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## Referential Transparency in Young Children's Picture Books: A Pilot Study

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**Referential Transparency in Young Children's Picture Books: A Pilot Study**

Brianna M. Kinnie

Honors Thesis

Submitted to the Honors Department

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In Partial Fulfillment of the Requirements for the Degree of Honors Scholar in Cognitive Science

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### Abstract

A wealth of research has shown that reading picture books supports several aspects of young children's learning and development. In this thesis, we explore the hypothesis that the power of picture books is in part due to their referentially transparent nature. To test this possibility, we designed a picture-book version of the Human Simulation Paradigm (HSP), an experimental paradigm previously used to quantify the referential transparency of child-directed speech in parent-child interactions. Adult participants ( $N = 18$ ) were presented with pages from children's picture books (with text blocked out) and asked to identify either the nouns or the verbs on that page. Our analyses focused on (1) how referential transparency in picture books compared to that of parent-child conversations, (2) how referential transparency differed across word types (i.e. nouns vs. verbs), and (3) whether referential transparency differed as a function of book age-range (i.e., targeting younger vs. older children). Contrary to our hypotheses, picture books were actually *less* referentially transparent than child-directed speech. We also found that noun transparency was greater than verb transparency, and that transparency did not vary as a function of target age groups. Ongoing research in our laboratory is using these pilot data to further investigate referential transparency in children's picture books specifically, and how children's picture books support learning more generally.

*Key Words:* picture books, referential transparency, language learning, Human Simulation Paradigm, child development

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Finally, the financial contribution of the Presidential Scholars Enrichment Award is truly appreciated. Without this support and funding, this project could not have reached its goal.

### **Referential Transparency in Young Children's Picture Books: A Pilot Study**

A good number of childhoods are filled with the stories of fairy tales, adventures, mischievous and troublemaking animals, and distant cities and people. Whether it is a book read before bedtime, during circle time in school, or on a soft rug in the middle of the library, children's picture books are an integral part of growing up for those who are lucky enough to have access to them. Many researchers have suggested, and demonstrated, that picture books are not only central to many of young children's lives but also integral to early learning and development (Farrant & Zubrick, 2012; Karrass & Braungart-Rieker, 2005; Whitehurst, Arnold, Epstein, Angell, Smith, & Fischel, 1994). The purpose of this project was to examine a potential mechanism by which picture books support early learning. Specifically, the current thesis asks whether picture books' power in shaping learning resides in part in the greater presence of referential transparency compared to other learning settings (e.g., parent-child conversations).

### **Picture Books as a Learning Tool in Child Development**

A multitude of studies using different methodologies all point to picture books being incredibly useful for early learning (Farrant & Zubrick, 2012, 2013; Ganea, Ma, & DeLoache, 2011; Logan, Justice, Yumus, & Chaparro-Moreno, 2019; Whitehurst et al., 1994). In a large meta-analysis, Bus and colleagues (1995) studied the frequency of shared book-reading to preschoolers and the subsequent outcome measures that came from it. They found results that supported the hypothesis that parent-preschooler book reading (PPBR) is related to language growth, emergent literacy, and reading achievement. They also concluded that PPBR accounts for 8% of variance of language development in preschoolers regardless of socio-economic status (Bus, van IJzendoorn, & Pellegrini, 1995). The most widely studied benefit of picture books is their positive effect on literacy and language development (Farrant & Zubrick, 2012, 2013). In

one correlational study of thousands of young children, Farrant and Zubrick (2013) found that children with low levels of parent-child book reading during infancy and early childhood had poor vocabulary measured at around four years of age. Whereas 25% of such children were later classified as having a “poor” vocabulary, only 8% of children who had high levels of parent-child reading were classified as such (Farrant & Zubrick, 2013). More recent research confirms this positive relation between home-reading frequency and children’s vocabulary development (Logan, et al., 2019). Logan and colleagues (2019) used data from 60 commonly read picture books to estimate the number of words children are exposed to during book reading sessions at varying frequencies during the first 5 years of life. Although they cautioned against taking the data too literally, they nonetheless suggested that “one year of daily read-alouds at home for a 4-year-old would provide a child with exposure to 75,000 more words than if these readings did not occur” (Logan et al., 2019).

Intervention studies suggest similar trends. For example, Whitehurst and colleagues (1994) found that low-income preschool children who were read to both at home and at day-care showed significant advances in language development in only a few weeks compared to children that only participated in supervised play with no reading. They found evidence that dialogic reading (where children are encouraged to be the storyteller and parents the active listeners) and subsequent related activities (i.e. asking questions about content, characters, or pictures) during young childhood can help enhance language and preliteracy which can later translate to helping children in learning to read and other academic tasks (Whitehurst et al., 1994). Similarly, Farrant and Zubrick (2012) found that measures taken to increase the frequency and quality of parent-child reading positively impacted the vocabulary development of children from low income households, as well as the language development of children with language delays.

Finally, there is neurobiological evidence consistent with the benefits of picture book reading. Utilizing functional magnetic resonance imaging (fMRI), child participants were exposed to three similar stories in audio, audio & illustrated, and animated formats followed by factual recall. The illustrated condition, that mimics a picture book, was associated with reduced strain on the brains' language network and maximal integration of visual perception, imagery, Default Mode Network, and cerebellar networks. These findings propose neurobiological evidence of the appeal of children's picture books providing scaffolding for language and learning (Hutton, Dudley, Horowitz-Kraus, DeWitt, & Holland, 2018).

### **Picture Book Properties That Promote Child Learning and Development**

Although most researchers agree that children's picture books are beneficial for development and learning, the precise mechanisms for why this is the case is less well understood. Existing research offers some candidate hypotheses however, including that picture books expose children to a unique language, that picture books stimulate parent-child conversations that would otherwise not have been had, and that picture books may support children's cognitive and socio-cognitive development.

#### ***Picture Books have a Unique Language***

One hypothesis for why picture books make such good learning tools is that they expose children to unique and uncommon language, language to which they may not otherwise be exposed. In one computational analysis comparing a corpus of words from popular children's picture books to a corpus of child-directed speech, Montag and Smith (2015) found the number of unique words in the picture book corpus to be far greater than in the conversation corpus. Furthermore, not only do picture books offer a greater variety of words than everyday parent-child conversations, picture books also contain a higher proportion of rare words, a greater

number of complex words, and a wider range of sentence structures compared to typical conversations (Massaro, 2015; Montag, 2019).

There are at least a couple of reasons for the uniqueness of picture book language. First, some have suggested that the uniqueness comes from the fact that picture books allow a child to experience a variety of objects and environments that they would not be able to in their daily lives (Montag, 2019). Picture books have been written about an infinite number of topics (animals, imaginative creatures and places, different cultures to name a bare minimum), many of which a child may not come in direct contact in their everyday life. As Karrass and Braungart-Rieker (2005) pointed out, a child living in an urban region may only ever experience and learn about life on a farm through picture books.

Second, the uniqueness of picture book language may have more to do with the nature of word choice in everyday conversations and the challenges in producing rare, diverse, complex language in those conversations. That is, rare nouns and verbs (e.g., proclaim, responsibility, tusk, spiral) may be used less frequently in spoken language because in everyday conversations, speakers are under a serious time-constraint to produce words, and rare and complex words are much slower to come to a speaker's mind. This constraint can bias speakers to limit word choice by sticking to more frequent words, simpler words, and basic sentence structures. Written language in picture books obviously does not face such constraints and is often by design much more poetic and selective in its word choice (Massaro, 2015).

### ***Picture Books Elicit Unique “Extratextual Talk” in Parents***

A second hypothesis for why picture book reading is a valuable tool is the extratextual talk (i.e. conversations that deviate from the text on the page) and non-verbal interactions elicited by picture books. Parents reading to their children often engage in conversation that involves

drawing the child's attention to the book's illustrations, labelling, and describing the scene (Muhinyi & Hesketh, 2017). This increases the amount of words that a child could be exposed to and also allows for more descriptive and referential language, a type of language we know supports language development (see Tamis-LeMonda, Song, Leavell, Kahana-Kalman, & Yoshikawa, 2012). For example, a parent reading a book about farm animals could point to a picture of a cow and say, "look at the cow," which may help the child to associate the word 'cow' to its referent. In one study, Fletcher and colleagues demonstrated that this extratextual talk occurring outside of a book's text has a positive association with children's literacy and language development (Fletcher, Cross, Tanney, Schneider, & Finch, 2008). Specifically, parents utilizing reading strategies such as labeling, using expansions, or asking questions pertaining to the book's content can be predictive of later outcomes of a child's cognitive and linguistic development. As such, it may not be the language in a picture book that affects learning but rather the language used by parents elicited from reading.

### ***Picture Books Stimulate Cognitive Development***

Finally, the pathway by which picture books support learning may be one that is not necessarily linguistic. That is, children's picture books are filled with a multitude of characters that go through situations or interactions that children may be able to relate to and understand, such as playing with friends or a pet, going to school, or getting ready for bed. These stories are filled with references to mental states and explicit references to characters' thoughts, emotions, and intentions (Dyer-Seymour, Shatz, & Wellman, 2000). In fact, researchers have found that of the books read to 47 preschool children by their parents in a single week, 78% of them contained internal state language, 34% contained false beliefs, and 43% contained personality descriptors (Cassidy et al., 1998). This theory of mind content in picture books allows for children to

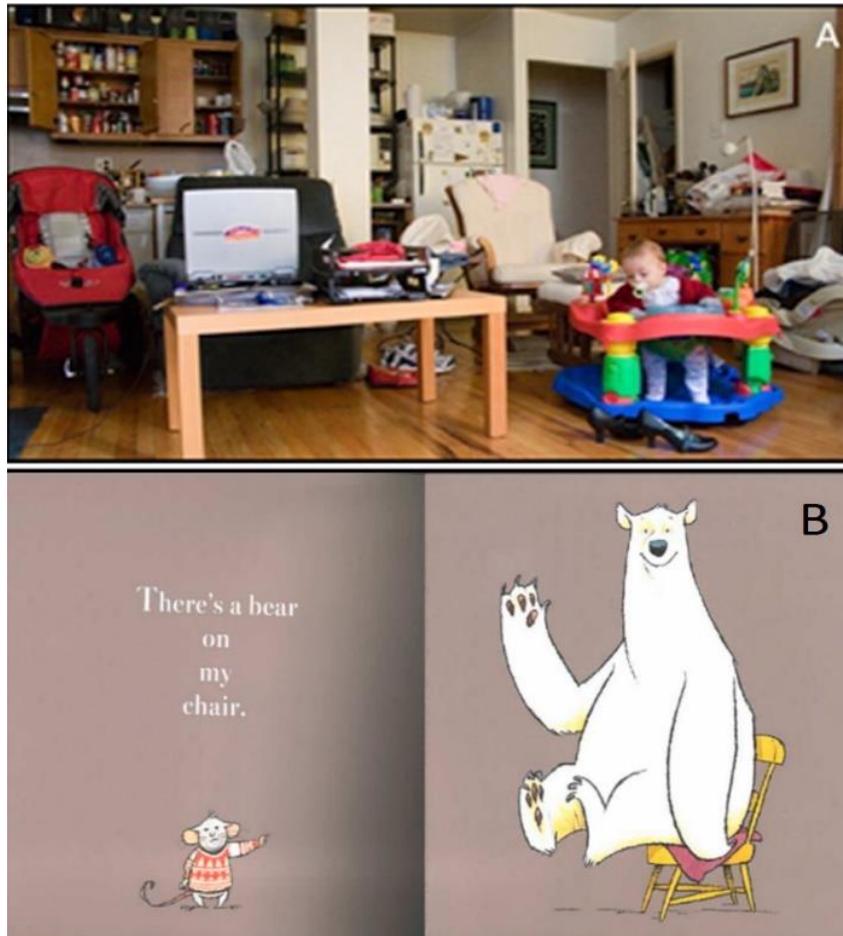
practice perspective taking, empathizing, and identifying with other people or characters as well as identifying their own emotions and knowledge (Dyer-Seymour et al., 2000; Kucirkova, 2019). Thus, perhaps it is through building cognitive and socio-cognitive processes inside children's minds that picture books have their special powers.

Picture books can also be used to explain nature, animal behavior, and other concepts of science. In one compelling demonstration, Ganea and colleagues (2011) investigated whether children can learn biological facts from picture books. They found that by the age of four, children were able to apply knowledge from a picture book about camouflage in animals to explain a similar situation with novel animals. Similarly, Hong (1996) found that children exposed to mathematical-related storybook reading had a more positive disposition toward math and also performed better on mathematical tasks compared to children who received normal storybook reading. This provides evidence of how picture books support the development of conceptual knowledge in young children.

### **The Function of Referential Transparency in Child Learning**

The aforementioned research investigating the candidate beneficial features of picture books have focused largely on the *verbal* or *linguistic* features of picture book reading: extratextual talk, exposure to vocabulary, and mental state words. Comparatively few studies have explored how the *visual* elements of picture books (or the concordance between the visual and linguistic elements) may also be a powerful source of children's learning. Yet the importance of the visual world and the "word-to-world" link is central to discussions of how children learn the meanings of words (Gillette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). In fact, word learning researchers often describe the core problem of learning words is how children map meanings in the busy, fleeting,

chaotic nature of their environment. For example, if a parent were to talk about the chair in Figure 1A, it would be extremely difficult for the child to match that word “chair” to its referent. That is, to a child who does not yet know what the word chair means, there are numerous candidate objects to which the word “chair” might refer to; such as a shoe, table, painting, or any of the other objects in the room.



*Figure 1. A) a plausible word-learning environment for the word “chair” (Medina et al., 2011) B) a plausible word-learning environment for the word “chair” when reading a picture book (Collins, 2016)*

The extent to which word meaning can be inferred from the immediate extralinguistic context is commonly referred to as “referential transparency” and has been a topic of increased empirical interest in recent years (see Cartmill, Armstrong, Gleitman, Goldin-Meadow, Medina, & Trueswell, 2013; Medina, Snedeker, Trueswell, & Gleitman, 2011). Referential transparency

is often studied via the Human Simulation Paradigm (HSP) in which naïve observers watch muted vignettes of parent-child play and guess the parents' words at certain points of time marked by audible beeps. Consistent with the notion that mapping words to their referents is a challenge, even adults with a mature cognitive system regularly struggle to correctly identify words in the HSP (see Cartmill et al., 2013; Gillette et al., 1999; Gleitman et al., 2005; Medina et al., 2011). Importantly, and especially relevant for the current study, Cartmill and colleagues found that the extent to which a toddlers' input is referentially transparent is predictive of that child's language development years later (Cartmill et al., 2013). Thus, the problem of referential transparency is not only a fun puzzle for linguists, philosophers, psychologists to think about but also a problem highly relevant for language learners.

Motivated by the work of Cartmill and colleagues specifically, and the HSP work more generally, we propose the possibility that referential transparency may be a key reason why picture books make for such good tools for language development. That is, in contrast to the low signal-to-noise ratio of the real-world, the signal-to-noise ratio in picture books is quite high. For example, the mouse in Figure 1B is complaining about there being a bear on their chair. In this case, when the child hears the word "chair", unlike in the real-world scenario in Figure 1A, the child's options for candidate referents are countable with one hand: the mouse, the bear, the chair, and possibly the blanket. In addition to its reduced clutter, the referents in picture books are static and constant, as opposed to dynamic and changing state. That is, whereas in the real world, actions and objects can appear fleetingly in real-world conversations and experiences, actions and objects in a picture book are static and frozen in time. We propose this static property of referents affords greater transparency for children's picture books. Thus, the primary goal of this Thesis is to examine the visual aspects of children's picture books in more detail and to

specifically ask whether picture books do indeed systematically possess higher referential transparency than everyday child-directed speech.

### **Current Study**

The goal of this thesis is to take a first step towards quantitatively analyzing the degree of referential transparency in children's picture books. Specifically, we ask three research questions: (1) are words in Picture Books more referentially transparent than words in child-directed speech, (2) does picture book referential transparency vary as a function of word type (i.e., nouns vs. verbs), and (3) does picture book referential transparency vary based on the audience (i.e., targeted age range)? To answer these questions, we constructed and conducted an experimental study that was heavily based on Gillette and colleagues' Human Simulation Paradigm, but with picture book pages (as opposed to videos of parent-child interactions) as its stimuli.

## **Methods**

### **Participants**

Eighteen college students participated in this study ( $M_{age} = 20.39$ ,  $SD = 1.72$ ,  $Range = 18 - 25$ ; Sex: 5 male, 13 female). The majority of participants identified as white and non-Hispanic. The participants were randomly assigned to either the Noun or Verb condition.

### **Materials & Stimuli**

#### ***Book Selection***

We constructed a corpus of children's picture books (see Table 1) through the following process. We selected ten books that target children from four different age ranges based on the book's information at Barnes & Noble: 0-3 years, 2-5 years, 3-7 years, and 4-8 years. Within each age group, we included a mix of well-known (all published before 2000; many on best-

sellers lists) and more recent children's picture books (all published 2015 or later). We limited our books to those with a narrative, those with illustrations, those without interactive elements (e.g., flaps, pop-ups, tactile features), and those without references to historical events that may be known to participants. All books were monolingual English.

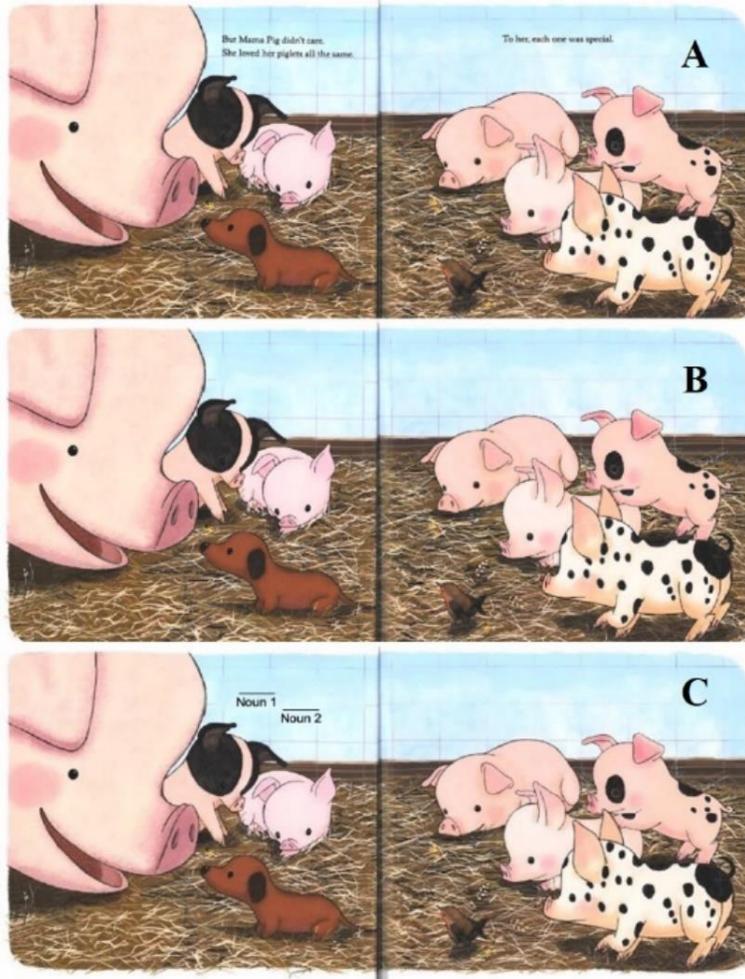
### ***Stimulus Selection***

For each book, we fully transcribed the picture book text and highlighted all nouns and verbs. Following previous Human Simulation Paradigm studies, pronouns and auxiliary verbs were excluded. We then randomly selected five pages per book that contained at least one noun (for the Noun condition) or one verb (for the Verb condition) satisfying the Noun condition, or one verb to satisfy the Verb condition. In total, the stimulus set consisted of 200 stimulus pages in each the Noun and Verb conditions.

### ***Stimulus Creation***

Once stimulus pages were selected, we scanned them and created into digital form. The text from the stimuli pages was removed/covered and numbered blanks were inserted where the target nouns or verbs originally occurred on the page (see Fig. 2). Repeated blanks were used if the target word appeared multiple times on the page. This was done with the intention to mimic the HSP protocol where an audible tone was presented numerous times to represent the target word being spoken more than once.

For both Noun and Verb conditions, stimuli pages were divided into five sets of 40 stimuli (one page from each book). Division of stimuli was done to minimize repeated target words within a set (Noun Condition: 4/139, Verb Condition: 22/109). However, only one set for both the Noun and Verb Condition were used in this Pilot Study.



*Figure 2.* Stimuli Creation Process: **A)** A page was first randomly selected (Steuerwald, 2019) **B)** the text on that page was then removed **C)** blank lines were placed where nouns or verbs were originally placed on the page. Participants would be shown pages like in C

## Procedure

Testing was done in groups of approximately five participants in a classroom with a projector screen where the stimuli were presented. Groups of participants were randomly assigned to either the Noun or Verb condition (9 assigned for each condition). Following the consent process, participants were informed that their task was to identify the nouns or verbs (depending on condition) they think occurred in a series of pages of children's picture books. Participants were then given three practice trials to ensure they understood the task. In these

practice trials, participants were first shown a picture on the projector (e.g., see Fig. 2C) and asked to identify the noun (or verb, depending on condition) that they thought occurred in the blank space. The purpose of these trials was to ensure participants understood the task and understood the distinction between a noun and a verb. During practice trials, after participants wrote down their answer on the answer sheets, the experimenter revealed the correct answers.

Immediately following the practice trials, participants were reminded whether they were to identify nouns or verbs and then were shown a series of forty stimuli (e.g., see Fig 2C). Just like the practice trials, participants were asked to guess what the noun or verb that had occupied the blank space(s) on a given stimulus page and to write their answers on an answer sheet. Once all participants in the room appeared to have finished, the experimenter moved on to the next stimuli until all forty stimuli were presented. Importantly, unlike the practice trials, the experimenter did not reveal the correct answer after each slide. After the study, participants completed a brief demographics questionnaire and were debriefed on the purpose of the study. The entire study lasted approximately 35-45 minutes.

### **Scoring**

Following prior HSP video protocol (see Gillette et al., 1999), we decided to score participant answers based on accuracy. Correct answers were considered to be ones that did not change the root of the target word. This included answers that were identical to the target word, abbreviations, plurals, and different tenses. For example, if the target word was “dog”, both “dog” and “dogs” were deemed acceptable. Any answer that changed the root of the target word were considered to be incorrect, even if those answers were close in meaning. For example, the answer “puppies” would be deemed inaccurate for the word “dog”. The data gathered from the eighteen participants was scored following this protocol using a binary system (i.e., “0” denoting

inaccurate and “1” denoting accurate). Altogether there was 141 noun stimuli (excluding proper nouns) and 109 verb stimuli, with 9 ratings per stimuli.<sup>1</sup>

## Results

Referential transparency for a given word was operationalized as the proportion of HSP participants who answered correctly for that word. Transparency was first computed for each stimuli word and then averaged across all stimuli words on a page, so that a page that may have had ten stimuli words did not overshadow a page with less stimuli. All of the following statistical analyses were conducted at the page level.

Our first question was on the degree of referential transparency in children’s picture books. To address this question, we compared the observed levels of transparency in Picture Books to previously published reports of referential transparency in parent-child interaction studies. The overall transparency for nouns of a picture book stimuli ( $M = 0.19$ ,  $SD = 0.19$ ) was significantly lower than reported parent-child interaction noun accuracy ( $M = 0.28$ ), as indicated by a single samples t-test,  $t(38) = -2.94$ ,  $p < .05$  (see Fig. 3).<sup>2,3</sup> Verb transparency of picture books ( $M=0.06$ ,  $SD=0.10$ ) was not statistically different from the established baseline ( $M = 0.08$ ),  $t(39) = -1.15$ ,  $p = 0.26$ .

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<sup>1</sup> One stimuli page was excluded from the Noun Condition for data analysis due to an error on the answer sheet given to the participants

<sup>2</sup> We decided to exclude proper nouns from the data analyses to mimic the HSP designs. There was no statistical significance between noun accuracy with or without proper nouns,  $t(77) = 0.27$ ,  $p = 0.78$

<sup>3</sup> In Gillette and colleagues’ 1999 study, participants rated six vignettes for every noun or verb. To compare the current paradigm more accurately (one page for every book), we used performance levels in the first vignette of the sequence as our baseline comparison (Gillette et al., 1999).

We next asked whether there were differences in referential transparency between word types within the Picture Book stimuli. As clear from Figure 3, transparency was much higher for nouns than verbs, replicating a well-established trend in non-picture book stimuli (see Gillette et al., 1999). A two-sample equal variance *t*-test confirmed that this difference was statistically reliable,  $t(77) = 3.71, p < .001$ .

Of interest however is not necessarily whether nouns would be more transparent than verbs but instead whether the picture book *advantage* for nouns and verbs would differ. Because nouns and verbs have different HSP baselines, we first normalized transparency scores in both noun and verb conditions, allowing scores to vary in both conditions from -1 (maximally worse than baseline) to 1 (maximally better than baseline). To do this, if there was a positive difference between the picture book transparency and HSP baseline transparency, normalized transparency was computed by  $[(\text{SCORE} - \text{BASELINE}) / (1 - \text{BASELINE})]$ , where SCORE is the observed picture book transparency and BASELINE is the HSP baseline transparency. For example, if the picture book transparency was .97 and the HSP baseline was .28, the normalized score would be:  $(.97 - .28) / (1 - 0.28) = 0.85$ . If there was a *negative* difference between picture book transparency and HSP baseline transparency, the normalized score was computed by  $[(\text{SCORE} - \text{BASELINE}) / \text{BASELINE}]$ . For example, if picture book transparency was 0 and the HSP baseline .28, the normalized score would be:  $(0 - .28) / .28 = -1$ . Analyses of normalized difference scores revealed no significant difference between Nouns ( $M = -0.42, SD = 0.49$ ) and Verbs ( $M = -0.61, SD = 0.51$ ),  $t(77) = 1.68, p = 0.10$ , suggesting that although nouns were more transparent than verbs, there was no reliable difference in the picture book *effect* on nouns and the picture book *effect* on verbs.

Finally, we asked whether the degree of referential transparency changed as a function of the target reader age. That is, we asked whether there was greater referential transparency in books for younger children relative to books for older children. A visual inspection of Figure 4 illustrates that with picture book nouns, referential transparency seemingly decreases as the targeted age of the book increases. However, a one-way ANOVA revealed no statistically significant effect of target age range on referential transparency,  $F(3,35) = 0.58, p = 0.621, \eta_p^2 = 0.05$ . A further analysis directly comparing the youngest ( $N = 10, M = 0.25, SD = 0.28$ ) and the oldest ( $N = 10, M = 0.16, SD = 0.13$ ) age group also revealed no statistically significant difference,  $t(18) = 0.37, p = 0.91$ . Similar lack of age effects was observed for verb transparency in picture book verbs (see Fig. 5). A one-way ANOVA determined no statistically significant effect of target age,  $F(3,36) = 0.62, p = 0.623, \eta_p^2 = 0.05$ , and a two-samples t-test revealed no difference between the youngest ( $N = 10, M = 0.06, SD = 0.13$ ) and oldest ( $N = 10, M = 0.05, SD = 0.06$ ) targeted age groups,  $t(18) = 0.75, p = 0.33$ .

### Discussion

The goal of this thesis was to investigate the presence and nature of referential transparency in children's picture books. Our hypotheses were that: 1) picture books offer more referential transparency than everyday parent-child conversations, 2) although nouns may be more transparent, the picture book advantage over parent-child conversations may be greater for verbs, and 3) picture books targeting younger children would have greater referential transparency than those targeting older children. Few of these hypotheses were supported by the data. Our results suggest instead that reference in children's picture books was less, not more, transparent than reference in everyday conversations, that verbs were especially difficult to identify, and that transparency did not differ as a function of targeted age groups. Here, we

consider some possible explanations for these findings, some important limitations of this study, and some ways to overcome these limitations in future studies.

### **Referential Transparency in Picture Books Compared to Parent-Child Conversations**

We had speculated that picture books would provide more referential transparency than parent-child conversations due to the higher referential signal-to-noise ratio evident in the casual inspection of children's picture books. Interestingly, we observed that there was less referential transparency in children's picture books than in parent-child interactions. One possible explanation for this is that picture books may have more instances of *absent referencing* than everyday conversations. That is, not all words mentioned in the text of picture books are actually depicted in the accompanying illustration. For example, in the book *Brown Bear, Brown Bear, What Do You See?* by Bill Martin Jr. (1996), the word "dog" is present in the text, as can be seen in Figure 6. However, the illustration is only of the purple cat (the dog does not appear until the following page in the story). Such absent referencing was quite frequent in our corpus but well known to be highly *infrequent* in everyday parent-child interactions (Adamson & Bakeman, 2006). Future studies or analyses that control for these differences may shed light onto whether absent referencing may have driven the difference we observed between picture book and parent-child conversation referential transparency.

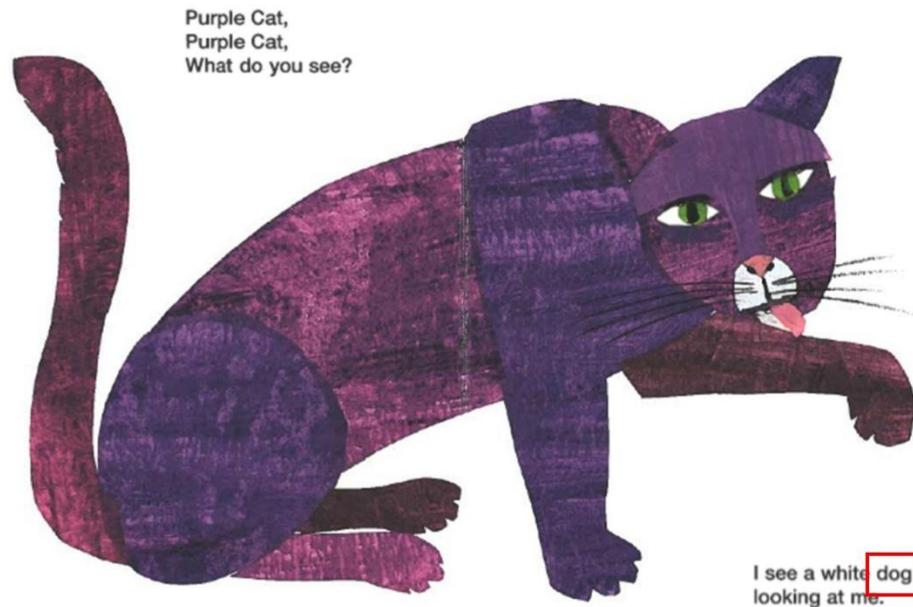


Figure 6. Example of absent referencing using *Brown Bear, Brown Bear, What Do You See?* (Martin Jr., 1996)

Picture books may also be less referentially transparent because the nouns and verbs in children's picture books are frequently rare and unique words (e.g., dragon, unicorn, responsibility). This fact about children's picture books has actually recently been documented in an analysis of picture book text that revealed a much greater diversity of words and a greater density of rare words in pictures books relative to child-directed speech (Montag & Smith, 2015). This has been attributed to the fact that books can be about anything: playing with animals, going on adventures to the moon, exploring the ocean, meeting mythical creatures, and many more. The implication of this for the current study is the decreased referential transparency of picture books may be driven by the fact that our participants would have been required to consider a larger number of possible words, including some words that are highly uncommon (e.g., tusk, quiver, trembling) and weird (e.g., cubby, morn, proclaimed). In contrast, the classic child-directed speech HSP work to which we are comparing the current work have only sampled

highly frequent words (e.g., go, mommy, look). Thus, a better comparison study would present picture book and HSP video stimuli of the same exact target words.

### **Effect of Word Type on Referential Transparency**

It was not surprising to see that picture book nouns were more transparent than picture book verbs. As we know, noun learning is superior to verb learning during language development (Gillette et al., 1999) and the concept of objects which are universally labeled by nouns are perceptually and conceptually more stable than the concept of actions labeled by verbs (Waxman, Fu, Arunachalam, Leddon, Geraghty, & Song, 2013). Paired with the fact that referents of nouns are typically better pictured with illustrations, it is easy to see why picture book nouns are more transparent than picture book verbs. Nevertheless, we expected that picture books would offer a unique advantage for verbs relative to any advantage picture books would offer to nouns. This is because in the real world, actions are naturally fleeting and are dynamic. Due to their static nature, illustrators of picture books must depict actions suspended in time. For example, a person running would be depicted mid-gait, a person hitting a ball would be depicted mid-swing, and a child eating would be depicted mid-chew. Despite what we thought was an intriguing and well-reasoned hypothesis, this turned out not to be true. If anything, picture book verbs appeared less transparent relative to its video counterpart than picture book nouns to its counterpart (although this effect was not statistically significant, it was trending).

After further consideration and analysis of our picture book stimuli what became apparent was that although it could theoretically be advantageous that picture books are able to portray actions frozen in time, there are also disadvantages. There may be actions that are not pictured at all due to spatial limitations or creative liberties taken by the illustrators. That is, because picture books are static, illustrators must focus on a single element of the plot whereas

the text may cover different elements of the storyline. This would result in multiple events / actions mentioned in the text but left off the illustration. As seen in one page chosen for the book *Owl Moon* by Jane Yolen (1987), there are ten target verbs (see Fig. 7). Some of these verbs reference actions and experiences that took place before the event that the illustration is portraying. This limits a participant's ability to guess the target verbs and could help account for the lack of verb advantage in picture books. In other words, the static nature of picture books (especially those with narratives) may contribute to the absent reference problem which in turn leads to challenges in our HSP task.

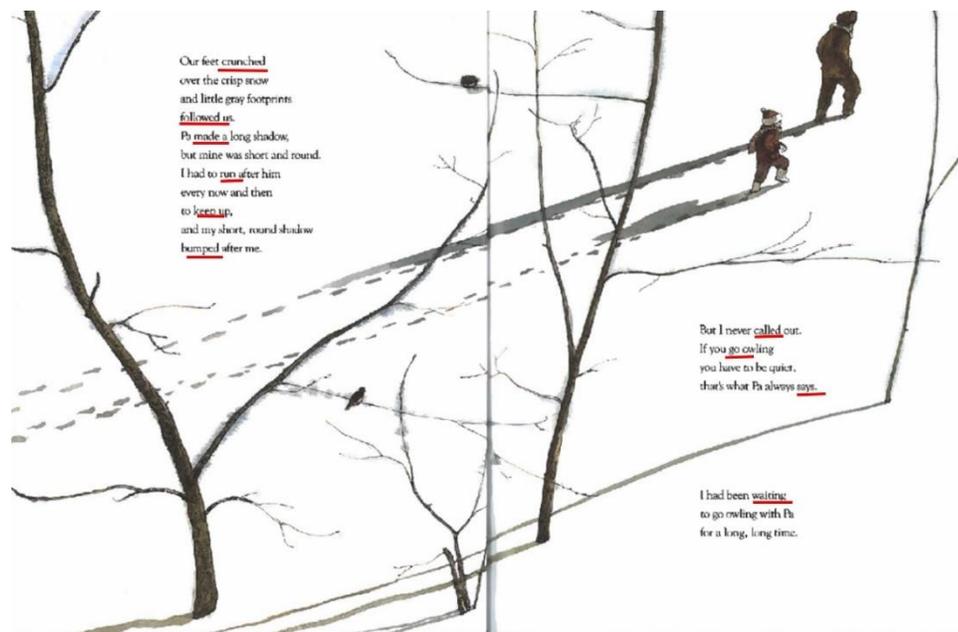


Figure 7. Example of absent referencing of verbs in *Owl Moon* by Jane Yolen (1987)

In addition, the challenge with picture book verbs may be due to the high density of stative verbs in children's picture books (Dyer-Seymour et al., 2000). Indeed, in our current stimuli set, nearly a third of the verbs were stative verbs (compared to only a quarter in Gillette and colleagues' 1999 study). Prior HSP research (Papafragou, Cassidy, & Gleitman, 2007) has demonstrated convincingly (and perhaps unsurprisingly) that people are less likely to identify stative verbs (e.g., think, feel, like) in videos of parent-child interactions than action verbs (e.g.,

kick, go, knock). Thus, assuming that this lack of referential transparency of mental verbs holds true for picture book stimuli as well, then the increased number of them may be partially to blame for the disproportionately non-transparent nature of picture book verbs.

### **Effect of Target Age Group on Referential Transparency**

Referential transparency did not vary as a function of target age range. We found this finding surprising as we had assumed that due to their simpler, less cluttered illustrations, as well as their more restricted vocabulary, picture books for younger children would be more referentially transparent (see Fig. 8). Although we did not find that the picture books for younger children themselves to be referentially transparent, this need not mean that picture book *reading* with younger children is not referentially transparent. That is, it is possible that the differences in referential transparency between picture books for younger and older picture books emerges through parent-child interactions with the books. Perhaps with younger children, parents are more likely to point, label, or explain illustrations and text in the picture books (see Namy, Acredolo, & Goodwyn, 2000). As children grow older, parents may feel as though this scaffolding behavior is less necessary, or children may be beginning to read on their own without these extra cues from parents. Thus, although picture books themselves may not be tailored based on age, this does not mean that shared book reading is also not tailored.

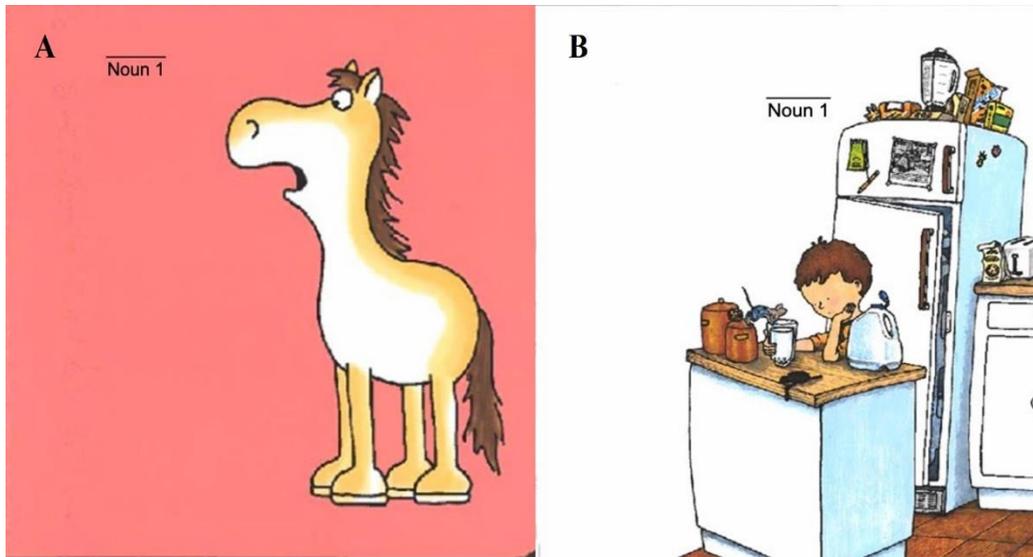


Figure 8. a) example of a younger child's picture book for ages 1-2 (Boynton, 1982) b) example of an older child's picture book for ages 4-8 (Numeroff, 1997).

### Limitations of the Present Study

A number of limitations of this pilot are worth noting. The first limitation is that our corpus of picture books was fairly small. Our corpus of forty books (10 per age category) may have especially impacted our comparisons across age groups. There is an existing trend that referential transparency seems to decrease as the target age increases, especially with nouns. A larger corpus may have helped clarify whether there is or is not an effect of target age on referential transparency. We also observed a statistical trend that verbs in picture books are less transparent than nouns relative to their HSP baselines. Again, a larger corpus may have helped clarify the robustness of this trend.

A second, and arguably more problematic, limitation of this study is the number of differences between the current study's design to Gillette and colleagues' HSP study that served as our baseline comparison. First, the words Gillette and colleagues used were different than the words in the current study. Gillette and colleagues (1999) tested the referential transparency of twenty-four highly frequent nouns and verbs in children's input. On the other hand, we were less

selective and included *all* nouns and verbs listed in the picture book pages we selected. Due to our less-selective approach, many of our stimuli (e.g., responsibility, quiver, spiral, succeeds, proclaimed, trembling) were “harder” than theirs (e.g., hat, ball, plane, look, go, throw). This discrepancy between the two tasks may have accounted for the worse performance in our picture-book study. Second, in the Gillette HSP video-vignette task, participants received more contextual information. That is, participants were exposed to 30 seconds of context before the cued beep played (which corresponded to when target word was uttered) and an additional 10 seconds of post-word context. Our Picture-Book task on the other hand did not provide that same contextual information. It is important to note that it is difficult to know what the equivalent context would be between these two mediums (i.e., one page prior, two pages prior?) and it may be the case that picture books and parent-child interactions are simply too different to properly control for differences in context. Finally, in our Picture Book study, we allowed for *multiple* target words per stimuli page. Although some of our stimuli pages had only one, others had more than a dozen. Note that this may not necessarily be a disadvantage, since when there are multiple target words one is not restricted to only one guess. Nonetheless, because we are comparing our results to the HSP study which focused on only one target word at a time, having more consistency between the vignette mediums would lead to a more accurate comparison.

Beyond these methodological limitations, we also consider possible limitations in the logic of this study. First, this study ran on the assumption that the Picture Book task and the HSP video task are comparable. However, as aforementioned, there are many factors that need to be controlled for in order to truly make these tasks equivalent. Some of these factors (e.g., equating for context / timing effects), raise the question of whether this is even possible. Separately, we also assumed that increased referential transparency is always better for learning. This

assumption may be wrong. It could be the case that this higher level of difficulty in identifying referents in picture books could be more helpful for child development in the long run. This could challenge children to learn language and keep pushing for them to do better as they age. Therefore, it is too early to completely disregard referential transparency as a driver of child learning.

### **Future Directions**

The goal of this pilot study was to understand the presence and nature of referential transparency in children's picture books. Based on the results of this pilot study and careful consideration of the limitations outlined above, we believe that two future projects are especially important to pursue. First, we believe that the differences between the current task measuring referential transparency in picture books and prior tasks measuring referential transparency in child-directed speech are sufficiently large to warrant a study that is a more careful comparison between the two. More closely aligned tasks would be in a better position to answer the research questions we posed at the beginning of the thesis. Towards this goal, we are currently designing a study comparing the transparency of Picture Book and Video vignettes with the *same* forty nouns and verbs. The two tasks were also constructed to have the same demands of identifying a single mystery word per vignette (whether picture book or video-based).

A second direction we are pursuing goes beyond comparing picture books to parent-child interactions. Instead we hope to compare the value of different sources of information for identifying word meaning (including referential transparency) all *within* the picture book contexts. That is, we are exploring how other sources of information (e.g., semantic networks, syntactic frames), in addition to referential transparency, could support word meaning identification in learning words from children's picture books. The study would closely mimic

the work of Gillette and others (see Gleitman et al., 2005; Papafragou et al., 2007; Zhang, Yurovsky, & Yu, 2015), who compared the contributions of different sources of information in identifying words from the input. We believe such a study would give us a better understanding of what property of picture books might be responsible for making picture books such a good learning tool.

### **Conclusion**

Children's picture books are powerful tools for early learning and development. The current thesis sought to investigate a candidate mechanism, referential transparency, for why books are such potent tools for learning. Contrary to our hypotheses, the data suggest that even for the youngest of learners, picture books present a formidable challenge in determining the reference. We believe these results offer more questions than answers, including how this challenge compares to the learning challenge children face in other settings, whether this challenge is actually beneficial in the long run, and whether there are facets of picture books, or shared picture book reading, that offset these challenges. Future research in our lab will build off this thesis, seek to explore these questions further and ultimately better understand not only how picture books contribute to learning but also how picture books might help when learning goes awry.

**Table 1**

*Books included in our picture book corpus*

<p><i>Are You My Mother</i> by P. D. Eastman</p> <p><i>Bread and Jam for Frances</i> by Russell Hoban</p> <p><i>Brown Bear, Brown Bear, What Do You See?</i> by Bill Martin Jr.</p> <p><i>Cars and Trucks and Things that Go</i> by Richard Scarry</p> <p><i>Green Eggs and Ham</i> by Dr. Seuss</p> <p><i>Hair Love</i> by Matthew A. Cherry</p> <p><i>How Do You Care for a Very Sick Bear</i> by Vanessa Bayer</p> <p><i>How to Grow a Friend</i> by Sara Gillingham</p> <p><i>If You Give a Mouse a Cookie</i> by Laura Numeroff</p> <p><i>I'm a Narwhal</i> by Mallory Loehr</p> <p><i>Jasper and Ollie</i> by Alex Willan</p> <p><i>Lambslide</i> by Ann Patchett</p> <p><i>Littles: and How They Grow</i> by Kelly DiPucchio</p> <p><i>Llama Destroys the World</i> by Jonathan Stutzman</p> <p><i>Madeline</i> by Ludwig Bemelmans</p> <p><i>Make Way for Ducklings</i> by Robert McCloskey</p> <p><i>Millions of Cats</i> by Wansa Gag</p> <p><i>Moo, Baa, La La La!</i> by Sandra Boynton</p> <p><i>No Biggy! A Story about Overcoming Everyday Obstacles</i> by Elycia Rubin</p> <p><i>Owl Moon</i> by Jane Yolen</p> <p><i>Rosie Goes to Preschool</i> by Karen Katz</p>
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*Stellaluna* by Janell Cannon

*Ten Little Night Stars* by Deb Gruelle

*That's What Dinosaurs Do* by Jory John

*The Color Kittens* by Margaret Wise Brown

*The Colors of Summer* by Danna Smith

*The Girls* by Lauren Ace

*The Happiest Tree: A Story of Growing Up* by Hyeon-Ju Lee

*The Nose Book* by Al Perkins

*The Peculiar Pig* by Joy Steurerwald

*The Poky Little Puppy* by Janette Sebring Lowrey

*The Someone New* by Jill Twiss

*The Story of Ferdinand* by Munro Leaf

*There's a Bear on My Chair* by Ross Collins

*Things that Go* by Shannon Hay

*Tikki Tikki Tembo* by Arlene Mosel

*We're Going on a Bear Hunt* by Michael Rosen & Helen Oxenbury

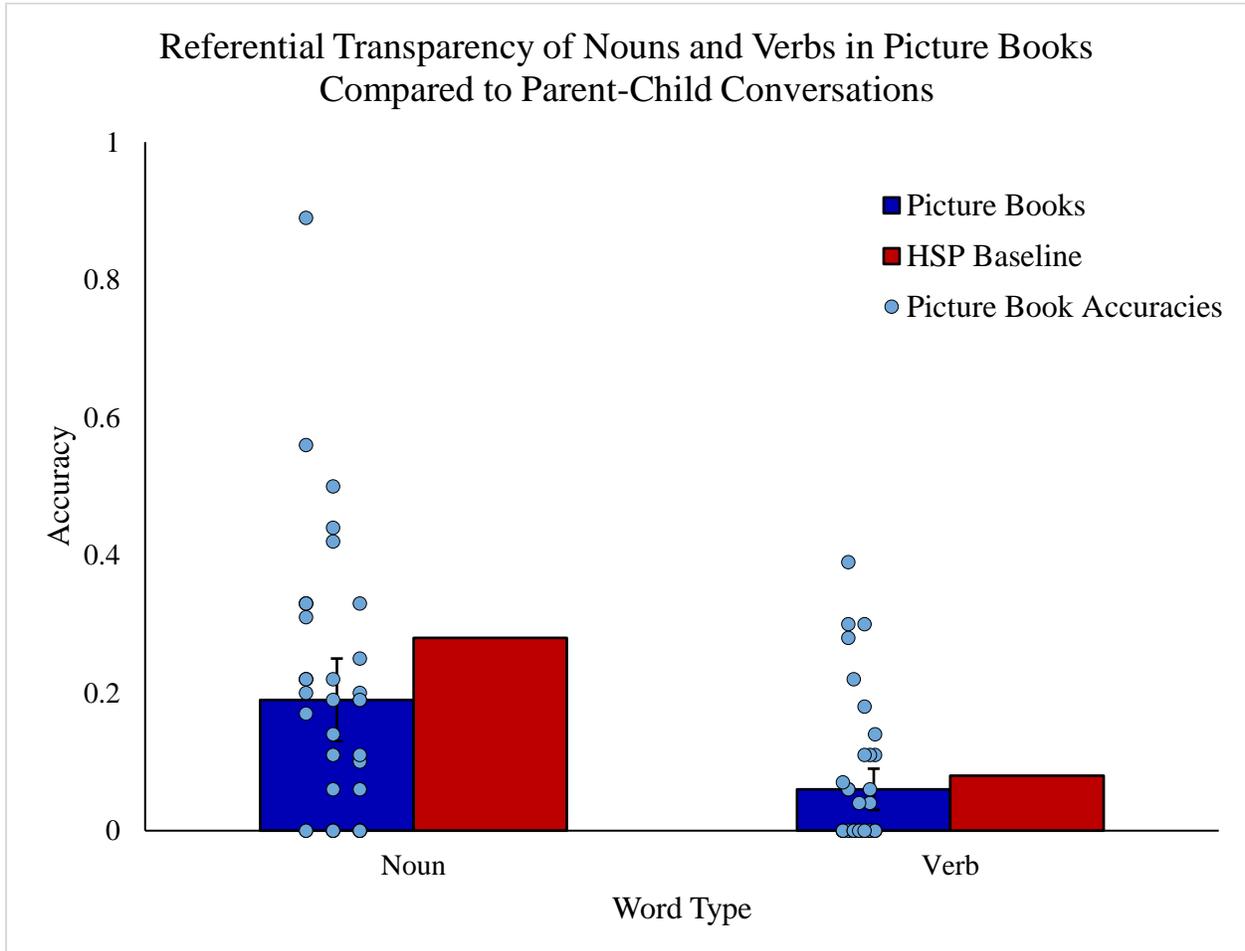
*When Pencil Met Eraser* by Karen Kilpatrick & Luis O. Ramos Jr.

*Whistle for Willie* by Ezra Jack Keats

*You Don't Want a Unicorn* by Amy Dyckman

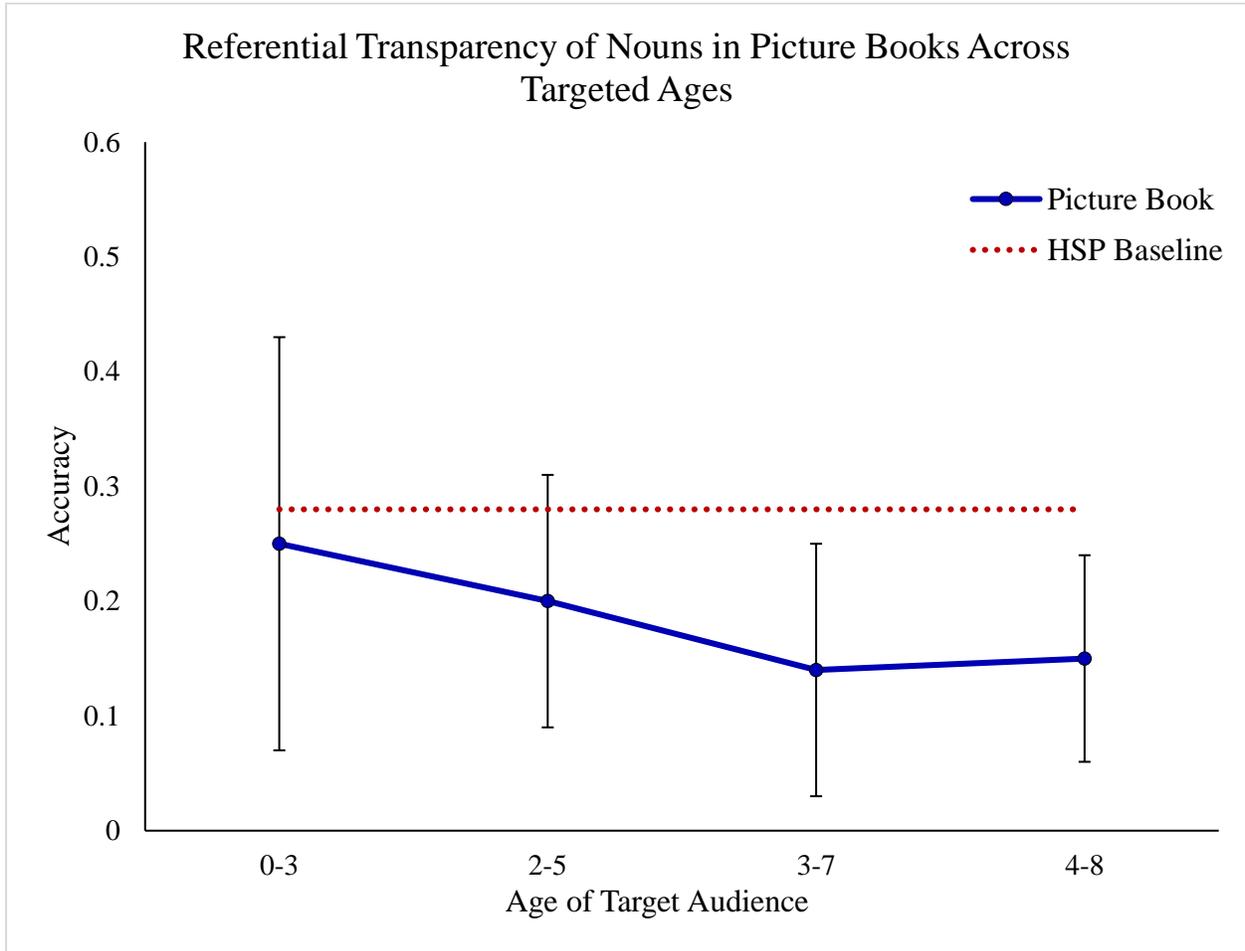
**Figure 3**

*Comparison between the referential transparency found in picture books and HSP video vignettes.*



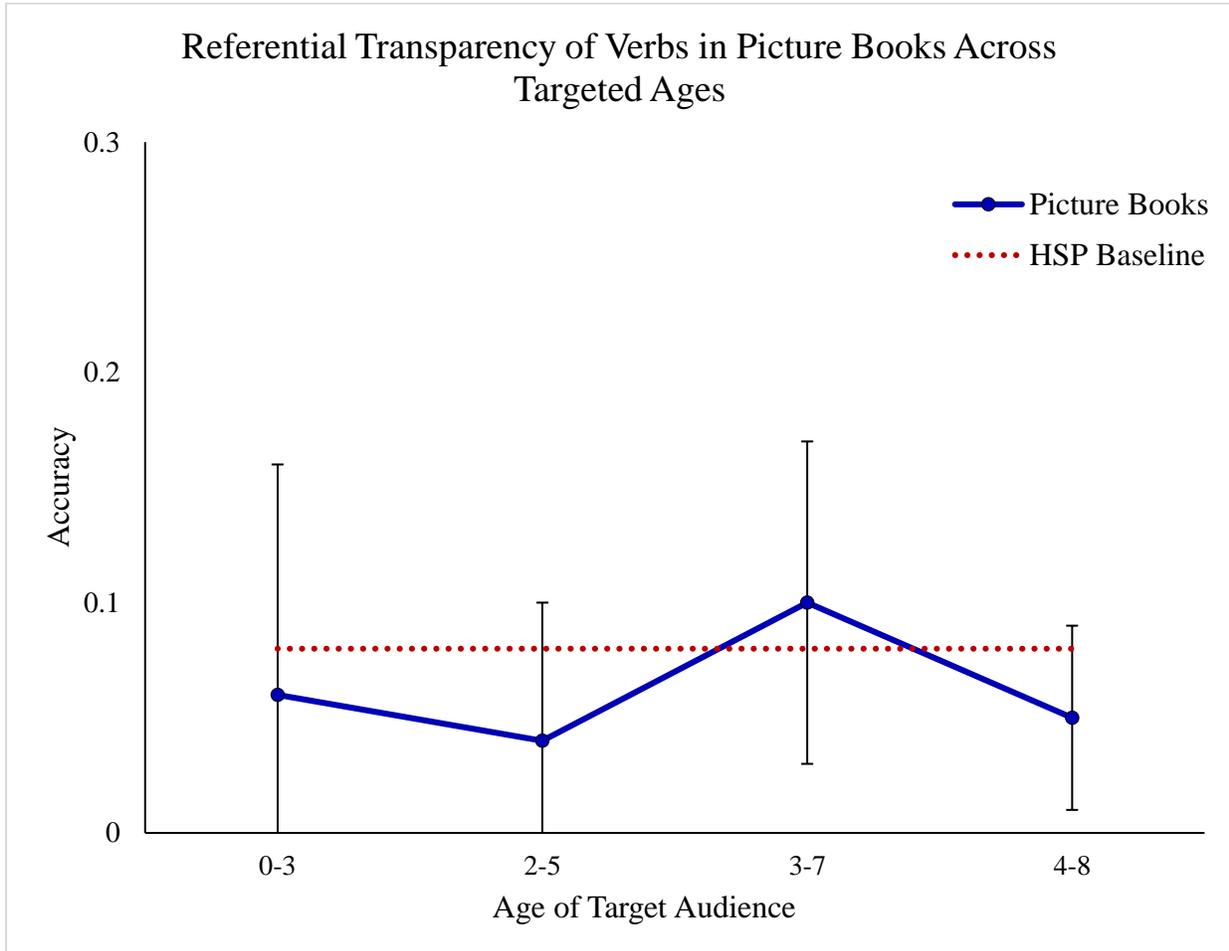
**Figure 4**

*Graph representing referential transparency of nouns across the targeted age group of the picture book*



**Figure 5**

*Graph illustrating the referential transparency of verbs across the targeted age group of picture books*



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