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THE EFFECT OF LINGUISTIC CONTEXT AND EXPLICIT CONTRAST ON THE FAST MAPPING OF VERBS

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A Dissertation Presented

by

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ABSTRACT

THE EFFECT OF LINGUISTIC CONTEXT AND EXPLICIT CONTRAST ON THE FAST MAPPING OF VERBS

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In typical language acquisition, word learning is an induction problem. When word learners hear an unfamiliar word, they make assumptions about the possible referent and its meaning. For nouns, this is relatively easy as word learners can rely on perceptual and pragmatic cues. For verbs, these two cues are fleeting, and word learners require additional kinds of cues for their meaning to be acquired. Two cues that affect verb learning include linguistic context and contrastive information. The current study used a within group comparison to examine the effect of linguistic context (i.e., rich vs. sparse) and contrastive information (i.e., implicit vs. explicit) on the fast mapping of novel verbs. Our study examined whether these two cues could facilitate verb learning in 20 children aged 3;0-5;11 and in 30 young adults. For child word learners, there was an interaction between age and contrastive information such that older, but not younger, preschool children's learning was facilitated by an implicit cue. With an implicit cue, older preschool children fast mapped more novel verbs in rich than sparse linguistic contexts. On the other hand, adult learners were more successful in using linguistic context to fast map verbs such that they inferred the meaning of novel verbs more often

in rich than sparse linguistic contexts. The results of the present study provide insights on the verb-learning differences between child learners and adult learners, as well as differences between younger and older preschoolers. These findings have implications for theories of word learning and provide information that may allow researchers to explore the effects of input, visual attention, and working memory on future verb learning studies in preschool-aged children.

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CHAPTER 1

INTRODUCTION

1.1 Word Learning

In typical language acquisition, word learning is an induction problem. This means children need to resolve the ambiguity around identifying the correct associations between words and referents in their natural environment when word-referent pairings could be anything (Quine, 1960 in Smith & Yu, 2008). For example, when children hear individual instances of a word, like "ball," they must decide from repeated observations of specific examples that the word "ball," maps on to a referent that is typically round in shape, and it can be kicked or thrown. Children are efficient in narrowing down the problem space to quickly rule out unlikely referents when word learning. This is especially the case for learning nouns, as children make use of several word learning biases or constraints to learn word meanings (Clark, 1990; Dollaghan, 1987; Golinkoff et al., 1992; Heibeck & Markman, 1987; Markman & Wachtel, 1988). When children are learning to map the word "ball" to its referent, they will likely use shape (Landau et al., 1988), and similarities (Markman & Hutchinson, 1984) to learn the word. However, to learn verbs, word to referent mappings are more difficult to discern. Children may hear *"kick* me the ball," or "he *threw* the ball," without observing the event or before the referent event has taken place. As a result, children must reconcile the type of event that took place with the ball and the event participants (i.e., who did what with the ball to whom? and who did what with the ball?; Gleitman & Gleitman, 1992). It becomes quite clear that noun learning and verb learning require children to utilize different kinds of information. For noun learning, children can typically rely on perceptual (e.g., shape, color, motion, novelty; see Wildt et al., 2019, for a review) and pragmatics cues (e.g., eye

gaze, pointing; Carpenter, Nagell & Tomasello, 1998 in Hollich et al., 2000), but for verb learning, children also need to make use of the linguistic information surrounding the verb. We know that children are using cues of some kind during their first encounters with unfamiliar nouns and verbs to infer their meaning (Dollaghan, 1985; Eyer et al., 2002; Horst & Samuelson, 2008; Oetting, 1999; Oetting et al., 1995; Rice et al., 1990; Spiegel & Halberda, 2011).

1.2 Fast Mapping

In the first few years of life, children are rapidly acquiring words at a rate of almost five words a day (Bloom & Markson, 1998). The longstanding question has been, how are children doing this? Carey and Bartlett's (1978) seminal study first introduced the term fast mapping, a process to explain how quickly children can identify or map a novel word to a referent (e.g., object or action) when they have only just heard the word for the first time. Within their study, they asked a classroom teacher to use a novel word to refer to a new referent during snack time: "bring me the chromium tray, *not the red one*; *I want the chromium one*" (Carey & Bartlett, 1978). Carey and Bartlett proposed that learning a novel word such as 'chromium' occurs in two phases: 1) fast mapping, or children's ability to learn after a quick exposure of a new label and its potential referent, and 2) extended mapping, or children's ability to retain the new label over time (see Carey, 2010 for a review).

A number of studies since Carey and Bartlett (1978) have found fast mapping to be a robust skill (Eyer et al., 2002; Heibeck & Markman, 1987; Johnson & de Villiers, 2009; Schafer & Plunkett, 1998; Woodward et al., 1994). In fact, decades of studies

suggest that children can fast map novel words in unambiguous and ambiguous conditions. Children can make use of external cues such as following the communicative intent of another to draw their attention to a specific referent through pointing (Tomasello et al., 2007), eye gaze (Mundy & Newell, 2007), and explicit linguistic contrast (Carey & Bartlett, 1978). Alternatively, children could use a process of elimination by implicitly using the perceptual cues (e.g., eye gaze, pointing, novelty) available to them in their environment, along with their word knowledge, to narrow down the meaning of a novel word (Mervis & Bertrand, 1994). To illustrate Mervis and Bertrand's (1994) process for selecting the correct referent, we present an example. Hannah, a 26-month-old, is making pancakes with her mother. The mother has laid out the utensils they will need: a spoon, a spatula, measuring cups, and a whisk. Hannah is familiar with the spoon, spatula, and measuring cups because she enjoys cooking with these utensils at her weekly playgroup's kitchen center, but she is not familiar with "whisk." Her mother asks, "Give me the whisk," and Hannah reaches over and hands her mother the whisk. Hannah selects the correct utensil without ever hearing the word whisk before, but how? Since Hannah already knows the names, category, and function for each of the three other utensils, and that each object can only have one name, Hannah inferred that the new label of "whisk" could only map on to the new, unfamiliar object in front of her. The logic and problem-solving Hannah used to fast map the noun "whisk" to its object cannot be directly applied to the learning of verbs. This is because children need to access different types of information to learn verbs. To learn the meaning of the verb "whisk" in the sentence, "I whisk the eggs, pancake mix, and milk together," Hannah must use the words

surrounding the action of "whisk" to figure out the word's meaning. But what are the possible cues one could use to derive verb meaning?

1.3. Verbs

Verbs provide the action of the sentence and serve as the link between the other words in the sentence. Not only does a verb determine a sentence's subject and predicate, but it also expresses the relationship between the subject and predicate (i.e., the predicate tells us what the subject is doing). When a word learner uses the words in the subject and predicate to learn a verb's meaning, we say that they are using linguistic context.

Linguistic context refers to the information that is available to the learner through the sentence. For verb learning, two relevant types of linguistic information include: argument structure and lexical content. In English, verbs require argument structure for a sentence to be complete. A verb's argument structure is expressed in the meaning of a sentence's predicate. In the example, "Sarah **reads**," "**reads**" is the predicate or event/action and it involves one person, Sarah, who is doing the reading. "Sarah" in this instance serves as the only argument, therefore this sentence's predicate takes one argument. Within the English language, most predicates take one, two, or three arguments. Here, the arguments are in brackets, and the predicates are in boldface.

One-argument predicate:	[Sarah] **reads.**
Two-argument predicate:	[Sarah]**reads** [a book.]
Three-argument predicate:	[Sarah]**reads** [a book] [to him.]

A predicate's argument structure(s) broadly informs us of the number of referents and their relationships to the verb, whereas the lexical content more narrowly informs us

of the specific referents involved in the verb's action. Structurally, in the sentence, "Sarah **reads** the book," the verb "**reads**" constrains the act to two referents, but the words surrounding "**reads**", "Sarah" and "book," tell a word learner exactly "who" and "what" are involved in the specific act of "**reads**." In this study, we use the expression "linguistic context" to refer to lexical content or the semantic information expressed between words and phrases, and how these semantic relationships help listeners determine a verb's meaning.

1.4 Verb Learning Theories

A word learner's use of argument structure and linguistic context to infer the meaning of verbs is evidence that there is a relation between the syntax and semantics of a verb. However, several theories describing word learning in neurotypical children l have been proposed to explain how children use different elements of the verb, the syntax, the semantics, or a combination of both. We will discuss how these theories emerged over the last thirty years and highlight the most relevant theory to the current study - the Emergentist Coalition Model.

1.4.1 The Verb Island Hypothesis

The verb island hypothesis claims that children learn verbs on an item-by-item basis (Tomasello, 1992). In other words, they learn the argument structure for a given verb independent of other verbs. Thus, each unique verb serves as an "island," and children gradually learn how that specific verb attaches to its argument structure from the simplest to the more complex argument structures. Here, we will demonstrate with the verb "**eat."**

Simple argument structure: [Ben] **eats**.

Complex argument structure: [Ben] **eats** [ice cream].

More complex argument structure: [Ben] **eats** [ice cream] [with a spoon].

Several theoretical concerns have been raised about the verb island hypothesis (Abbot-Smith & Behrens, 2006; Childers & Tomasello, 2001; Fernandes et al., 2006; Keren-Portnoy, 2006; Keren-Portnoy & Keren, 2011; McClure et al., 2006; Ninio, 1999; Savage et al., 2003). The primary criticism is that children do not learn verbs on an item-by-item basis, but rather through argument structure similarities (e.g., subject-verb-object patterns) that exist across verbs (i.e., syntactic bootstrapping; Ninio, 2003). In other words, children can generalize the syntax for learned verbs and in turn use it to help them learn other new verbs with similar meanings. Therefore, verbs that share similar meanings are likely to have similarities in the argument structures that they appear (Levin, 1993), for example 'general all purpose' (GAP) verbs. Children's early vocabularies are marked by a small set of high-frequency GAP verbs (e.g., do, get, have, make, put, come, give, look, play, see, take or want (Conti-Ramsden & Jones, 1997; Rice & Bode, 1993; Thordardottir & Weismer, 2001) which help them categorize verbs by action (Huttenlocher et al., 1983). Although children may initially learn GAP verbs on an item-by-item basis as Tomasello (1992) first suggested, it is the argument structure that a GAP verb appears in that allows children to make assumptions about that particular verb's syntax and semantics. Therefore, GAP verbs serve as a "template" from which to learn other verbs (e.g., more semantically specific verbs) (Thordardottir et al., 2001). To illustrate, "pass" is a give-type verb and shares similar meaning and argument structure.

In fact, this is exactly what young children do. McClure and colleagues (2006) used Tomasello's (1992) diary study to compare the verb-learning development of his then one year old daughter to an age-matched group of 10 children in a yearlong longitudinal study. Tomasello's verb-island hypothesis could not be experimentally replicated. The children in McClure's study (2006) used their verb-general knowledge to use new verbs in more sophisticated argument structures as they approached their second birthday. These results converge with the premise that syntax can be a mechanism for verb learning.

1.4.2 Syntactic Bootstrapping

When word learners determine the meaning of a verb through its argument structure, they are said to be using a process called syntactic bootstrapping (Fisher et al., 1991, 2020; Gleitman, 1990; Naigles, 1990). The theory of syntactic bootstrapping proposes that word learners extract the argument structure from a sentence to identify the referents related to the action. For example, word learners use the differences in argument structures (e.g., intransitive "Elizabeth sleeps" vs. transitive "Elizabeth hits Ben)" to identify the people and actions in the event. In turn, this helps the word learner understand the semantics for the novel verb. In one of the first studies testing the syntactic bootstrapping hypothesis, Naigles (1990) used familiarization within a preferential looking paradigm to test syntactic bootstrapping in 25-month-old-children. For example, children saw two actions, side by side, while hearing a causative or non-causative sentence. Novel verb comprehension was measured by the children's visual fixation to the matching and non-matching screens when they heard the auditory stimulus. Children looked longer at the target picture when auditory stimuli matched the

action of the referents in the scene (e.g., when children heard, “The duck and bunny are blicking!” they looked at the non- causative scene). When children heard transitive sentences (e.g., “The duck is gorping the bunny!"), they looked longer at the scene that depicted two-person causation than the scene that depicted the two-person non-causative scene and vice versa for intransitive sentences (Naigles, 1990). Following this initial study, Naigles and Kako (1993) examined the relationship between syntactic frame (e.g., transitive, intransitive, and no-frame) and verb-type (e.g., causation versus contact). Across a series of experiments, 27-month-old children performed similarly to Naigles (1990). Specifically, young children made use of argument structure to infer the meaning of a novel verb (Naigles & Kako, 1993). Later studies have continued to confirm the syntactic bootstrapping hypothesis as children used structural information to interpret the meaning of novel verbs (for a review, see Fisher et al., 2020). While syntactic bootstrapping explained how children use argument structure from the input to learn a verb, it could not account for whether children also use the linguistic context that is available in the sentence to learn verbs.

1.4.3 Structure Mapping Account

Before children can use a sentence’s structural information to learn verb meaning, some verb researchers theorize that young children may be biased to use the sentence’s nouns to infer the meaning of a verb (Fisher, 1996, 2002a; Gleitman, 1990; Yuan et al., 2012). According to the structure mapping account, children interpret the meaning of novel verbs through a one-to-one mapping of the noun phrases. Here, children are quite literally mapping the order of the nouns that they hear in the sentence to a scene that depicts the structural alignment of the sentence. In an earlier study testing the syntactic

bootstrapping hypothesis, Fisher (2002a) suggested that children as young as 28-months may have used the number of noun phrases heard in transitive and intransitive sentences to interpret the verb's meaning. In the language comprehension task, two-and-a-half-year-old children first watched a dynamic scene where one actor performed a causative action on the other actor, or one actor performed a non-causative action. At test, when the children heard transitive sentences (e.g., "She stipes her over there."), they were asked, "Which one verb(ed) the other one?" Children pointed to actor who performed a causative action on the other actor. When the children heard intransitive sentences (e.g., "She stipes over there."), and were asked, "Which one verb(ed)?" The children proceeded to point to the actor who performed the non-causative action.

In a similar study, Yuan et al. (2012) used an alternative forced choice preferential looking paradigm to assess verb learning in 21-month-old children. Children looked longer at a dynamic scene that matched the auditory stimulus (e.g., transitive or intransitive sentence) than they looked at the dynamic scene that did not match the auditory stimulus. Yuan and colleagues suggested that children were using the noun phrases to infer verb meaning. On the other hand, they could not determine whether children were matching the number of people on the screen with the sentence that they heard or if they were using the noun phrases in the sentence to map the meaning of the novel verb. This motivated a follow-up experiment where they manipulated a "bystander," so that all dynamic scenes presented to the children had the same number of people in each scene. For example, when children heard an intransitive sentence (e.g., "He's gorping."), the children saw two side-by-side dynamic scenes: 1) one actor performing an action and a bystander standing in the scene, and 2) a two-actor causation

scene. When children heard a transitive sentence (e.g., “He’s gorping him.”), the children saw two side-by-side dynamic scenes: 1) one actor performing an action and a bystander standing in the scene, and 2) a two-actor causation scene. This required the children to figure out how the number of people in each scene mapped on to the nouns in the presented sentence. Similar to Yuan and colleagues’ previous results (2012), children looked longer at the dynamic scene that matched the auditory stimulus, and not the dynamic scene that featured the bystander. Thus, it was concluded that children were able to successfully associate the relational meaning in transitive sentences to two-event participants (Yuan et al., 2012). The results from these two experiments highlight the role of noun phrases in a sentence’s linguistic context to acquire verb meaning. While young children may be biased to interpret the linguistic context in a particular way (e.g., counting the full-noun phrases), a problem arises when the linguistic context is under informative (e.g., pronouns in place nouns; but see Lidz et al., 2009). The use of full-noun phrases in a sentence allows the word learner to more readily identify the meaning of a novel verb, but this is not the case when pronominal phrases are used (e.g., “The boy is pilking the balloon,” vs “He’s pilking it.”). When the pronominal phrase is used, the child has limited resources to interpret verb meaning because the sentence’s referents (i.e., people and objects) are not specifically labeled. It is unknown whether children might use the weak cues (e.g., singular vs. plural) that are in pronouns to figure out a verb’s meaning. This sheds light on the fact that sentences offer multiple cues to word learners and when these cues are combined, they could facilitate word learning. The verb-learning theories we have discussed so far have focused on one type of cue to explain how children learn verbs. However, in real life, word learners are using and integrating

multiple cues, from different sources of information (e.g., activating prior knowledge, using argument structure and linguistic context, scanning the visual scene, etc.) to learn a word's meaning. This learning scenario has been described by the Emergentist Coalition Model of word learning.

1.4.4 Emergentist Coalition Model

The Emergentist Coalition Model (EMC) was designed to describe child learners' integration of multiple cues in noun learning. Specifically, it highlights that children at different ages integrate multiple cues and weight them differentially (Hollich et al., 2000). Across noun learning studies, this effect is demonstrated in younger children (e.g., whole-object, taxonomic and mutual exclusivity assumptions; Markman, 1990), older children (e.g., spatial relations; Johanson & Papafragou, 2014), and in adults (e.g., classification of categories; Gentner & Bowerman, 2009 in Guo et al., 2010). Given that these effects can be demonstrated across the lifespan, in other languages (Choi et al., 1999) and across word type (e.g., nouns and adjectives; see Hollich et al., 2000), this theoretical model is robust. To our knowledge, the ECM has not been experimentally validated for verb learning. However, it has been generalized to nouns and adjectives, thus, we have no reason to believe that it could not be generalized to verb learning. This study would contribute to the idea that word learners use multiple cues to learn verbs. In previous literature, researchers acknowledge that young word learners are integrating multiple cues to learn verbs (Christiansen & Monaghan in Hirsh-Pasek & Golinkoff, 2006). Specifically, they are using internal cues (e.g., phonological, prosodic, distributional) to identify a verb in the speech stream and external cues (e.g., observing actions, abstracting relational concepts, etc.) to map meaning from the novel verb to its

event. For children in their first year of life, they are integrating both of these cues to identify words and their meaning. However, as children mature, they are able use more sophisticated cues from the input (e.g., argument structure, linguistic context, observation, etc.,) to learn verbs. Therefore, if this model can be applied to verbs, we would expect children to be able to use multiple cues, simultaneously, when learning verbs, even if the precise patterning of those multiple cues differed across development. Thus, in this study, we offer a test of the ECM for verb learning by exploring word learners use multiple cues (e.g., linguistic context and contrast), in the language input to learn verbs.

1.5 Linguistic Context & Verb Learning

The verb learning literature generally has focused on how noun knowledge drives verb learning (Arunachalam et al., 2013; Arunachalam & Waxman, 2011; Gillette, et al., 1999; Imai et al., 2005, 2008; Piccin & Waxman, 2007). Most studies considered how word learners might use linguistic context, especially how nouns present in the sentence may be used to infer verb meaning. In English, word learners are at an advantage because their vast noun knowledge facilitates their verb learning. This is because they are more likely to identify the people and objects in the sentence to infer verb meaning.

Linguistic context is a verb-learning cue that improves as children age. When given more linguistic information about a sentence, adults and older children (e.g., 7-year-olds) improve their identification of referents for unfamiliar verbs (Gillette, et al., 1999; Piccin & Waxman, 2007). Gillette et al., (1999) examined the extent to which linguistic information in the input facilitates verb learning in adults. Adults viewed a silent video of a mother interacting with her child. Adults were asked to identify the

"mystery" verb with the linguistic information that they were provided. Adults more readily identified the "mystery" verb when they had access to the argument structure (e.g., "Why don't you gorp?") and the semantic content (e.g., "Can you gorp Markie on the phone?) in the linguistic context (Gillette, et al., 1999). Using similar procedures, Piccin and Waxman (2007) tried to replicate these findings with younger children via two experimental conditions (i.e., no linguistic information and full linguistic information). Seven-year-old children were randomly assigned a condition (i.e., no linguistic information or full linguistic information) for a verb guessing game. Target verbs were replaced in the presented Sesame Street video clips by a beep. In the no-linguistic condition, children silently viewed Sesame Street clips and heard only the beep when the target verb was uttered by the character on screen (e.g., BEEP). In the linguistic condition, children heard the speech of the characters before and after the beeped-out target verb (e.g., 'Hey Elmo, do you BEEP an apple?'). When children heard the beep, they were asked to guess the verb. Children who heard the full-noun phrases surrounding the "mystery" verb were more accurate identifying the verb than children who did not have access to the linguistic condition. Together, these results suggest that adults and older children may need access to rich linguistic context to infer the meaning of a verb.

There is ample evidence to suggest that young children depend on linguistic context to learn a novel verb (Arunachalam & Waxman, 2011, 2015; Fisher, 1996, 2002a; He et al., 2020; Imai et al., 2008; Naigles, 1990; Syrett et al., 2014; Yuan et al., 2012; Valleau & Arunachalam, 2018). One ongoing debate in the literature surrounds the *amount* of linguistic context. In particular, is more or less context better? In some studies, less linguistic context supports verb learning. For example, toddlers learned verbs

better with pronominals (e.g., “he”) than with a lexical noun phrase (e.g., “the boy”) as the subject (Lidz et al., 2009) and three-year-olds learned verbs better without an adjective modifying the subject (e.g., “the tall girl is fezzing” vs. “the girl is fezzing”) (He et al., 2020). These findings seem to suggest that a semantically *sparser* context (i.e., ‘less context’) is more facilitative for toddler’s verb learning. On the other hand, other studies support the hypothesis that more linguistic context is better (Arunachalam & Waxman, 2011, 2015). Arunachalam and Waxman (2011) taught two-year-olds novel transitive verbs in one of two conditions: semantically rich context and semantically sparse context. In both conditions, children viewed the same dynamic scenes within a familiarization paradigm, but the auditory stimuli differed for each condition. In the semantically rich condition, children heard novel verbs in sentences flanked by full-noun phrases (e.g., **The man** is pilking **a balloon**.) In the semantically sparse condition, children heard novel verbs in sentences with pronominal subjects and predicates (e.g., **He’s** pilking **it**). At test, the children were asked to point the to the scene that depicted the meaning of the novel verb (e.g., Where is he pilking something?). Children were more successful in learning the novel verb when more linguistic context was made available to them, specifically, the names of the referents (e.g., The man is pilking the balloon).

In a follow-up study focusing on 24-month-old children, Arunachalam and Waxman (2015) manipulated the presentation of the linguistic context. Here, in the semantically rich condition, children heard two sentences but had to map the referents labeled by full-noun phrases from the first sentence onto the pronominal phrases in the second sentence (e.g., Let’s see a boy and a balloon. He’s gonna pilk it.). In the semantically sparse condition, children also heard two sentences, but they were not

provided with noun phrases that identified the referents (e.g., Let's see what happens now. He's gonna pilk it.). After a few exposures to the novel verb and referent, children had difficulty learning verbs in both the semantically rich and the semantically sparse conditions. The children did not benefit from having the full-noun referents (i.e., "boy" and "balloon") in the first sentence or the pronouns (i.e., "he" and "it") in the second sentence. These results have been consistently found for older children too (e.g., three-years-old) from other studies (Imai et al., 2005, 2008). Arunachalam and Waxman explained this finding by hypothesizing that children had difficulty with how the information was packaged and the use of two sentences impedes learning.

In a more recent study Valleau and Arunachalam (2018), took a different approach to examining how children, ages 31-36 months, learned novel verbs in different linguistic contexts. Through the use of eye-tracking, Valleau and Arunachalam (2018) measured children's eye gaze while they heard a sentence with a novel verb and viewed a dynamic scene. The same linguistic context stimuli from Arunachalam and Waxman's prior studies (2011, 2015) were used. Similar to their previous studies, the visual and auditory stimuli were presented in a familiarization paradigm (e.g., exposure to stimulus before test). Surprisingly, the children performed similarly in both the rich and sparse linguistic contexts (Arunachalam & Waxman, 2011, 2015; Waxman et al., 2009). The eye-tracking results revealed that at first map, children's gaze went to the object that was being manipulated by the agent. Valleau and Arunachalam (2018) hypothesized that children's failure to map a novel verb in a rich linguistic context revealed incorrect mapping between the referents and the action. Thus, to date, it is not clear whether more or less linguistic context facilitates verb learning. In prior studies, the methods used to

determine the role of linguistic context was tested using extended mapping tasks. That is, children had more exposures and opportunities to map the novel verb to its referents and create an understanding of the relationship between the referents. However, our knowledge of the role of linguistic context is limited because fast mapping has not been used. A fast-mapping task would reveal how well children use linguistic context at first map. This is an important gap to fill because it can tell us which cues children are using to correctly map the meaning of an unfamiliar verb for the first time and how likely they are to acquire and grow their vocabulary with new words. Therefore, examining whether children make use of linguistic context to learn verbs in initial fast mapping tasks may provide valuable information that could shed light on this debate.

1.6 Explicit Contrast & Verb Learning

Despite the mixed findings, the studies reviewed above show that linguistic context plays a role in children's verb learning. A problem may arise when word learners do not have access to full-noun phrases or rich linguistic context to infer the meaning of a novel verb. This begs us to ask whether other types of linguistic information can be useful when learners do not have sufficient information from the linguistic context. More recently, some have begun to examine whether the use of contrast might play a role (Arunachalam & Waxman, 2011; Childers et al., 2014; Piccin, 2007; Waxman et al., 2009). Contrast refers to the information that tells the word learner what the novel verb is and what it is not. The use of contrast has been widely studied in noun and adjective word learning, but it has been underutilized in verb learning (Au & Laframboise, 1990; Markman, 1994; Markman & Wachtel, 1988; Waxman & Klibanoff, 2000).

To date, four studies have examined children's use of explicit contrast in verb learning (Arunachalam & Waxman, 2011; Childers et al., 2014; Piccin, 2007; Waxman et al., 2009). All provided children with contrastive information to help them learn what the novel verb's action was and what it was not. Three of the studies used familiarization paradigms with the same visual and auditory stimuli with two different age groups, two-year-olds and three-year-olds. Piccin (2007) was the first to present the task. In dynamic familiarization scenes, children saw an agent performing a simple action and heard a novel verb in a sentence that provided a rich linguistic context (e.g., "Look, the man is pilking a balloon!"). Before test, children heard an explicit contrast in two sequential scenes (e.g., Uh-oh! He is not pilking that; Yay! He is pilking that!). At test, the children were asked to find the novel verb's action (e.g., Where is he pilking something?). The three-year-old children were successful in extending the meaning of the novel verb when verbs were presented in rich linguistic contexts with the contrast phase. Waxman and colleagues (2009) found similar results with identical procedures with two-year-old children when the linguistic context of the sentence was manipulated and used with the contrast phase (e.g., "Look, the man is pilking a balloon!" or "Look, he's pilking it!"). Arunachalam and Waxman (2011) incorporated a dialogue phase before the familiarization and explicit contrast phases to help the children identify the novel word (i.e., verb) of interest. With these experimental procedures, two-year-old children extended the meaning of the novel verb at test. These three studies highlight how repeated exposures, linguistic context, and explicit contrast can be used to facilitate verb learning in young children. Although these studies used explicit contrast phases in their

experiments, it is unclear if explicit contrast was the learning mechanism that facilitated the young children's verb learning.

Childers et al. (2014) used an "acting-out" paradigm, where they used explicit contrast (e.g., "Look, I'm meeking it!" vs "Look, I am not meeking it!") and implicit contrast (e.g., "I'm meeking it" vs "I'm koobing it") to draw preschool-aged children's attention to the meaning of the verb. At test, the children were asked to enact the events that corresponded to the new verb. The two-and-a-half-year-olds were not able to use the contrastive cues to map meaning to the novel verb. Three-and-a-half-year-olds were aware of the contrastive cues as demonstrated by some learning; however, they were not able to differentiate the cues to learn verbs greater than chance. For four-and-a-half-year-old children, on the other hand, successfully integrated the contrastive cues during the learning process to correctly map the meaning of novel verbs. This is the first study to demonstrate that contrast cues have the potential to be a verb-learning mechanism in preschool-aged children. This finding motivates the increasing need for research in this area, given the vast literature demonstrating children's difficulty in acquiring verbs. Thus, the impact of contrastive information in verb learning appears to be promising but the extent to which it can be used as an effective facilitator remains limited.

1.7. Research Questions, Implications & Predictions

Past research has shown linguistic context to be an informative verb learning cue across the ages, despite the fact that while sometimes rich context facilitates learning other times sparse context facilitates learning (Arunachalam & Waxman, 2011, 2015; Gillette et al., 1999; Piccin & Waxman, 2007). More specifically, rich linguistic contexts

facilitate verb learning when older children and adults use the noun phrases flanking an unfamiliar verb in a verb guessing task (Gillette et al., 1999; Piccin et al., 2007). While linguistic contexts have demonstrated their usefulness for words learners, most of the children studies focused on extended verb mapping, and sentences that lacked variability in object phrases. Thus, it remains unclear how well linguistic context contributes to preschool-aged children's verb learning when they encounter a novel verb for the first time (i.e., fast mapping). Therefore, in order to better understand the effects of linguistic context on children's verb learning, our research takes the first step in addressing how novel verbs presented in rich versus sparse linguistic contexts affect children's first mappings of verb meaning. We will use a fast-mapping paradigm to explore the role of linguistic context.

In addition to exploring the role of linguistic context, we are also interested in the role of explicit contrast in the fast mapping of verbs. The premise of contrastive information is to help the word learner know what the verb meaning is by explicitly telling letting them what the verb meaning is not. In the only study of explicit contrast, the findings suggest that the role of explicit contrast as a cue in verb-learning is more accessible with age (Childers et al., 2014). These results motivate the need for additional inquiry to provide us with a better understanding of the use of contrast in verb learning. First, we do not know how well this cue, on its own, facilitates verb learning across the lifespan. Second, it may be that the role of contrast may be better used when it is combined with another verb-learning cue like linguistic context. After all, we know that word learners use multiple cues to learn words (Hollich et al., 2000). Thus, this study was designed to begin addressing these gaps in the literature.

1.7.1 Research Questions

Taken together, the current studies were designed to refine our understanding of the fast mapping of verbs specifically when individual versus multiple cues (e.g., linguistic context and explicit contrast) are available to words learners in the language input. Thus, in the current studies, we ask the following questions about verb learning, linguistic context, and contrastive information: 1) What are the unique effects of linguistic context and explicit contrast on verb learning in a fast-mapping task? 2) What is the interaction between linguistic context and explicit contrast on verb learning in a fast-mapping task? and 3) Do the unique effects and/or interaction between linguistic context and explicit contrast differ for child versus adult learners?

1.7.2 Research Question 1 & Predictions

In our first research question, we examine the role of linguistic context and explicit contrast individually in a fast-mapping verb task similar to previous studies (Arunachalam & Waxman, 2011, 2015; Childers et al., 2014; Valleau & Arunachalam, 2018). To test the unique role of linguistic context, participants were asked to match a scene with an auditory stimulus that includes a sentence where the verb is flanked by rich linguistic contexts (i.e., full-noun phrases), or by sparse linguistic contexts (i.e., pronominal phases). If learners benefit from rich linguistic contexts, we expect fast mapping to be more accurate when they are asked to identify the picture that corresponds to the sentence that features full-noun phrases. This finding would be consistent with Arunachalam and Waxman (2011; 2015) and Gillette, Gleitman, Gleitman and Lederer (1999). If learners benefit from sparse linguistic contexts, we expect fast mapping to be

more accurate when learners are asked to identify the picture that corresponds to the sentence that features pronominal phrases. This finding would be consistent with Lidz, Bunger, Leddon, Baier and Waxman (2009). If both cues are informative for verb meanings, then we expect there to be no difference in fast mapping when learners are asked to identify the picture that corresponds to "Alyssa /tidz/ the doh to Nicole" versus "She /kimz/ it to her." Although there is no literature to support this particular finding, if it occurred, it could mean that word learners are using another cue available in the sentence (e.g., argument structure) to learn verb meaning.

To test the unique role of explicit contrast on verb learning in a fast-mapping task, participants were asked to match a scene with an auditory stimulus where the verb is provided with an explicit contrast (i.e., a second sentence that provides that contrast), or implicit contrast (i.e., no second sentence). If learners benefit from explicit contrast, we expect fast mapping to be more accurate when they are asked to identify the picture that corresponds to the sentences that feature the explicit contrast. This finding would be consistent with Childers, Hirshkowitz, and Benavides (2014). If learners benefit from implicit contrast, we expect fast mapping to be more accurate when learners are asked to identify the picture that corresponds to the sentence that features the implicit contrast. This finding would be consistent with Arunachalam and Waxman (2011; 2015). If both cues are informative for verb meaning, then we expect there to be no difference in fast mapping when learners are asked to identify the picture that corresponds to "Alyssa /tidz/ the doh to Nicole" versus "Alyssa doesn't keep the doh. Alyssa /hɔbz/ the doh to Nicole." To date, there is no literature to support this finding; however, if this finding emerged, we might conclude that word learners are using other cues in the input to infer verb meaning.

1.7.3 Research Question 2 & Predictions

For our second research question, we explored how word learners might integrate multiple cues (i.e., linguistic context and explicit contrast) from the language input to fast map a verb's meaning. Therefore, we asked: What is the interaction between linguistic context and explicit contrast on verb learning in a fast-mapping task? Participants were asked to match a scene with an auditory stimulus that includes a sentence where the verb is embedded in a sentence with either a rich linguistic context (i.e., full-noun phrases) or a sparse linguistic context (i.e., pronominal phrases) while contrast information is also provided (e.g., either implicit contrast or explicit contrast). If the interaction between context and contrast is significant, we might conclude that the effects of linguistic context and contrast depend on each other such that one type of contrast is only beneficial when paired with one type of linguistic context. For example, it could be the case that learners benefit from rich linguistic context, but only when explicit contrast is provided. In other words, we might find that there is one particular pairing between linguistic context and contrast that facilitates better verb learning. Additionally, we could find that there are multiple pairings that contribute to verb learning, or that there is one pairing that is particularly poor for verb learning. Given that we are the first study to test the interaction between linguistic context and contrast, there is no prior literature to support a specific direction of the interaction effect, but any interaction would support the Emergentist Coalition Model of verb learning suggesting that learners integrated multiple cues (Hollich et al., 2000). If learners do not benefit from the pairing of these two cues, we expect there to be no interaction which would suggest that these two cues, linguistic context and contrast, will have primary effects but operate independently of each other.

Research Question 3 & Predictions

Our third research question asked whether the effects of linguistic context and explicit contrast as well as any interactions are similar for adult and child learners? We know that children and adults integrate multiple cues from sentences to identify the meaning nouns and adjectives (Hollich et al., 2000) Previous studies only tested how explicit contrast and linguistic context facilitated verb learning on their own, and only in children. In everyday life, however, visual scenes are messy and complex, and word learners may integrate multiple pieces of linguistic information to learn verbs simultaneously. To our knowledge, we are the first to use this design with both adults and children in the same study, and although we expect there to be child-adult differences in terms of overall performance, we are not sure of how these differences will play out. If children and adults perform similarly with both of these cues, it would suggest that these cues become useful early in development and continue to remain useful in word learning across the lifespan (Ichinco et al., 2009; Jones, 2018; Vouloumanos, 2008). However, if children's and adults' performances differ with these cues, it would suggest that how they are using and integrating these cues changes throughout development (Hall et al., 1993; James et al., 2019).

CHAPTER 2

RESEARCH DESIGN

2.1 Research Design

We used a within-group research design implementing a fast-mapping paradigm to measure the effect of two independent variables: linguistic context (i.e., rich vs. sparse) and contrast (i.e., implicit vs. explicit) on one dependent variable - verb learning (i.e., percent accuracy scores on a receptive fast-mapping verb-learning task). The two independent variables (i.e., linguistic context and contrast), each with two levels, gave rise to four verb-learning conditions: 1) implicit-rich, 2) implicit-sparse, 3) explicit-rich, and 4) explicit-sparse. A power analysis for a two-way repeated measures ANOVA was calculated with power at .95, an alpha of .05, and a medium effect size of .5 (Cohen, 1988).The results indicated that a minimum sample size of 12 participants would be needed to detect within-group differences. All methods proposed in this study were approved by the University of Massachusetts (UMass) Amherst's IRB (protocol # 2673). The methodology described was used with both our adult and child learners with the exception of modifications made to the visual stimuli and procedures for the children.

2.2 Experimental Stimuli

The pictured stimuli for this study consisted of 30 still photographs of actors engaged in familiar transitive and ditransitive actions. The familiar actions were mostly GAP verbs (Rice & Bode, 1993) and verbs that are early acquired (Dale & Fenson, 1996). The picture stimuli were created by the researcher and photographed by research assistants. Sample picture stimuli are shown in Figure 1. The familiar actions and early acquired verbs that were depicted are listed in Appendix A.

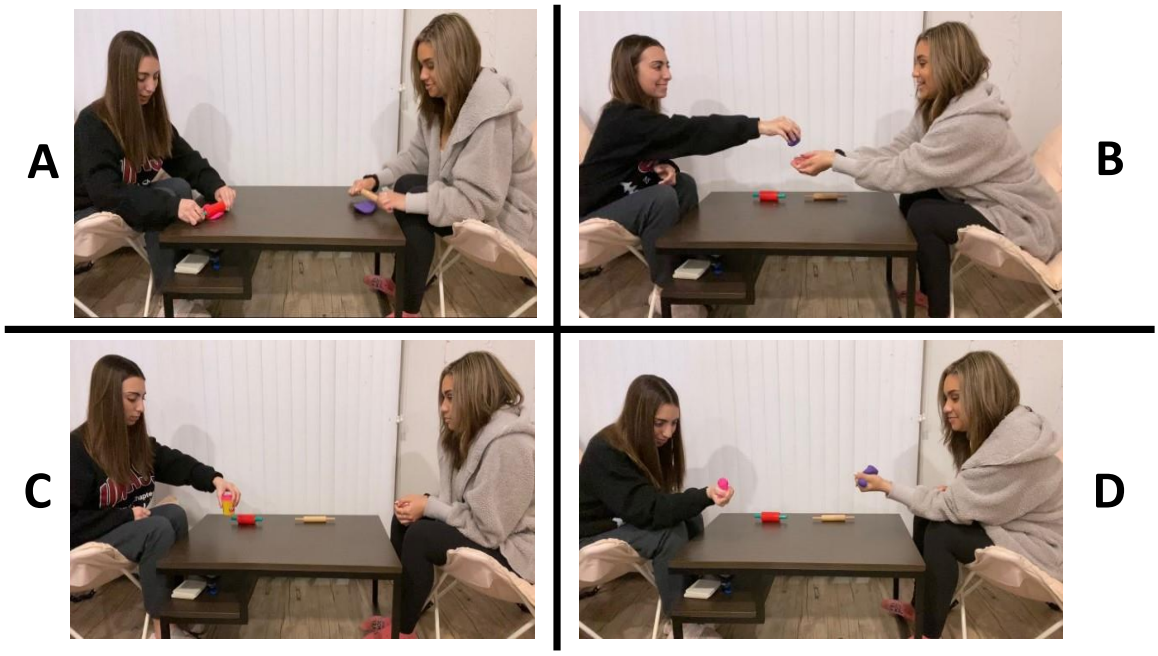


Figure 1. Sample picture stimuli.

2.2.1 Visual Stimuli

Still photographs were taken with same actors and props because we had singular and plural subjects performing our verb actions. In the first set of still photographs, one actor performed an action while the second actor was a bystander in the scene (e.g., Alyssa puts the doh on the table while Nicole is sitting passively in the scene). In the second set of still photographs, both actors performed the same action (e.g., Alyssa and Nicole both put doh on the table). The visual stimuli were presented in a four-alternative forced choice (4AFC). To determine which four visual stimuli was to be presented on a slide, still photographs from both sets (i.e., singular, and plural subjects) were combined. Each photograph was assigned a numerical number (e.g., 1, 2, 3, etc.,). The numbers within this numerical range were put into an online calculator (random.org) to randomly generate which four alternatives would be depicted on one slide (see Figure 1).

Picture scenes were designed so that the meaning of the novel verb form could not be inferred by eliminating non-target pictures based on the nouns or subjects depicted in those pictures. For example, in the sentence "Alyssa /pæbz/ the doh to Nicole," all four pictures in the 4AFC included Alyssa, Nicole, and the doh; but in only one picture (i.e., picture B) was Alyssa acting the intended meaning 'give.' However, two of the four pictures in this 4AFC depicted a singular subject performing the action (see Figure 1, pictures B and D), while the other two pictures showed plural subjects performing an action (see Figure 1, pictures A and C). The pictures were designed in this way to guard against the visual scene, rather than the linguistic input, acting as a cue for verb-learning.

2.2.2 Still Photograph Validation

We validated our still photographs in the 4AFC presentation to be sure that our actors and their actions were representative of our target verbs in each of the four different conditions. Thirty English-speaking adults (18 – 75 years old) were recruited from a sample of convenience to participate in the validation. The participants completed a fast-mapping paradigm to determine the intended meaning of the novel verb embedded in a sentence among four pictured choices. The target photograph's location was balanced among the four pictured choices by the researcher so that there was no pattern among the choices (A, B, C, D) as they moved through the task and made their selections. Target photographs were randomized among the four quadrants: quadrant A - 28%; quadrant B – 27%; quadrant C – 26%, and quadrant D – 19%.

Participants completed the validation using a Google Form from a provided link. Before starting the fast-mapping paradigm, they were asked to watch a recorded video,

located at the top of the Google Form, which contained the instructions for the task. The instructions were: *Hi! I'm Sam and this is my alien friend Ziggy. He does not know many English words. In fact, he replaces many English words with alien words. Look at these four pictures and let's listen to Ziggy. Ziggy says, 'Kate like to /hɛb/.' What does he mean? I think he means picture B. Now use the pictures below to match Ziggy's sentence to the picture that it depicts.* For each sentence presented, adult participants read a sentence containing a novel verb form and were asked to select the picture from the four pictured choices (A, B, C, D) that best depicted the intended meaning of the novel verb. Participant responses were recorded on the Google Form.

Results for each presented sentence with a novel verb form were calculated by the total number of responses per picture in the 4AFC, divided by the total number of participants who completed that item. A basic percentage score was calculated through Google Forms. These percentage scores were used to eliminate picture sets (i.e., one set = four pictured choices + their sentence context) that did not clearly depict the intended meaning of the novel verb form in the target sentence structure type among the four pictured choices. We chose photograph picture sets that were at least 90% in agreement for the meaning of the intended novel verb form in its presented sentence structure aligned with the target photograph in the 4AFC. We then used these 4AFC photographed picture sets in our experiment. The target photographs in our 4AFC were represented across the four quadrants in all four conditions as: quadrant A – 25%, quadrant B – 25%, quadrant C- 29%, and quadrant D – 21%.

2.2.3 Four-Alternative Forced Choice Preparation (4AFC)

All sentence conditions were controlled for their sequence presentation in the fast-mapping paradigm. We counterbalanced the presentation of the conditions by using a Latin Square counterbalancing design to help remove sequence effects so that the presentation of any given condition and the condition that followed did not present an ordered effect. In our Latin Square design, this meant we had a 4X4 square where each of the four ordered conditions appeared only once in each row and each column (see Appendix B). Each column represented the order of testing conditions, and each row represented the participant who received the different order. Within our 4X4 square, we now had four sequences from which we could present the four verb-learning conditions. From these four sequences, we generated a random sequence order with an online calculator (e.g., random.org) so that the order of the conditions was randomly determined for the participants following the first four subjects.in our study (see Appendix C). Within each block of conditions, participants individually heard the same seven verb-learning sentence frames and saw a 4AFC presented on the screen. The order of trials within a condition were the same for all participants.

2.2.4 Sentence & Word Stimuli

Seven sentences were created. All sentences were transitive (n = 4) or ditransitive (n = 3) and created from familiar actions s (shown Appendix D). Instead of presenting the familiar action's verb, we replaced the real verb with a novel verb form (e.g., /bɛm/). Twenty-eight monosyllabic CVC novel words were selected as the novel verb forms for this experiment. Each novel word form contained consonants typically present in children's early phonemic inventories. These novel words were selected from a corpus of

consonant-vowel-consonant nonwords (e.g., /pæb/; /hɛb/; /mub/) (Storkel, 2013). The novel verb forms were randomly assigned to sentences and were only replaced if the novel verb form had the same initial phoneme and/or final phoneme as the real lexical form it replaced (e.g., /gɛb/ for ‘get’;/tik/ for ‘take’). We did not want similarities in the phonemes in our novel verb forms to be a possible cue for the intended meaning of the lexical verb. Nor did want to confuse the participants by having them select another picture in the 4AFC because the novel verb was phonetically similar to another pictured action. The final list of novel verb forms used in this study can be found in Appendix E.

Once the novel verbs were placed into a sentence, we then altered the linguistic context so that half of the sentences presented the subject and predicate in a rich linguistic context (e.g., “Alyssa /bæfs/ the doh with the roller”). The other half of the sentences were presented in sparse linguistic context where the subject and predicate were replaced by pronouns (e.g., “She /nɪɔmz̲/ it with the thing”). For half of the rich linguistic context sentences, we added explicit contrast sentences (e.g., “Alyssa doesn't build a tower. Alyssa /daɪbz/ the doh with the roller”). The same was done for the sparse linguistic context sentence, such that half were presented with the added explicit contrast sentences (e.g., “She doesn't build something. She /tʌdz/ it with the thing”) and the other half were presented as implicit contrast. This gave rise to our four verb-learning conditions. The final list of sentences can be found in Appendix F.

The researcher, a native English speaker with a New England dialect, recorded the novel verb forms embedded in the sentences from each of the four sentence conditions as well as a script to introduce the task. All auditory stimuli were recorded with a free-standing RODE NTUSB Versatile USB Condenser Microphone with Zero Latency.

Sentences were recorded at a 44.1 -kHz sampling rate using Version 22 of Adobe Audition recording software (Adobe Audition, 2022) and edited in Version 3.1.3 of Audacity recording and editing software (Audacity Team, 2022). All sentences were clipped to include 1ms of silence before and after the presentation of the auditory stimuli. Then the auditory stimuli for each sentence were embedded into their targeted 4AFC photograph set by condition within PowerPoint. We played the auditory stimuli over a free-field USB laptop speaker connected to a PC laptop at a comfortable listening level.

CHAPTER 3

ADULT LEARNERS

3.1 Participants

Thirty young adults (28 females; 2 males) with a mean age of 20 years, 6 months (range: 18;9 – 24;3 years; months SD: 11 months) currently taking an undergraduate course in the communication disorders department volunteered to participate in this study. All adult university students were compensated for their time with extra credit towards a course of their choice. Electronic recruitment flyers were distributed to their instructors to post on their learning management systems and announce in their classes.

Inclusionary criteria required that all participants were at least 18 years of age and were monolingual speakers of English with typical language, cognition (i.e., no medical diagnoses), and hearing. Interested participants used the website link or QR code on the electronic recruitment flyer to sign-up for a time to participate via a free online software tool for participant management. Through the online sign-up platform, the researcher sent a reminder email one day before their scheduled appointment.

3.2 Procedures

All participants met the researcher and research assistant in a quiet room in a research laboratory. At the start of the session, the researcher verbally communicated the process of informed consent to the participant with a written copy of the informed consent form in front of them. The researcher periodically checked for the participant's understanding of the procedures and right to privacy with yes/no questions and confirmed their permission for their pointed responses to video recorded. Following the participant's

verbal and written consent, the research assistant presented the adult history intake form for the participants to fill out. Each participant was reminded that they did not have to disclose any information that they did not feel comfortable sharing.

The adult participants were informed that the researcher was interested in how adult learners and child learners used different cues in verb learning, and if these cues were the same or different. The researcher also informed the adults that the experimental stimuli was designed with children in mind. At the start of the fast-mapping task, all the adults participated in a pointing-task to orient them to all the quadrants on the screen by pointing to an object or an action. Next, the adults listened l to the prerecorded script to introduce the fast-mapping task while watching the puppet talk on the screen, "telling" them what to do. The prerecorded script read:

> *Here is my alien friend Ziggy. He is new to learning English and he does not know many English words. Sometimes he uses alien words instead of English words. We have to figure out what he means. I want you to guess what Ziggy means and point to that picture. It's OK to make a guess. Let's practice guessing what Ziggy means.*

The researcher then presented a 4AFC training presentation on the screen and played the prerecorded sentence with a novel verb: "Ziggy says, Sarah and Katie /pug/ books. What does Ziggy mean? Point to the picture, Sarah and Katie /pug/ books." The novel verb word form /pug/ and its intended verb meaning, read, were not included in the experimental stimuli. Following this training trial, a new screen appeared with the words "Are you ready?" The researcher asked the adult if they were ready and proceeded with the task.

All adults were presented the four verb-learning conditions described in chapter 2, with the same novel word form –word meaning pairings for each item in their respective condition. For example, in the implicit rich linguistic context condition, all children heard the item “Alyssa /tidz/ the doh to Nicole.” [/tidz/ = “give”], and in the sparse linguistic context condition, they heard “She /kimz/ it to her. [/kimz/ = “give”]. The order of each condition was predetermined and randomized. Within each block of conditions, adults individually heard seven verb-learning sentence frames and were visually presented with a 4AFC. The prerecorded auditory was played twice for the adult on any given trial. Adults completed the fast-mapping task in 15 minutes.

3.3 Dependent Variable Scoring & Reliability

During the fast-mapping task, after each verb-learning sentence was presented in the 4AFC, the researcher wrote down the adult’s pointed response (i.e., A, B, C, D) for later scoring. Adults received a score of “0” when a non-target response was provided from that particular 4AFC, and a score of “1” when the target response was provided. The number of correct responses (out of a total of 28) given by each adult for each of the four verb-learning conditions provided the scores used in reliability testing. A research assistant who was not involved in the data collection reviewed the videos of the adults participating in the fast-mapping task and recorded the response that the adults pointed to in the 4AFC. The research assistant then the scored responses are correct (i.e., 1) or incorrect (i.e., 0). To ensure agreement and consistency in the recorded responses, we used percent agreement to verify 1) the accuracy of the recorded responses and 2) the accuracy in marking the responses as correct or incorrect. The research assistant verified the accuracy between their scoring and the researcher’s scoring to obtain our inter-rated

reliability rate. Rates of 90%-95% were used to establish inter-rated reliability; scoring agreement was 99%.

3.4 Adult Learner Results

The purpose of this experiment was to determine whether the linguistic context of a sentence (rich vs. sparse) affected verb learning and if contrast (explicit vs. implicit) could facilitate verb learning in rich and sparse linguistic contexts in typical adult English language users. The dependent variable, verb learning, was measured as the proportion of correct responses. Before we analyzed the effects of our independent variables on our dependent variable, we assessed the internal validity of our items in the fast-mapping paradigm. Our fast-mapping paradigm for verb learning consisted of 28 items. The internal consistency, as determined by a Cronbach's alpha, was valued at .719 and indicates our 28 items have acceptable internal consistency (for a review, see Taber, 2018). For the remaining analyses, we used these 28 items, with seven items in each of the four verb-learning conditions.

First, we analyzed our dependent variable using 2 linguistic context (rich vs. sparse) x 2 contrast (implicit vs. explicit) repeated measures ANOVA. The comparisons of interest were the main effect of linguistic context, and the interaction between linguistic context and contrast. Second, Bonferroni post-hoc analyses were performed to further identify which particular differences among the conditions were significant.

3.4.1 Main Analysis

There was a significant main effect of linguistic context, $F(1,29) = 14.34$, $p < .001$, $\eta^2 = .331$. Figure 2 depicts adult learners fast mapping novel verbs better in rich ($M = .97$; SEM = .012) linguistic contexts than in sparse ($M = .91$; SEM = .02) linguistic contexts (MD = .059, $p < .001$, 95% CI [.027 - .091]). However, there was no significant main effect for contrast (Explicit: $M = .94$; SEM = .016; Implicit: $M = .93$; SEM = .021) $F(1,29) = .274$, $p = .61$, $\eta^2 = .009$. That is, there were no overall fast mapping differences between the implicit and explicit verb-learning conditions (see Figure 3). No significant interaction for linguistic context and contrast occurred, $F(1,29) = .143$, $p = .24$, $\eta^2 = .047$. Figure 4 show the percent correct accuracy for the adult learners across the four verb-learning conditions

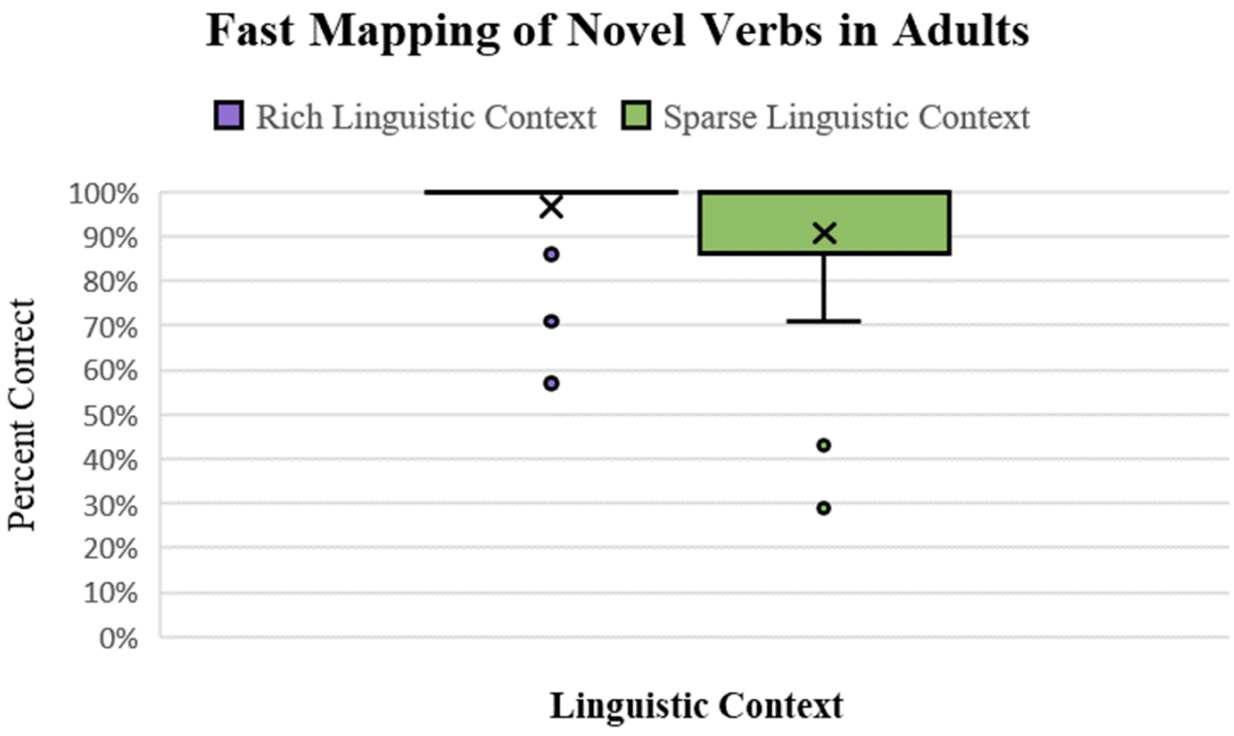


Figure 2. Adult's fast mapping performance on novel verbs in rich and sparse linguistic contexts.

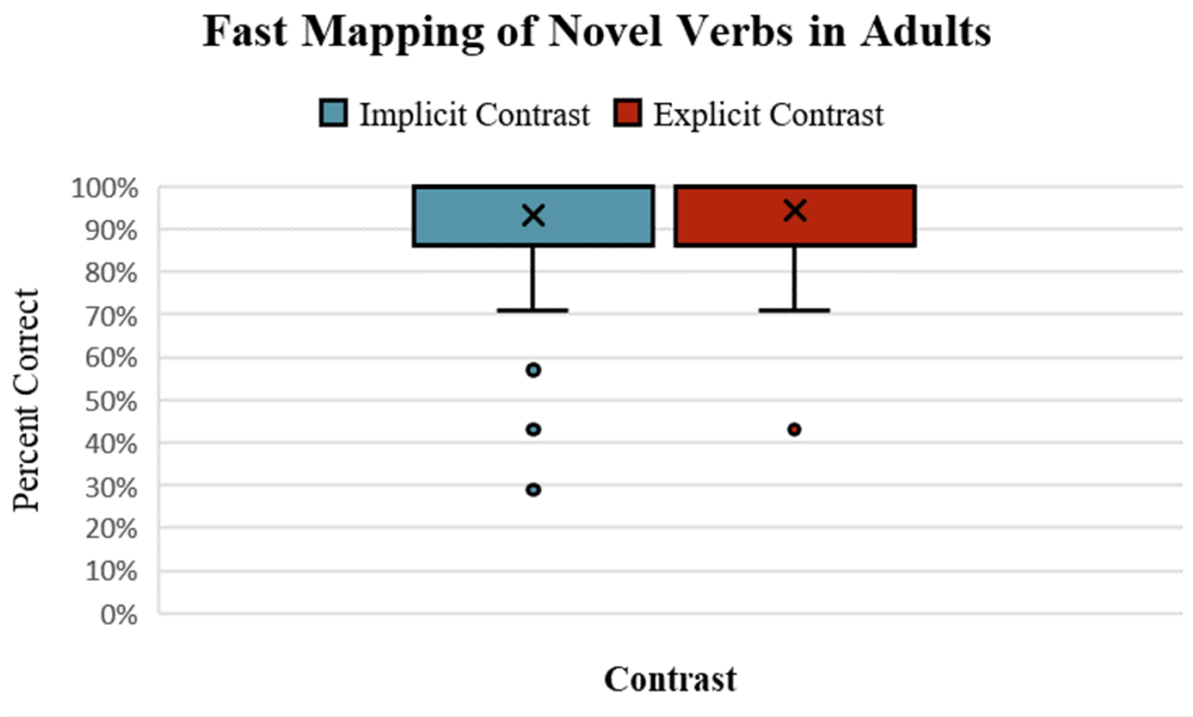


Figure 3. Adult's fast mapping performance on novel verbs in implicit and explicit contrast conditions.

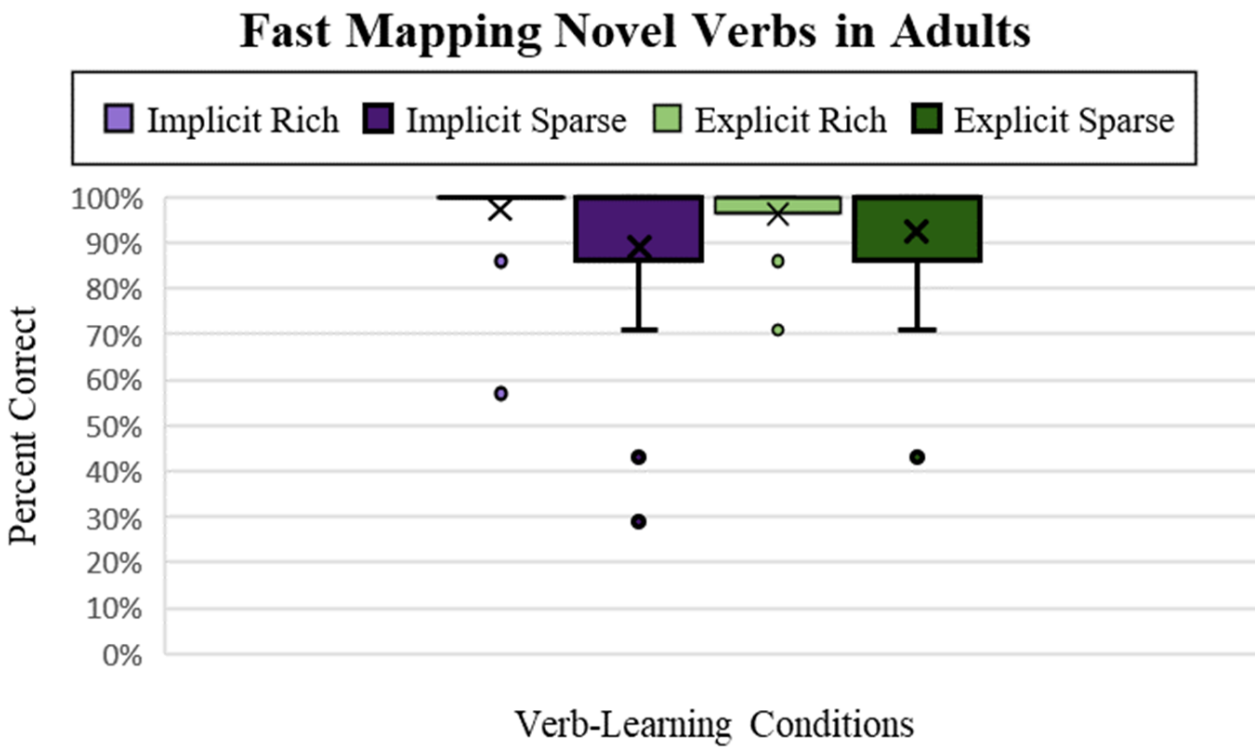


Figure 4. Adult's fast mapping performance on novel verb in the four verb-learning conditions.

3.4.2 Post-hoc Pairwise Comparisons

Although we did not find a significant interaction between linguistic context and contrast on verb learning, we did find a significant effect for linguistic context. We conducted post-hoc testing to identify which of the linguistic verb-learning conditions differed from one another**.** In rich linguistic contexts, adult learners fast mapped novel verbs similarly in the implicit and explicit contrast conditions, $F(1,29) = .31$, $p = .58$, $\eta^2 = .011$. In sparse linguistic contexts, adult learners fast mapped novel verb similarly in implicit and explicit contrast conditions, $F(1,29) = .78$, $p = .39$, $\eta^2 = .026$. When explicit contrast was offered, adult learners showed a significant difference in their fast mapping of novel verbs, $F(1,29) = 4.46$, $p = .043$, $\eta^2 = .133$. Specifically, they fast mapped novel

verbs better in rich (*M* = .96; SEM = .014) linguistic contexts compared to sparse (*M* = .93; SEM = .022) linguistic contexts (MD = .038, p = .043, 95% CI [.001 - .074]. When implicit contrast was presented, adult learners showed a significant difference in their fast mapping of novel verbs, F(1,29) = 7.94, p = 009, η^2 = .215. In implicit contrast conditions, adult learners fast mapped novel verbs better in rich (*M* = .97; SEM = .016) linguistic contexts than in sparse (*M* = .89; SEM = .03) linguistic contexts (MD = .081, p = .009, 95% CI [.022 - .140].

3.5. Summary

The effects of linguistic context and contrast and their interaction on the fast mapping of verbs were analyzed with a two-way repeated measures (2 X 2) ANOVA. We did not find an effect for contrast, and only a small effect for the interaction between linguistic context and contrast. However, we found a large effect size for linguistic context with adult learners fast mapping novel verbs better in rich linguistic contexts. These results reinforce prior findings that rich linguistic context aids adult learners (Gillette et al., 1999) and older children (Piccin et al., 2007) in identifying the meaning of a novel verb.

CHAPTER 4

CHILD LEARNERS

4.1 Participants

Twenty-three children were recruited, but three were excluded because they were unable to complete the fast-mapping task. Thus, 20 children (9 females; 11 males) with a mean age of 4 years, 7 months (range: 3;3 – 5;11 years; SD: 9 months) participated in this study from the surrounding areas of Amherst, Massachusetts, and Hartford, Connecticut. Electronic recruitment flyers were distributed on social media and to preschool directors. Inclusionary criteria required that all participants were between the ages of 3;0 and 5;11 years and were monolingual speakers of English with normal language, cognition (i.e., no medical diagnoses), and hearing. Interested parents of preschool-aged children used the website link or QR code on the electronic recruitment flyer and provided their contact information to the researcher on Google Form. The researcher contacted the parents by their preferred mode (e.g., phone or email) to verify that their children met the predetermined inclusionary and exclusionary criteria specified above and if they still wished to participate. If the children were eligible to participate in the study, the researcher sent the parents a secured link from the encrypted database, REDCap, to complete the electronic consent and child intake form.

4.1.1 Measures

Children's receptive vocabulary development was assessed via the Peabody Picture Vocabulary Test, 4th Edition (PPVT-4; (Dunn & Dunn, 2007), and their language skills were assessed via Clinical Evaluation of Language Fundamentals: Preschool 2nd Edition (CELF-P2; (Semel et al., 2004). Parents had the choice to have their child

participate in this study virtually or face-to-face. If the parents chose virtual participation, they were asked if they agreed to be facilitators during this remote research study. Parents were informed of the participation that was required of them. First, they were instructed to not guide their child's learning or answers during language testing or the experiment. Second, they were asked if they would be willing to verbally report which quadrant their child pointed to on the Zoom screen so that their child's response could be recorded. For those parents that chose face-to-face participation, they were also instructed to not guide their child's learning or answers during language testing or the experiment. Three children participated virtually via Zoom and 17 children participated face-to-face. To ensure confidentiality, all children's data were entered into an electronic, encrypted, HIPAA secured database approved by the UMass IRB (UMass OneDrive). Table 1 contains the participants' demographic information and standardized scores.

Table 1. Participants Demographic Information & Standardized Scores

Characteristic	TD
Number of Participants	20
Gender	
Female	9
Male	11
Age Range (years; months)	3;3-5;11
Mean Age in years; months (SD)	4;7 (9)
Mean (SD) PPVT-4 Raw Score	89.9 (26.16) (55-119)
Mean (SD) PPVT-4 SS	110 (12.72) (90-128)
Mean (SD) CELF-P2 SS	107 (12.72) (90-121)

Note: TD = typically developing
PPVT-4 SS= Peabody Picture Vocabulary Test, Fourth Edition Standard Score
CELF-P2 SS = Clinical Evaluation of Language Fundamentals: Preschool Second Edition Standard Score

4.2 Setting

Parents had the choice of how they wished for their child to participate in the study: virtually over the video conferencing platform Zoom or face-to-face. If the parent chose virtual participation, the child was accompanied by their parent as they sat in front of their computer to view the screen and examiner via web cam. If the parent chose face-to-face participation, the child was accompanied by their parent or another caretaker as they sat in front of the experimenter's computer either in the child's home, preschool or in the research lab. For children who participated in their home, distractions were asked to be kept to a minimum with the television turned off and the child and parent/caregiver in a quiet space.

4.3 Visual Stimuli

We used the visual stimuli described in chapter 2, but we modified elements of it to appeal to the children. First, the quadrants were renamed from letters to numbers due to the phonemic similarity between the phonemes /b/ and /d/. This could have posed a difficulty in differentiating the verbal responses from parents who were participating virtually and verbalizing the quadrant that their child selected by point. Second, we also added an image of our puppet, Ziggy, in the center of the screen, for each photograph picture set (see Appendix G). Third, to minimize fatigue in after seven verb-learning sentence frames were presented from a condition, an animated GIF (e.g., animal, cartoon character), appeared on the screen for a brief break before continuing.

4.4 Procedures

Prior to each child's first session, the researcher confirmed that the parent electronically signed the consent form and agreed to have their session video recorded. Children completed the standardized testing, fast-mapping task, and the naming task in one to two sessions. In the first session for all children, the researcher used the expressive vocabulary subtest on the CELF5- P2 as a warm-up task and then transitioned to the fast-mapping task. For the fast-mapping task, the laptop was placed directly in front of the child. If the child and parent were participating remotely, parents were reminded to not help their child in any way, only to verbally report the quadrant of their child's pointed response. The researcher then recorded the task with either an Apple iPhone 8 camera on a tabletop tripod facing the computer screen to record the child's pointed responses when face-to-face, or turned-on Zoom's recording feature to collect the parent's verbal response

At the start of the fast-mapping task, all children participated in a warm-up game designed to encourage them to point to the screen and orient them to the quadrants on the screen. The researcher presented four, individual photographed sets that contained a picture in each quadrant. For face-to-face participants, they were offered to pick a colored pointer from a choice of three to aid in their pointing on the screen. In the first photographed set, the child was asked to point to a familiar object among four objects (e.g., cup) and in the second photographed set, the researcher asked the child to point to another familiar object located in a different quadrant from the first familiar object (e.g., cupcake). In the third and fourth photographed sets, the child was asked to point to a familiar action among four actions (e.g., hug, and sleep, respectively) which were also located in different quadrants. By the end of the warm-up pointing task, all children would have pointed to each of the four quadrants. If a child was hesitant to point, the researcher demonstrated a point. If the child was completing the task remotely, their parent was asked to demonstrate a point. If the children pointed incorrectly, the researcher or the parent pointed to the correct item. Next, all children listened to the prerecorded script to introduce the fast-mapping task while watching the puppet talk on the screen, "telling" them what to do. The prerecorded script read:

> *Here is my alien friend Ziggy. He is new to learning English and he does not know many English words. Sometimes he uses alien words instead of English words. We have to figure out what he means. I want you to guess what Ziggy means and point to that picture. It's OK to make a guess. Let's practice guessing what Ziggy means.*

The researcher then presented a 4AFC training presentation on the screen and played the prerecorded sentence with a novel verb: “Ziggy says, Sarah and Katie /pug/ books. What does Ziggy mean? Point to the picture, Sarah and Katie /pug/ books.” The novel verb word form /pug/ and its intended verb meaning, read, were not included in the experimental stimuli. If the child pointed to the correct picture, the researcher informed them that, “Yes, you are right. Ziggy means “read.” If the child pointed to the incorrect picture, the researcher told the child, “No, that is not Sarah and Katie /pug/ books. Here is Sarah and Katie /pug/ books (while pointing to the correct picture). Ziggy means “read.” Following this training trial, a new screen appeared with the words “Are you ready?” The researcher asked the child if they were ready and proceeded with the task.

All children were presented the 28 trials featuring the four verb-learning conditions. Within each block of conditions, children individually heard seven verb-learning sentence frames and y presented with the 4AFC. The researcher made sure to secure the children’s attention before playing the prerecorded auditory stimuli (e.g., “Ready? Or “Let’s listen to Ziggy. He needs your help!”). The prerecorded auditory was played once for the child on any given trial, and the researcher verbally repeated the auditory stimuli no more than twice to encourage a pointed response. If a child was hesitant to point, they were prompted with “Show me,” or “What does Ziggy mean?” No feedback about performance was provided, only encouragement to keep momentum (e.g., “Now let’s see another,” “Here’s another one,” “Ziggy has more to say.”).

Following the fast-mapping task, the researcher presented a naming task. The children were shown seven individual photographs one at a time. Each photograph was

the target visual stimuli in the seven 4AFC photograph picture sets. For each photograph the child viewed on the computer screen, they were prompted with, “What are they doing?” or “What is she doing?” to elicit the action they viewed happening in the picture. The purpose of the naming task was to determine if the children could verbally identify our target actions. If they could, it suggests they could recognize the familiar action. Next, the researcher administered the remaining core language index subtests from the CELF5-P2 and then the PPVT-4. Depending on the availability of the children and their family, children completed all these tasks in one or two sessions. For those children who participated in two sessions, their first session ended after the naming task and in their second session, they completed the remaining standardized language and vocabulary measures in the order that it was presented above. Children completed the fast-mapping task in 15 minutes.

4.5 Dependent Variable Scoring & Reliability

During the fast-mapping task, after each verb-learning sentence trial was presented in the 4AFC, the researcher wrote down the child’s pointed response (i.e., 1, 2, 3, 4) for later scoring. Children received a score of “0” when the incorrect response was provided, and a score of “1” when the correct response was provided. The number of correct responses given by each child for each of the four verb-learning conditions were used to calculate the dependent variable. A research assistant, who was not a part of data collection, reviewed the videos of the children participating in the fast-mapping task and recorded the response that the children pointed to in the 4AFC. The research assistant then the scored responses are correct (i.e., 1) or incorrect (i.e., 0). To ensure agreement and consistency in the recorded responses, we used percent agreement to verify 1) the

accuracy of the recorded responses and 2) the accuracy in marking the responses as correct or incorrect. The research assistant verified the accuracy between their scoring and the researcher's scoring to obtain our inter-rated reliability rate. Rates of 90%-95% were used to establish inter-rated reliability; scoring agreement was 98%.

4.6 Child Learner Results

The purpose of this experiment was to determine whether the linguistic context of a sentence (rich vs. sparse) affected verb learning and to determine if explicit contrast could facilitate verb learning in rich and sparse linguistic contexts in typically developing, preschool-aged children. The dependent variable, verb learning, was measured as the proportion of correct responses. Before we analyzed the effects of our independent variables on our dependent variable, we assessed the internal validity of our items in the fast-mapping paradigm. Our fast-mapping paradigm for verb learning consisted of 28 items. The internal consistency, as determined by a Cronbach's alpha, was valued at .368. We eliminated an item from each of the four verb learning conditions in an effort to improve our internal consistency. We selected one item from each of the four conditions that was poorly correlated with the other items, and when these four items were removed, it increased our Cronbach's alpha ($\alpha = .571$). For the remaining analyses, we used these 24 items, with six items in each of the four verb-learning conditions.

We analyzed our dependent variable using 2 linguistic context (rich vs. sparse) x 2 form of contrast (implicit vs. explicit) repeated measures ANOVA. The comparisons of interest were the main effects of linguistic context and contrast, as well as the interaction between linguistic context and contrast. We performed, post-hoc analyses to further

explore a correlation between age and verb learning, and the differences in verb learning between older and younger participants.

4.6.1 Main Analysis

There was a significant main effect of contrast, $F(1,19) = 4.96$, $p = .04$, $\eta^2 = .21$ (see Figure 5). Child learners fast mapped novel verbs better in implicit ($M = .40$; SEM = .035) contrast conditions than in explicit ($M = .32$; SEM = .036) contrast conditions (MD = .079, p = .04, 95% CI [.005 - .153]. The main effect of linguistic context was not significant $F(1,19) = 2.81$, $p > .05$, $\eta^2 = .13$. That is, there were no overall fast mapping difference between rich ($M = .39$; SEM = .043) linguistic contexts and sparse ($M = .33$; SEM = .032) linguistic contexts (see Figure 6). Moreover, the interaction between linguistic context and contrast was not significant, $F(1,19) = 2.86$, $p > .05$, $\eta^2 = .13$. Figure 7 shows the percent correct accuracy for the child learners across the four verb-learning conditions.

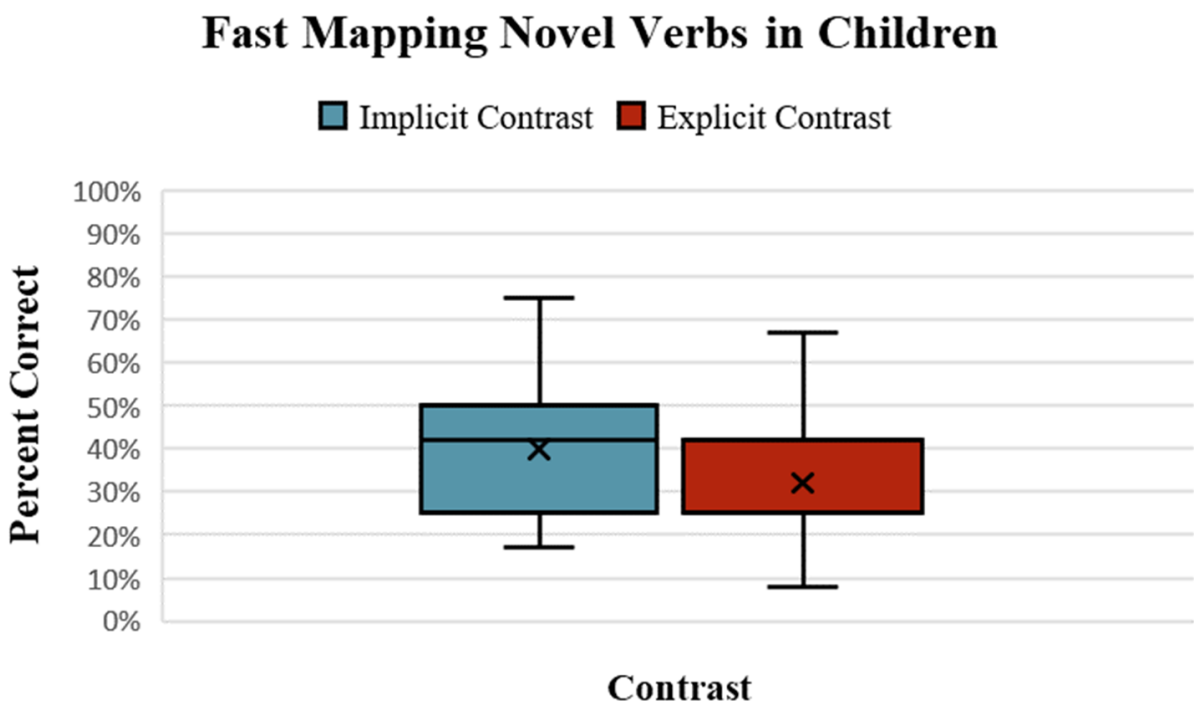


Figure 5. Children's fast mapping performance on novel verbs in implicit and explicit contrast conditions.

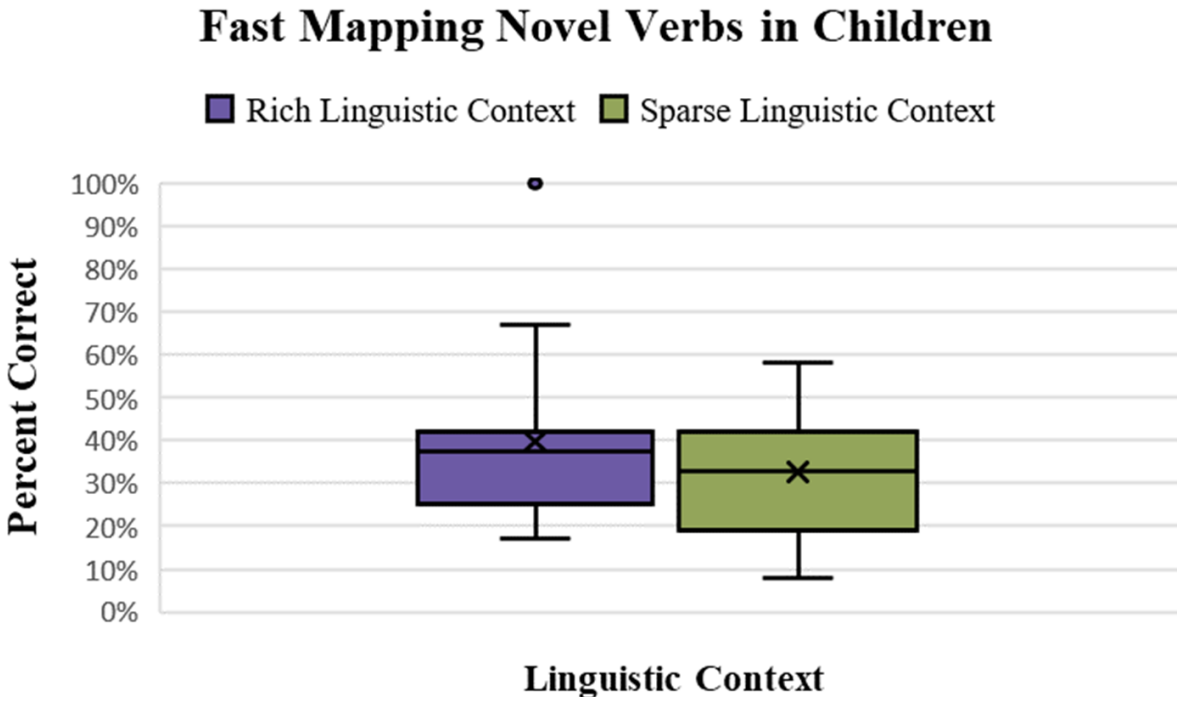


Figure 6. Children's fast mapping performance on novel verbs in rich and sparse linguistic contexts.

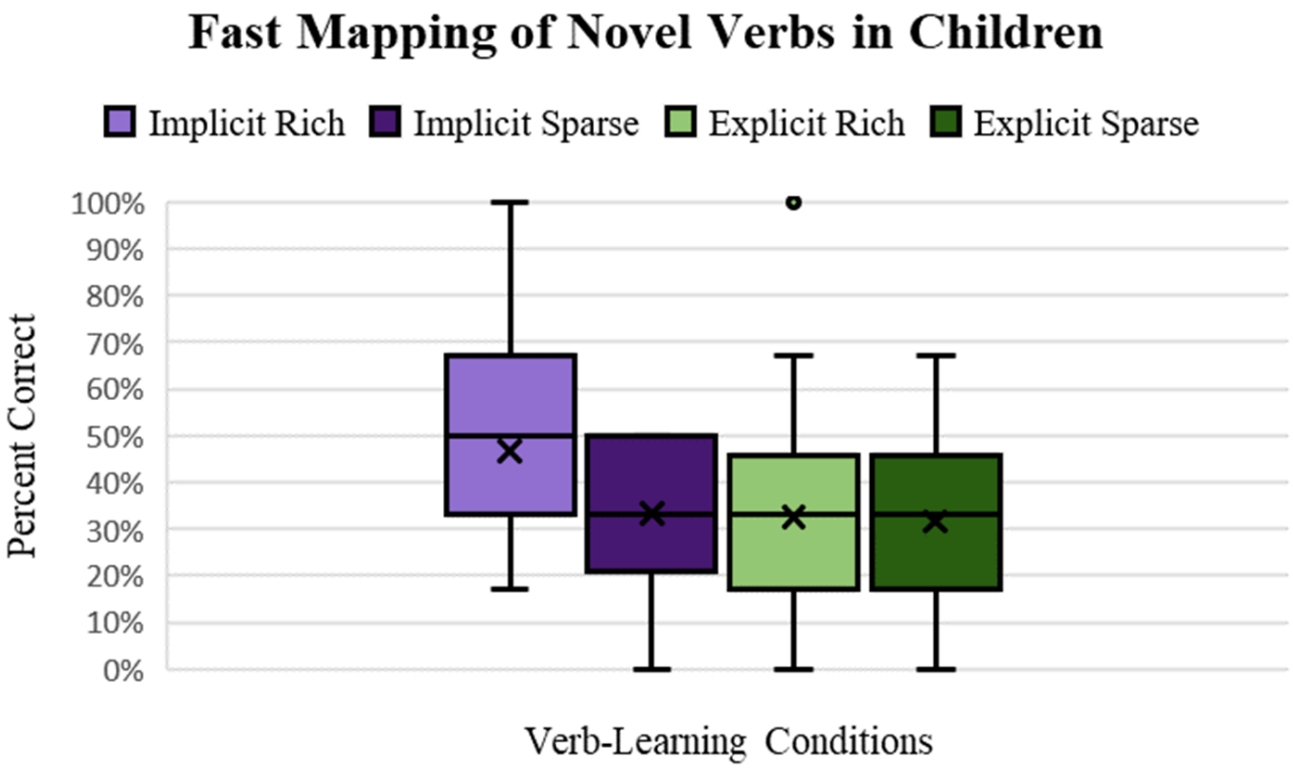


Figure 7. Children's fast mapping performance on novel verb in the four verb-learning conditions.

4.6.2 Post-hoc Pairwise Comparisons

Although we did not find a significant interaction between linguistic context and contrast, we did find an unexpected significant main effect for contrast. Given the significant main effect of contrast, we conducted post-hoc testing to identify which of the contrast conditions differed from one another**.** When implicit contrast was presented, children showed a significant difference in their fast mapping of novel verbs, $F(1, 19) = 5.75$, $p = .03$, $\eta^2 = .23$. Specifically, children fast mapped novel verbs better in rich (M = .47; SEM = .052) linguistic contexts than in sparse linguistic contexts (M = .33; SEM = .036), (MD = .135, p = .03, 95% CI [.017 - .252]. When explicit contrast was offered, child learners did not show a significant difference in their fast mapping of novel verbs,

$F(1,19) = .03$, $p = .88$, $\eta^2 = .001$. Specifically, children fast mapped novel verbs similarly in rich ($M = .33$; SEM = .05) linguistic contexts and sparse ($M = .32$; SEM = .042) linguistic contexts (MD = .009, p = .88, 95% CI [-.111 - .129]. Although the main effect of linguistic context was not significant, planned pairwise comparisons confirmed the results from our primary analysis.

4.6.3 Group Difference Exploratory Analyses

Given that age effects are common in the word learning literature for nouns (He & Arunachalam, 2017) and verbs (Imai et al., 2005, 2008), we wanted to consider the possibility that they might also be at play within our preschool group. Thus, we conducted exploratory analyses to examine possible age effects in younger and older preschoolers and their fast-mapping novel verb performance across the four verb-learning conditions. We took our age range 3; 0 – 5; 11 (years, months) and divided the children into two groups. If children were younger than 4;6, they were in our younger group (n = 8), and if they were older than 4;6, they were placed into our older group (n =12). Due to our small samples size per group violating the normality assumption, we used a non-parametric test, Friedman's test with pairwise comparisons, to detect whether there were differences in our verb-learning conditions within each group.

4.6.4 Younger Group (3;0-4;6)

A Friedman test was conducted to determine if there were verb-learning differences in the linguistic context and contrast conditions in our younger children (ages 3;0 to 4;6). The fast mapping of novel verbs was not significantly different across the four verb-learning conditions χ^2 (3) = 1.56, $p > .05$. Figure 8 shows the percent correct accuracy for the children in our younger group (n=8). As shown in Figure 8, most of the

children showed essentially no difference in their accuracy of fast mapping novel verbs in each of the conditions: implicit-rich linguistic context, implicit-sparse linguistic context, explicit-rich linguistic context, and explicit-sparse linguistic context.

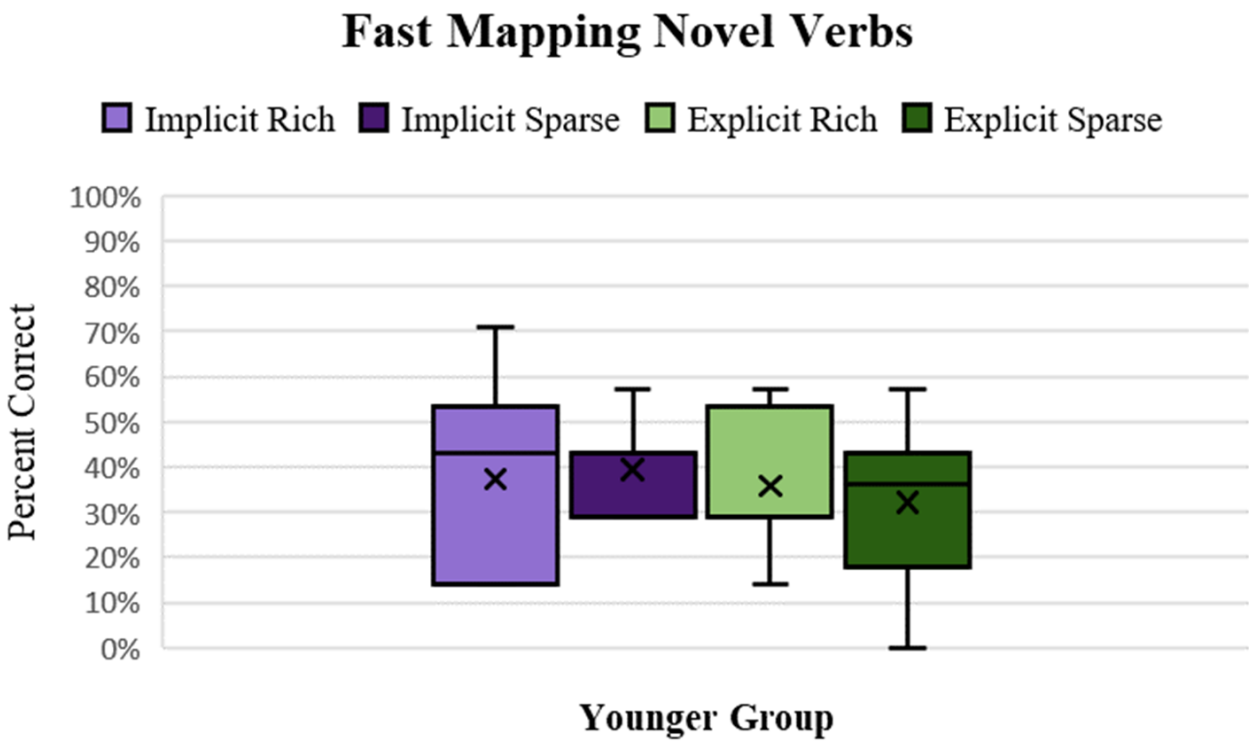


Figure 8. Younger preschool-aged children's fast mapping performance on novel verbs across the four verb-learning conditions.

4.6.5 Older Group (4;7-5;11)

A Friedman test was conducted to determine if there were verb-learning differences in the linguistic context and contrast conditions in our older children between (ages 4;7 to 5;11). The fast mapping of verbs was significant across the four verb-learning conditions, χ^2 (3) = 10.354, p = .02. Pairwise comparisons were performed (SPSS, Statistics, 2022) with a Bonferroni correction for multiple comparisons between the conditions. Post hoc analysis revealed for the implicit contrast condition, older

children fast mapped novel verbs better in the rich (*M* = .49; SD = .21) linguistic contexts compared to the sparse (*M* = .27; SD = .15) linguistic contexts (p <.05). Figure 9 shows the percent correct accuracy for the children in our older group (n=12).

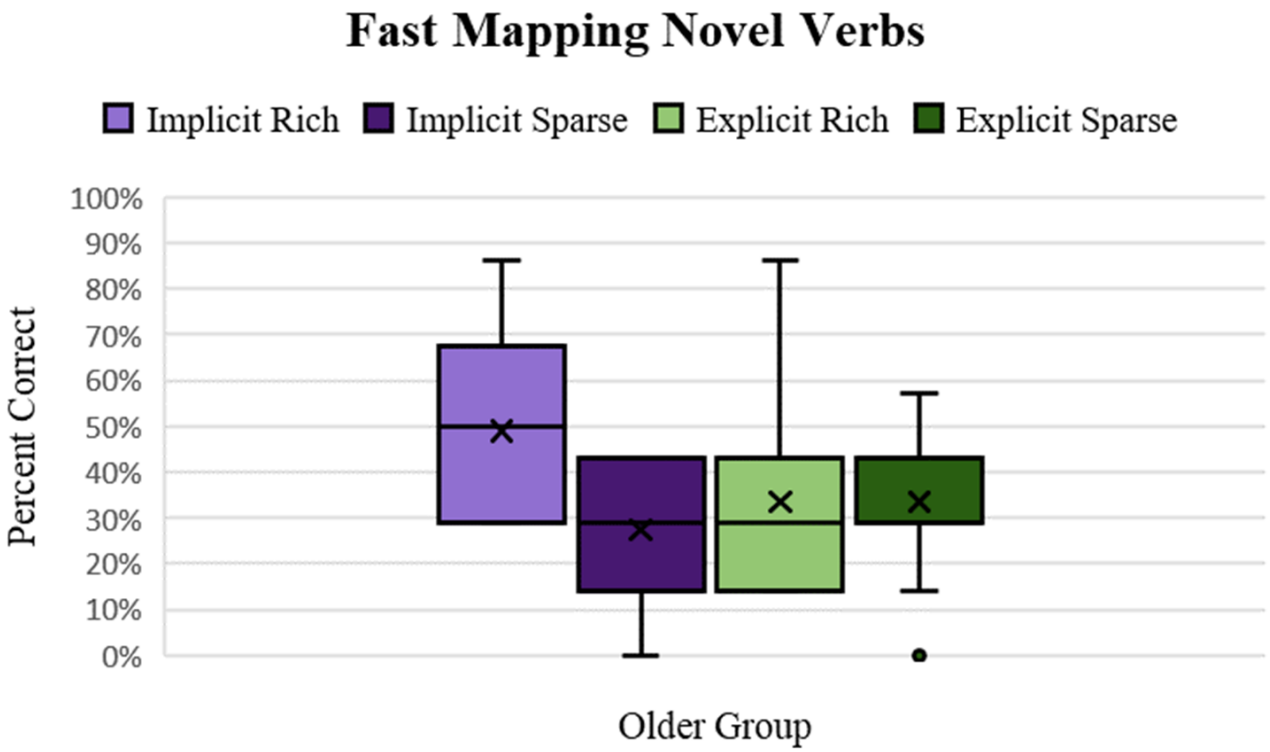


Figure 9. Older preschool-aged children's fast mapping performance on novel verbs across the four verb-learning conditions.

4.6.6 Naming Task

Recall that we administered a naming task for the purpose of determining whether children could identify our target actions. Table 2 shows the children's responses to the naming task when presented a photograph and prompted with, "What are they doing?" or What is she doing?" The children saw these seven photographs in a 4AFC photograph picture set that were used across the four verb-learning conditions. These seven photographs depicted the target GAP verbs present in each of our sentence stimuli conditions (e.g., implicit-rich linguistic context, implicit-sparse linguistic context,

explicit-rich linguistic context, and explicit-sparse linguistic context). As table 2 shows, children could verbally identify the target action in the photographs and for some actions, they offered actions with similar meaning. Children demonstrated their knowledge of the familiar actions, but interestingly, in our fast-mapping task, they had difficulty extending the meaning of these familiar actions.

Table 2. Children's Responses to Naming Task

Target Verb Meaning	Child Responses
get	playing, picking it up, putting, making, taking, sharing, grabbing, eating, moving
put	rolling, playing, going to, putting, holding, doing, IDK
eat	eating
give	passing, playing, sharing, giving, dropping, putting, handing, IDK
throw	tossing, throwing, putting, playing, like battle
drink	drinking, sipping
roll	rolling, doing, IDK

*IDK = Child's response for "I don't know."

4.7 Summary

The effects of linguistic context and contrast and their interaction on the fast mapping of verbs were analyzed with a two-way repeated measures (2 X 2) ANOVA. The main effect for linguistic context on child learners' verb learning was not significant, but we did find a large effect of contrast. Specifically, for child learners, the use of contrastive information matters, and in our study, less was more. Moreover, in the implicit contrast conditions, our older group of children fast mapped novel verbs more accurately in rich linguistic contexts than in sparse linguistic contexts. The older children's performance likely drove our main effect of contrast as our younger children

performed similarly across all four verb-learning conditions. In our naming task, most children correctly labeled the action depicted in the scene. Thus, children's knowledge of our target verbs was expressed better in our production, not receptive, task.

CHAPTER 5

GENERAL DISCUSSION

The goal of the current studies was to determine how well word learners use linguistic context with and without contrastive information to facilitate verb learning. This study was the first to consider these cues in concert, rather than as isolated main effects. Moreover, we were interested in whether the effects of these cues differed across development. We addressed this by looking at how children and adults used these cues. These were important methodological advancements because children and adults integrate multiple cues to identify the meaning of words, and how they use these cues could change over development. We asked three research questions: (a) How well do word learners use rich and sparse linguistic contexts to fast map novel verbs? and (b) Can contrast be used as an additional cue to trigger verb learning in rich and sparse linguistic contexts? and (c) Are the effects of linguistic context and explicit contrast, as well as any interactions similar for adult and child learners? For child word learners, we found no effect of linguistic context on their verb-learning, but we did find an effect of contrast, albeit in the opposite direction than we expected. We predicted that children would fast map novel verbs better in rich than sparse linguistic contexts because previous studies with children and adults demonstrated that they make use of this linguistic information to learn and extend the meaning of novel verbs (Arunachalam & Waxman, 2011; Gillette, 1999; Piccin & Waxman, 2007). We found this to some extent, however, our study showed that only older children benefit from rich linguistic context and only with an implicit contrast. That we found implicit contrast to be fairly helpful in verb learning counters our predictions that contrastive information would facilitate verb learning because of emergent findings in the literature (Childers et al., 2014). On the other hand,

adults benefit from linguistic context, specifically rich linguistic contexts, to identify verb meanings more accurately. Given our findings, we offer three hypotheses as to why we may not have found an effect for linguistic context with and without the use of explicit contrast.

5.1 Hypothesis 1: Input Problem

In this study, we have an initial map problem, and this may be less surprising than we might have thought given the effects that the quantity and quality of the input have on word learning. In terms of quantity, frequent input builds children's understanding of words faster than limited input (Goodman et al., 2008; Huttenlocher et al., 1991; Naigles & Hoff-Ginsberg, 1998; Rice et al., 1992; Theakston et al., 2004). On the other hand, the quality of that input also matters (for a review, see Rowe & Snow, 2020). The purpose of the fast-mapping paradigm is to examine how quickly word learners map meaning between a referent and the unfamiliar word. However, it does not consider frequency-sensitive learning mechanisms, the complexity or quality of the stimuli, or the interactive exchanges between children and adults that promote language learning. In other words, high quantity, but poor quality may not be better than low quantity, but high quality. This leaves it open for others to explore what type of exposures are needed to promote verb learning in various linguistic contexts, especially for children. Is it the quantity or the quality of the input? For adults, fast-mapping performance in this study suggests that the quantity and/or quality of the input does not have an effect on verb learning. Therefore, we propose several future experiments that may help us address the role of input in children's verb learning.

5.1.1 Future Experiments: Input Quantity

The first few times the children heard the novel verb and saw the scenes in our 4AFC presentation, they had difficulty resolving the meaning of the unfamiliar word. One issue that arises is one of input quantity. We counterbalanced our verb-learning conditions and randomized the presentation of the conditions to reduce the chances of order and carryover effects. However, this does not negate the possibility of learning effects occurring within a verb-learning block of trials. In other words, as children continued through the trials within a particular verb-learning condition, did their fast mapping of novel verbs improve as they became familiar with the condition? If yes, this would suggest that children required increased input to facilitate their verb learning. If not, this could mean that a single exposure or two of a novel verb embedded in the middle of the sentence was not sufficient enough for children to map meaning between the novel verb and its potential referents. Future studies will need to tease apart the quantity of the input within and across trials to fully understand how input plays a role in verb learning. Specifically, children may have required more repetitions to map the novel verb if the input problem is due to limited exposure to a target verb, then we need to increase the input and add repetitions in the learning task.

5.1.2 Future Experiments: Input Quality

In our study, children heard the novel verb flanked by full-noun phrases or pronominal phrases. Although we manipulated the linguistic context surrounding the novel verb, we may have made the linguistic input too difficult for children than in previous verb-learning studies. Most prior word-learning studies, for nouns and verbs,

positioned novel words at the end of the utterance, not the middle (He et al., 2020; Maguire et al., 2002; Spiegel & Halberda, 2011). In such experiments, young children tend to be efficient word learners in just a single exposure to a new word. We chose to put the verb in the middle of the sentence because it allowed use to use different argument structures. In hindsight, however, it is possible that embedding a target verb in the sentence medial position may have been too complex. Previous word-learning studies traditionally embed the target word in the sentence final position (e.g., "Hide the koob," Dollaghan, 1985; "Watch this one tiv" Eyer et al., 2002). A next step would be to include sentence stimuli that compares novel verbs embedded in the medial position and final position of utterances to better understand the positional effects of novel verbs and how word position affects linguistic context during fast-mapping tasks.

On the other hand, our stimuli may have included the right amount of challenge, but the computerized interface did not allow children to benefit from a dyadic interaction with an adult. We know that language learning often takes place in the context of social interactions and contingent responses (McGillion et al., 2013). In our study, we may have stressed children's language learning mechanisms to such an extent that it did not reveal their learning potential. To better understand their learning process, research investigating preschooler's verb learning within mediated learning experiences (MLE) has the potential to explain the learning context and the level of skilled support children may need for learning to occur (Feuerstein et al., 1985; Hoff, 2006). In the case of our study, children may have benefitted from explicit instruction on how to map a verb to its subject and predicate, how to use full-noun phrases and pronominal phrases to identify potential referents, or how to use contrastive information in their process of elimination. Within

the learning context of MLE, we would be able to distinguish between strong and weak language learners, and more importantly, identify children with possible language impairments (Ukrainetz et al., 2000).

5.2 Hypothesis 2: Visual Attention Problem

Our results suggest that we designed an experiment that was conceptually challenging for preschool-aged children. We provided them with rich linguistic input where they needed to parse the sentence, figure out which of the words was a novel word, identify the meaning of the novel verb form, and map the intended meaning of the verb to a visual scene. Not only was this a difficult task in and of itself, but our 4AFC photographed scenes may not have provided visual cues that would have made it obvious that two of the scenes must be incorrect (e.g., singular versus plural subjects). Our sentences explicitly told the children the person and number for singular (e.g., “Alyssa” or “She) and plural (e.g., “Alyssa and Nicole” or “They”) subjects. The linguistic context alone in our sentences, rich or sparse, could have helped cue the children to identify the correct number of subjects for a 50/50 chance in identifying the meaning of the novel verb between two visual scenes, assuming that the children understood “they” to refer to plural subjects rather than to singular ones, as “they” can be used a singular pronoun. Although we were not tapping into their subject and verb agreement knowledge directly, the fact that the children did not make use of this cue suggests one of two things. First, our children’s understanding of number agreement may not have been sensitive enough to perceive tense and agreement differences as this has been shown to be mastered for English language learners between the ages of five and six years (Johnson et al., 2005). Second, our visual scenes serving as foils may have been too similar to the visual scene

of the target verb and this could have made it too difficult for the children to visually attend to the objects and differentiate the relations among the four scenes. This seems more likely as previous studies have shown that children look to objects when fast mapping verbs and extending the meaning of a new verb (Childers, 2020; Imai et al., 2005, 2008; Valleau & Arunachalam, 2018). Our 4AFC presentations had the same objects, in relatively the same locations across scenes. This would have required the children to use what they heard in the sentence's subject and predicate to correctly map the meaning and relations of the novel verb. At best, the children would need to have detected the visual nuances across the four scenes. For our adult learners, they had the perceptual flexibility to parse and process the sentence and detect the visual nuances across the scenes to map the verb's meaning to a picture stimulus.

We predicted that children would use the linguistic context within a sentence to map a novel verb because of the verb-learning literature supporting syntactic bootstrapping and structure mapping theories (Fisher et al., 1991; Gentner, 1983; Gleitman, 1990; Naigles, 1990; Yuan et al., 2012). Not only would children count the nouns in the linguistic context, but they would also structurally align the order of the presented noun phrases to correctly map the meaning of the novel verb. Our failure to find a main effect for linguistic context suggests the surface similarity among the visual scenes made the task too complex, especially for the younger children. Previous research has shown that younger children benefit from progressive alignment experiences where they pay visual attention to relevant elements across multiple events when learning verbs (Childers et al., 2016). But for children who are older than four and a half years, they may not need progressive alignment experiences to learn new verbs. This may have been

why our older preschoolers were more successful at fast mapping novel verbs in the implicit contrast-rich linguistic condition because they could visually attend and compare which relevant elements mattered in the moment. This result is especially important because it converges with the body of literature that says linguistic context matters for verb learning and it is used by older children and adults (Gillette et al., 1999; Piccin & Waxman, 2007).

5.2.1 Future Experiments: Eye-Tracking

In recent years, eye tracking has been used in extended verb mapping studies to reveal where children are looking. Although this information does not address our initial map problem when linguistic and contrastive information are manipulated, we can use eye-tracking methods to gain a deeper understanding of children's visual attention at first map. What are children looking at in the moment when they hear a novel verb embedded in the middle of a sentence? How are they scanning the scene? Childers and colleagues first found that two-and three-year old children looked to objects and tools in dynamic scenes across multiple events (2020) and later found that preschool-aged children looked to the agent's hands to see how they manipulated the object or used the tool to perceptually learn the novel verb (2022). Since we did not find a main effect for linguistic context, we predict that eye-tracking measures may reveal which elements children are visually attending to in the fast-mapping paradigm. If the children are solely scanning the objects across the four scenes, this could explain why our children were inaccurate in their first map because they did not visually attend to the relations in the scene. If children are scanning objects and hands across the four scenes, and still select the incorrect scene, they may not be extracting the visual nuances that align with the input.

Therefore, future studies will need to explore children's visual attention with eye tracking to understand what attracts their immediate attention during an initial map of a novel verb. This information would tell us about what parts of the sentence they are paying attention to, especially when we found that they were not using rich linguistic context to identify singular and plural subjects.

5.3 Hypothesis 3: Working Memory Problem

Our adult learners were successful in fast mapping novel verbs in rich and sparse linguistic contexts and when contrastive information was explicitly offered. It could be that adult learners were more successful than child learners because they could balance the processing and attentional demands. The adults could process the sentence(s) while comparing the four scenes on the screen while simultaneously attending to the agent(s), instrument or tool, and affected objects to align the referents to the relational structure of the sentence. In other words, the cognitive demands placed on them did not diminish their working memory capacity. However, for our child learners, we were asking them to process a lot of cognitive tasks at once and this may be why we did not see an effect for linguistic context nor an interaction for linguistic context and contrast. Our findings are consistent with the packaging problem. When young children need to integrate information across two sentences, it is too challenging for them to identify the referents and the meaning of a novel verb when linguistic context is manipulated (Arunachalam & Waxman, 2015). Arunachalam and Waxman (2015) attempted to draw children's attention to the referents in the sentence whereas we tried to provide an action that was the opposite meaning of the novel verb. If we could tell our word learners what the referents were not, it could provide them with a clue as to which meaning the novel verb

could take in the second sentence. We predicted that the contrastive information in the first sentence would help constrain the possible verbs meanings and eliminate those visual scenes that could not align with their new conceptual understanding of the novel (e.g., “They don’t play with the cupcakes. They /tɛb/ the cupcakes.”). Even when the novel verb was flanked by full-noun phrases and the referents were specifically labeled, the amount of information the children had to hold in their working memory and connect it with other information may have been too much.

More surprisingly, in our naming task, we did not create new actions. We purposely used General All Purpose (GAP) verbs because they are familiar actions to children and many verbs are associated with them (e.g., give = share, pass, hand over). The naming task tells us that children can identify the sentence in the picture with a real verb, but in the fast-mapping task, they could not draw upon the argument structure of that known verb and link it to the meaning of the unfamiliar novel verb with the same sentence structure. Or children had difficulty in overriding their initial bias against a familiar action having multiple names (Markman & Wachtel, 1988). Our adult learners, on the other hand, did this rather easily. Previous work suggests their success may have relied on their ability to use other strategies to identify the meaning of the novel verb. Gillette and colleagues (1999) found that adults were more likely to entertain the possible verb meaning given the nouns in the sentence, which helped them constrain the novel verb’s meaning. It also could have been possible that adults were more likely to use the number of nouns and pronouns present in the sentence to cue the number of arguments that novel verb’s predicate could take (Gillette et al., 1999). The present study’s results indicate that adults readily use linguistic context to map a novel verb’s meaning, but that

they can also make quick associations between their initial verb interpretation to already known events a verb might describe. However, for our child learners, they had difficulty mapping novel verb form to the verbs meaning that they are already knew (but see, Fisher et al., 2020).

5.3.1 Future Experiments: Multiple Cues & Supports over Time

We do not believe the children's results were due to weak or partial representations of known verbs and their sentence structures as Tomasello and Abbot (2002) might imply. Rather, the difficulty to map what they already know about familiar verbs to a novel verb form in the moment was an issue of working memory such that children were unable to make use of too much available linguistic information. The usefulness of linguistic context and contrast may depend on the age of the child as our group of older preschoolers made use of the cue in the implicit contrast-rich linguistic context condition. In future work, it will be important to look into which strategies or cues might be more useful for verb learning across the development of preschool-aged children.

First, to address the overall processing load, previous research explored the use of scaffolding to gradually draw children's attention to specific elements of the sentence's linguistic context in verb learning (Lidz, 2009 when one cue is better than two). By pre-exposing the 22-month-old children to the subject (e.g., "Look at the girl. See the girl? The girl is gorping"), Lidz and colleagues (2009) speculated that the chunking of the sentence's linguistic context made it more accessible to the word learner to infer the meaning of the verb. Our younger group of preschoolers may have benefited from this

strategy to ease the processing load on their working memory and select the correct subject and referents that they heard in the sentence.

Second, age may have been a factor in our study such that child learners may rely on different cues to map novel verbs at different developmental times (e.g., Emergentist Coalition Model (ECM); Golinkoff & Hirsh-Pasek, 2008; Hollich et al., 2000). In future work, it will be important to understand how verb learning evolves over the preschool period and how different attentional and linguistic cues hinder or facilitate verb learning in children. By examining the effects of these cues in six month increments across age, we will better understand how to cue preschool-aged children between three-and-five-years old to aid their verb learning. In addition, examining these cues within sentence structures can help us understand the development of syntactic bootstrapping (Fisher et al., 2020) as a mechanism of learning verbs that are related to GAP verbs rather than failing to assign a new verb to a known action, as our children did here. The implications of these future studies may be of benefit to children with language impairments who are known to have verb-learning difficulties ((Kan & Windsor, 2010; Rice et al., 2005).

5.4 Limitations

For child learners, linguistic context had a small effect on their verb learning. A sample size of 20 children may not have had the statistical power to expose a larger effect. Future studies should consider increasing the sample size to determine the effects of linguistic context on verb learning in preschool-aged children. Also, given the age range of our children, 3;0-5;11 (years; months), our results indicate there may be verb-learning differences between younger and older children. Our sample sizes in each group were small, specifically, the younger preschool-aged children. We may not have had

enough child learners in the younger group to detect possible effects on our variables of interest. To confirm this finding, future studies will also need to increase the number of child learners across age groups.

Our stimuli choices could have also limited children's performance. The use of a 4AFC presentation for our visual stimuli may have made it difficult for children to scan the scenes and infer verb meaning. Not only were children attending to the information presented in the auditory stimulus, but they also had to visually search for a scene that matched the sentence they heard. For adults and older children, they exhibited the perceptual flexibility to succeed in the fast-mapping task whereas younger children struggled. Another limitation may have been our sentence stimuli. Our use of transitive and ditransitive sentences may have presented too much information in the sentences for children to process the sentence and extract the verb's meaning. Specifically, our explicit contrast conditions presented two consecutive sentences with multiple argument structures (e.g., transitive, and ditransitive sentences; "Alyssa doesn't keep the doh. Alyssa /hɔbz/ the doh to Nicole"). This could have confounded our results as implicit contrast (i.e., a single sentence; "Alyssa /hɔbz/ the doh to Nicole.") was revealed to be more effective for verb learning. Also, we presented our transitive and ditransitive sentences in static scenes, and this could have limited how well children interpreted the action. The use of dynamic scenes could have eased this burden.

An additional confound could have been our target verbs, which were familiar actions (e.g., GAP verbs: put, get, give, etc.). Initially, we did not think this would be an issue because GAP verbs serve as a "template" from which to learn other verbs (e.g., more semantically specific verbs; Thordardottir & Weismer, 2001). In other words, if

children have knowledge of the verb "give," then they should be able to extend its meaning and argument structure to other 'give-type' verbs (e.g., share, pass, hand over, etc.,). In our naming task, children provided synonyms to our target verbs (e.g., Giving "passing" as a response when looking at the picture depicting Alyssa giving the doh to Nicole), yet it was more difficult for them to accept our novel verb forms in sentences as synonyms for actions that were already in their vocabulary. When children heard a novel verb form in some fast-mapping tasks, they use the mutual exclusivity constraint to associate the novel verb form with a new action, as they do with nouns (Markman & Watchel, 1988). However, we did not present novel actions in our pictured stimuli to suggest the novel verb form was a novel action. This may have hindered children's verb learning because actions can have multiple names. For our adult learners, they could entertain the novel verb form as a possible synonym. If GAP verbs were a confound, testing GAP verbs and novel verbs (e.g., both form and meaning; /mik/ = to scoop up an object with an instrument and place it in a new location) within our research design would help tease a part this issue.

Lastly, the use of the fast-mapping paradigm has largely been used in noun learning studies that take place in research laboratories – an environment that could not be any more opposite than the environments where children and adults learn words. The fast-mapping paradigm allows us to manipulate and hypothesize the types of cues word learners are using in one, quick moment to learn words, most often nouns. However, for verbs, it may be more difficult to capture their essence in a fast-mapping task. Instead, cross-situational learning paradigms may be better in simulating how word learners learn

and refine the meanings of novel verbs across multiple exposures with contrastive information and in different linguistic contexts.

5.5 Conclusion

The combined results from adult learners and child learners support the theoretical framework of the emergentist coalition model (Hollich et al., 2000). Adult learners used the linguistic context provided by full-noun phrases, pronominal phrases, and object phrases to infer the meaning of the novel verb. Even when adult learners were provided with sparse linguistic contexts, they still correctly identified the referents at first map. This suggests that their verb-learning performance can also be attributed to their language experiences and syntactic knowledge. However, the fast-mapping paradigm limits us in determining which cues adults used in the moment to infer verb meaning. As for our child learners, older preschool-aged children fast mapped the meaning of novel verbs with more accuracy when the verb was flanked by noun phrases in the implicit contrast condition. The younger preschool-aged children fast mapped novel verbs different from chance in each of the four verb-learning conditions but have not begun to differentiate the verb-learning contexts to map the correct referents to the novel verb. The fast-mapping differences between younger and older preschool-aged children could indicate child learners may rely on different cues to map novel verbs at different developmental times. Our results motivate future studies that could be designed to explore the effects of input, visual attention, and working memory on future verb-learning studies in preschool-aged children. This, in turn, could be used to better understand the difficulty children have in acquiring verbs and inform us which learning contexts facilitate verb learning.

APPENDIX A

LIST OF FAMILIAR ACTIONS & EARL ACQUIRED VERBS

1. Get
2. Put
3. Eat
4. Give
5. Throw
6. Drink
7. Roll

APPENDIX B

CONDITIONS COUNTERBALANCED WITHIN LATIN SQUARE DESIGN

Latin Square Design: Each condition occurs in every column and row.

Participant #	**Condition Presentation**			
1	A	B	D	C
2	B	C	A	D
3	C	D	B	A
4	D	A	C	B

A: Implicit-Rich Linguistic Context Condition
B: Implicit-Sparse Linguistic Context Condition
C: Explicit-Sparse Linguistic Context Condition
D: Explicit-Rich Linguistic Context Condition

APPENDIX C

ORDER OF PRESENTED VERB-LEARNING CONDITIONS

Order of presented conditions as determined by the sequence generator (random.org)

Participant #	**Condition Presentation**				**Condition Sequence Determined By:**
1	A	B	D	C	Latin Square
2	B	C	A	D	
3	C	D	B	A	
4	D	A	C	B	
5	C	D	B	A	Random Sequence Generator
6	A	B	D	C	
7	B	C	A	D	
8	D	A	C	B	
9	B	C	A	D	
10	A	B	D	C	
11	C	D	B	A	
12	D	A	C	B	
13	D	A	C	B	
14	B	C	A	D	
15	C	D	B	A	
16	A	B	D	C	
17	A	B	D	C	
18	B	C	A	D	
19	D	A	C	B	
20	B	C	A	D	

APPENDIX D

LIST OF TRANSITIVE & DITRANSITIVE SENTENCES

Sentence Type	Sentence Structures	Example
Transitive	[NP] + V + [NP]	Izzy **eats** the cupcakes.
	[NP] + V + [NP] + location	Alyssa **puts** the doh on the table.
	[NP] + V + [NP] from location	Izzy **gets** the cupcake from the table.
Ditransitive	[NP] + V + [NP] + to [NP]	Alyssa **gives** the doh to Nicole.
	[NP] + V + [NP] to PRON	Alyssa and Nicole **throw** the doh to each other.
	[NP] + V + [NP] with [NP]	Alyssa **rolls** the doh with the roller.

APPENDIX E

WORD STIMULI: NOVEL LEXICAL VERB FORMS

1. /nɔɪt/
2. /hun/
3. /bɛm/
4. /tid/
5. /kɛm/
6. /tɔɪm/
7. /bæf/
8. /bɑd/
9. /huk/
10. /tɪd/
11. /kim/
12. /nug/
13. /neg/
14. /nɪɔm/
15. /wId/
16. /nʌd/
17. /wom/
18. /hɔb/
19. /wɪb/
20. /bɔɪn/
21. /daɪb/
22. /wɔd/
23. /dub/
24. /tɛb/
25. /dæk/
26. /mɪb/
27. /hod/
28. /tʌd/

APPENDIX F

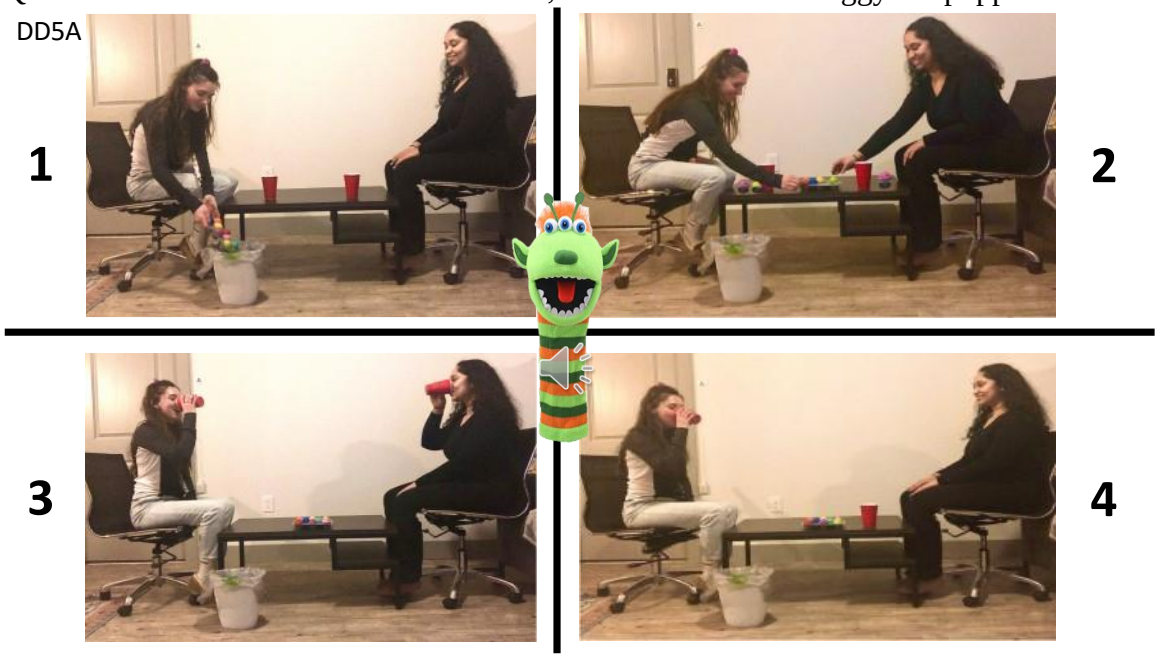
FINAL LIST OF SENTENCES BY CONDITION

Condition	Verb-Learning Sentence Frame
Implicit Contrast-Rich Linguistic Context	Izzy and Rachel /nɔɪt/ the cupcakes from the table.
	Alyssa and Nicole /hun/ the doh on the table.
	Izzy and Rachel /bɛm/ the cupcakes.
	Alyssa /tidz/ the doh to Nicole.
	Alyssa and Nicole /kɛm/ the doh to each other.
	Izzy /tɔɪmz/ the water.
	Alyssa /bæfs/ the doh with the roller.
Implicit Contrast-Sparse Linguistic Context	They /bɑd/ it from it.
	They /huk/ it on the thing.
	They /tɪd/ them.
	She /kimz/ it to her.
	They /nug/ it to each other.
	She /negz/ it.
	She /nɪɔmz/ it with the thing.
Explicit Contrast-Rich Linguistic Context	Izzy and Rachel don't gɪve each other cupcakes.
	Izzy and Rachel /wId/ the cupcakes from the table.
	Alyssa and Nicole don't hold the doh.
	Alyssa and Nicole /nʌd/ the doh on the table.
	Izzy and Rachel don't play with the cupcakes.
	Izzy and Rachel /wom/ the cupcakes.
	Alyssa doesn't keep the doh.
	Alyssa /hɔbz/ the doh to Nicole.
	Izzy doesn't spill the water.
	Izzy /bɔɪnz/ the water.
	Alyssa doesn't build a tower.
	Alyssa /daɪbz/the doh with the roller.
Explicit Contrast-Sparse Linguistic Context	They don't gɪve each other them. They /wɔd/ them from it.
	They don't hold it. They /dub/ it on the thing.
	They don't play with them. They /tɛb/ them.
	She doesn't keep it. She /dæks/ it to her.
	They don't keep it. They /mɪb/ it to each other.
	She doesn't spill it. She /hodz/ it.
	She doesn't build something. She /tʌdz/ it with the thing.

APPENDIX G

MODIFICATIONS MADE TO CHILDREN'S 4AFC PLATE

Quadrants renamed from letter to numbers, and the addition of Ziggy the puppet.



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