we do not develop a reliable measure.

Additionally, participants in this dissertation study who experienced the advanced organizer did not acquire deeper expressive word knowledge compared to children in the control condition. However, children's target word knowledge, regardless of condition, did significantly improve. This improvement in word knowledge is likely due to the fact that all children in this study experienced the second phase of the study, the 6 week intervention that explicitly taught the target vocabulary items.

Future research could examine how to improve upon the advanced organizer so it can serve its purpose of fostering categorization ability so preschoolers can more readily learn in an intervention that teaches words through taxonomies. One possibility is to intensify the dosage of the advanced organizer. The current study only had 3 weeks (1 day per week) of the advanced organizer. A future study could perhaps increase the dosage to a few months. Alternatively, a future advanced organizer may need to incorporate more "hooks" into the category to be taught in the intervention. In other words, before the actual vocabulary words are taught, the advanced organizer may have to more precisely target the taxonomy about to be taught. For instance, researchers could start illustrating the category of fish and aquatic life for children before delving into sophisticated vocabulary items related to that category.

Finally, the advanced organizer did not improve children's ability to make inferences based on categorical knowledge. A next step with our data will be to explore if there was a “yes” or “no” response bias on the inferences task. Given that previous research in this age group has revealed a “no” bias when unfamiliar words appear in the question, we hypothesize that there may be a “no” bias among children’s answers. Future work must examine another method of probing preschoolers’ ability to make categorical inferences. Ideally, this measure would not include words that preschools do not comprehend. Gelman and Markman (1986) showed that preschool children *have* the ability to make category-based inductions and it’s important to recognize that the prompts used in their study did not contain unknown vocabulary words. Therefore, future research should explore a more accurate method to appropriately assess children’s induction skills.

Conclusions

Children need strong vocabulary skills to enjoy reading success (Wexler, 2019; O’Reilly et al., 2019; Schneider et al., 1989). Research shows, however, that the language skills of children from underprivileged backgrounds often lag behind those of their more advantaged peers, even before they reach kindergarten (Hart & Risley, 1995, Golinkoff et al., 2018; Fernald et al., 2013). There are numerous school-based interventions aimed at closing this word gap, but unfortunately, most of these studies have not made significant progress in increasing young children’s vocabulary ability (Wasik et al., 2016; Dickinson et al., 2011). Researchers recently suggested that interventionists utilize principles from the science of learning as a foundation for teaching vocabulary (Hassinger-Das et al., 2017). The *World of Words* (WOW) program (Neuman et al., 2011; Neuman & Kaefer, 2018) uses two of these tenets: that rich word knowledge can be built through *semantic networking* and through *category formation*.

Unfortunately, while these principles are directly in line with how children learn language, children do not exhibit substantial learning gains in these studies. This dissertation implements an intervention study that employs the principles of word learning that are utilized in WOW. However, in an attempt to improve both the methodologies and outcomes of vocabulary interventions, the current study offers preschoolers a foundation upon which to build richly-connected word knowledge. The *advanced organizer* employed in the dissertation aimed to lay a base of categorical knowledge before teaching vocabulary through a taxonomical approach.

Results from the study demonstrated that this foundation did not improve children's categorization ability, children's expressive target word knowledge, nor their ability to make inferences based on category knowledge. Future work should examine the impacts of an advanced organizer implemented with greater dosage. Moreover, the measures used to analyze children's categorization and induction ability must be improved to more accurately capture the abilities of preschoolers. Overall, this dissertation adds to the vocabulary intervention literature by offering a first step into examining how improving the categorization abilities of disadvantaged children may help bolster their word learning outcomes.

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APPENDIX A

TEXT OF THE ADVANCED ORGANIZER

BOOK 1	**BOOK 2**
P.1 We live in a great big world full of plants and animals! Here are some leopards playing under the trees. What are some plants you can think of?	P.1 All around us we are surrounded by plants and animals! Here is a zebra walking on top of a grassy hill. What other animals can you see here?
P.2 We can find plants all over the place! Does anyone have plants in their home? Lots of people have plants that live in their home – here's a jade plant and palm plant that a lot of people have inside.	P.2 Animals live in all sorts of places. Does anyone have animals living in their home? A lot of people have dogs, cats, fish, and even birds that live with them in their house!
P.3 We can find plants all over the place! What are some plants we see here? Here we can see trees, some flowers, and even a bush with strawberries growing on it!	P.3 Animals are all difference shapes and sizes. Here's an animals that's very big – a huge white tiger! Some animals are long and skinny, like this red and grey snake.
P.4 Plants come in all different shapes and sizes. Here we can see teeny, tiny plants – like the grass down here, there are tiny blades of grass. There's also this giant tree, with big branches and lots of leaves.	P.4 Here is another big animal – an elephant! Next to the elephant is the biggest bird in the whole world – the ostrich! Can you think of some other big animals?

BOOK 1	BOOK 2
P.5 The leaves on plants can look very different. Some are green and some are red. Some plants even grow flowers. Where have you seen flowers before?	P.5 Some animals are super small – like bugs. Here is an earthworm slithering in the grass. And a moth about to fly around with her wings. What are some other small animals you can think of?
P.6 Let's think about how plants live in all different places. Here's a cactus. It lives in where the sun shines all day long and it's really hot outside!	P.6 Let's think about how animals live in all different places. Here's a brown bear, he lives in the forest that's full of trees.
P.7 Here are two plants that grow in another place – the farmer's garden! Here's the carrot plant and the potato plant. We can eat these plants that the farmer grows in the garden! Can we think of other plants we might eat from a garden?	P.7 Here's an animal who lives in another place – the leopard. She lives in the hot desert where the sun shines all day long. What other animals can we think of that live in a hot place?
P.8 Some plants don't grow in the ground, some live on top of the water. Look at this lily - it floats on top of the water and grows a pretty flower on top of it.	P.8 Here's a big polar bear … brrr! I wonder where he lives? What do we think? Yes, he lives where it's really cold and snowy outside.

BOOK 1	**BOOK 2**
P.9 Now let's talk about how all plants are the same. All plants need water to help them grow. When it rains outside, all the trees and flowers can get the water they need. We can use a watering can to give our inside plants water!	P.9 Now let's talk about how all animals are the same. All animals move around places – no matter how they do it (flying, slithering, walking). This frog hops around and this deer runs from place to place.
P.10 All plants also need sunlight. The light from the sun helps plants grow. Let's all point to the sun. If we have plants inside our house, where should we put them so they can get lots of sunlight?	P.10 All animals also need to eat food and drink water so they can grow. Look at these turtles eating lettuce! What kinds of foods do you eat to grow strong and healthy?

P.11 We've talked a lot about animals and plants during these last few weeks.

Let's think about how plants and animals are different from each other

P.12 Animals can move around to find their food. Plants don't move like animals do. They stay in the ground and need the sun and the rain to grow big and strong.

Let's think of an animal that would move around to find food. Let's think of a plant that needs water.

P.13 But animals and plants are all *living things*. Living things all grow and all need water to be healthy and strong.

Let's think of 2 living things – 1 plant and 1 animal!

APPENDEX B

TARGET WORD DEFINITIONS AND GESTURES

Parrotfish (n) – definition: a colorful fish with a small mouth that swims in warm water, GESTURE: SWIM WITH YOUR ARMS AND MAKE A TINY MOUTH

Eel (n) – definition: a long skinny fish that looks like a snake, GESTURE: PUT HANDS TOGETHER AND SLITHER THEM LIKE A SNAKE

Mackerel (n) – definition: a green and silver fish that likes to eat other fish, GESTURE: SWIM WITH YOUR ARMS WHILE BITING

Grouper (n) – definition: a fish with a big mouth that lives at the bottom of the ocean, GESTURE: SWIM WITH YOUR ARMS AND OPEN YOUR MOUTH VERY WIDELY

Seahorse (n) – definition: a small fish with a head like a horse and a tail like a monkey, GESTURE: MAKE SEAHORSE WITH HAND AND GLIDE IT ACROSS

Gills (n) – definition: the holes on a fish's body that let it breathe underwater, GESTURE: PUT 4 FINGERS ON SIDE OF YOUR RIBS AND BREATHE IN

Fins (n) – definition: a part on the outside of a fish's body that help it swim around, GESTURE: PUT YOUR ARMS TO YOUR SIDE AND USE YOUR FINGERS AS FINS

Seaweed (n) – definition: plants that grow in the ocean and can provide protection for fish, GESTURE: MOVE YOUR FINGERS LIKE SEAWEED

Coral (n) – definition: a hard and colorful animal that looks like a rock, GESTURE: MAKE A FIST

Propel (v) – definition: when you move forward with lots of strength, GESTURE: MOVE ARMS BACK AND FORTH LIKE YOU'RE RUNNING

Respire (v) – definition: to breathe, GESTURE: LOUDLY BREATHE IN AND OUT AND MAKE YOUR CHEST PUFF OUT

Snorkel (v) – definition: when you swim underwater using a mask to see and a tube to breathe air above the water, GESTURE: MOVE YOUR HEAD FORWARD LIKE YOU'RE SWIMMING AND PUT HANDS INTO A BOX OVER YOUR EYES LIKE IT'S A MASK

Tropical (adj) – definition: when something belongs in a place that is warm, GESTURE: FAN YOURSELF WITH YOUR HAND LIKE IT'S HOT OUTSIDE

Carnivorous (adj) – definition: when an animal eats other animals, GESTURE: PRETENDING YOU'RE EATING

Enormous (adj)- definition: very big, GESTURE: MOVE YOUR HANDS AND ARMS OUT WIDE