Preschoolers' curiosity about novel words

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To my parents who taught me to be curious and value learning

To Matt whose support was indispensable

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CHAPTER I

INTRODUCTION

When a 4-year-old child hears the word "democracy" for the first time, she might be curious about what the word means because of its novelty. Her likelihood of being curious about word meaning might also depend on individual traits such as the size of her lexicon, metacognitive abilities, or her epistemic curiosity. These traits all may be rapidly developing during the preschool years. Additionally, her curiosity about the novel word could depend on the discourse context in which it was offered. Children encountering a novel word in a familiar context might be more inclined to want to know about it than if it is introduced without context. Currently, there is a paucity of research on curiosity about novel words. We have yet to determine when word curiosity emerges, how it changes with development, and the factors that influence it. If attention to the novelty of words provides initial motivation for children to explore that word's meaning, then it might aid word learning.

Given the wealth of research on young children's word learning, it may be surprising that word curiosity has not been addressed. For decades, word acquisition researchers have determined that preschoolers are adept at using information in their environment to uncover the meaning or referent of novel words. When faced with the task of learning a new word, children can use the familiarity versus novelty of a referent (Carey & Bartlett, 1978; Markman & Wachtel, 1988), the shape of an object (Landau, Smith, & Jones, 1988), speaker intention (Nameera Akhtar, Carpenter, & Tomasello, 1996; Baldwin, 1993), distributional regularities

(Smith & Yu, 2008), and associations between words and referents across multiple presentations (cross-situational learning, Yu & Smith, 2007). The goal of most word acquisition research is to determine which information children will make use of to learn words, and most paradigms involve researchers providing the material to a relatively passive recipient. As a result, the methodology of these previous studies does not provide information about self-guided learning as children are not selecting their own learning material, and the provision of information is not contingent on their interest in particular words.

Therefore, less is known about the situations in which preschoolers actively propel their vocabulary acquisition forward by seeking out information about novel words. This type of self-guided learning may be important for word acquisition. When children and adults are given the chance to select which words to learn about, they retain the label information better than if they do not have a choice (Kachergis, Yu, & Shiffrin, 2013; Partridge, Mcgovern, Yung, & Kidd, 2015). The act of choosing what to learn about may make children more motivated to learn more than they would otherwise (Gureckis & Markant, 2012). This may be because learners can direct their cognitive effort at material that they are more likely to assimilate (Metcalfe, 2002). Knowing more about curiosity-driven word learning could help us understand a previously unstudied mechanism in preschoolers' word acquisition.

Research on information seeking in the toddler and preschool period has revealed that from early in development, children are proficient question askers (e.g., Chouinard, Harris, & Maratsos, 2007; Fitneva, Lam, & Dunfield, 2013; P. Harris, 2012; P. L. Harris, Ronfard, & Bartz, 2016). In one study, it was estimated that children between the ages of 1 and 5 asked an average of 107 questions an hour (Chouinard et al., 2007). Chouinard et al. (2007)'s monograph on children's questions reported a descriptive analysis of children's questions using the

CHILDES database (Study 1) and a diary study of children between the ages of 1 and 5 years (Study 2). The most frequent types of questions were questions about labels (described as "the name for an object, or to what a name applies"), activities of people and things, and locations of things. The proportion of questions that were classified as being about labels decreased with age, but still accounted for 12 (Study 1) to 24 (Study 2) percent of the questions children asked as they approached their fifth birthday (i.e., in the 4;6-4;11 age bracket). Additionally, as research in our lab has shown, children seem to ask a greater proportion of questions about abstract words as they get older. This evidence from corpus studies suggests a developmental emergence of self-directed word learning that happens in the preschool years. However, there is also large variability in children's tendency to ask about words. For example, while one child in the CHILDES corpus asked for definitions 65 times and for labels 230 times, another asked for a definition only once, and for labels 66 times (Jimenez, Sun, & Saylor, 2018). Information seeking about novel words may emerge in the preschool years, but perhaps not equally for every child.

Word learning is a hallmark of the preschool years, and just as there is variability in children's question asking, we see large variability in vocabulary size for children entering kindergarten. For instance, the vocabulary-gap between privileged and underprivileged populations, in terms of SES and racial minority status, becomes solidified by the time children enter kindergarten. In terms of vocabulary knowledge, the group of low-SES African American children appear to be one year behind their high-SES White peers when they enter kindergarten and this remains unchanged at age 13 (Farkas & Beron, 2004) and influences academic experiences (Dickinson & Tabors, 2001). In addition to differences in input (Golinkoff, Hoff, Rowe, Tamis-LeMonda, & Hirsh-Pasek, 2018; Hoff, 2013), there may be characteristics of the child, such as a tendency to attend to novel over familiar words that contributes to this discrepancy. Knowing more about the child-characteristics that support self-directed learning in the preschool years could help with understanding, and possibly addressing, the vocabulary-gap at this crucial age. Self-directed information gathering has been shown to lead to greater word-learning in preschoolers (Partridge et al., 2015). One way that self-directed learning might be supported is through a child's curiosity about novel words.

Curiosity is a broad term that encompasses many different concepts, and curiosity about novel words, falls under the umbrella of epistemic curiosity. Epistemic curiosity refers to the liking and wanting of new information (Litman, 2005; Litman, 2008). Epistemic curiosity, emerges both at the trait-level—remaining at a constant level for a particular person, and at the state-level—different situations may elicit more curiosity (Jirout & Klahr, 2012; Loewenstein, 1994). Curiosity about novel words might also be manifested at these two levels.

In addition to curiosity, variability in preschoolers' other cognitive processes may influence both their ability to identify a word as novel and their systematic information-seeking directed towards uncovering its meaning. Since many potentially foundational cognitive skills are rapidly developing through the preschool years, there may be a great deal of variability in preschoolers' curiosity about novel words. For example, preschoolers' emerging metacognitive abilities could be particularly important for identifying novel words. Their developing executive function could aid them in systematically choosing to learn about the unknown word, and their language skills could allow them to access their lexicon more effectively and give them a knowledge base that makes it easier to assimilate new words.

In what follows, the individual factors that may lead preschoolers' to be curious about novel words will be explored. First, I will delve into the concept of curiosity and what it means for a child to be curious about the meaning of a word. In this section, preschoolers' exploration of novelty and trait-level curiosity will be considered as a possible motivator of novel word exploration. Second, the mechanisms supporting the identification of a word as novel, such as metacognition, specifically uncertainty monitoring and lexical awareness will be examined. Third, I will address additional cognitive traits such as executive function and language ability that could also be important contributors to preschoolers' word curiosity.

Wanting to know about a word

Children's interest in words and word meanings may vary; that is, some children may be more likely to be "word-nerds" than others. These word-interested children may be more prone to show interest in what words mean. Children will, of course, learn words regardless of whether they find themselves pondering the meaning of unknown words, because they have access to many robust, automatic processes to support word learning (Akhtar & Tomasello, 1996; Baldwin, 1993; Landau et al., 1988; Smith & Yu, 2008; Yu & Smith, 2007). However, interest in words may give some children a boost. At present, there are no available measures for testing preschoolers' interest in vocabulary (independent of their vocabulary size, which may be related to interest in words, but is likely also heavily input driven). This previously untested factor might predict variability in the size and scope of children's vocabularies.

Children's interest in words' meanings may be related to their levels of curiosity. While recent cognitive development research has deemed term curiosity, as "a hopeless endeavor to categorize…and certainty beyond what any reasonable person would undertake pre-tenure" (Bonawitz, Bass, & Lapidow, 2018, pg. 214), it was in fashion in the middle of the 20th century and considered a driving force in guiding children's learning. From the mid 1950's to the late

1970's many studies investigated how children's minds and features of their learning environment stimulated exploration and discovery (e.g., Berlyne, 1954, 1960, 1966; Cantor & Cantor, 1964; Charlesworth, 1964; Greene, 1964; Mittman & Terrell, 1964; Smock & Holt, 1962). Daniel Berlyne (1924-1976), in particular, provided an influential framework for understanding the roots of exploratory behavior in humans (and other animals). Central to the discussion here is Berlyne's definition of curiosity as, "the condition of discomfort, due to the inadequacy of information, that motivates specific exploration" (1966, pg. 26). The idea that curiosity creates an unpleasant sensation that we seek to reduce is echoed in more contemporary views of the drive that underlies our tendency to seek out information when it is lacking or when available evidence is incongruous (e.g., Litman, 2005; Loewenstein, 1994). According to Berlyne (1954, 1966), curiosity was aroused, in part, by percepts or ideas that are novel, irregular, and incongruous.

Novelty preference may be an important component of curiosity. Infants and children's preference for novel stimuli is well established, at least in the visual domain. Infant's preference for novelty seems to be so reliable that researchers have taken advantage of it to study cognitive processes with the high-amplitude sucking procedure (Siqueland & DeLucia, 1969) and the head-turn preference procedure (D. G. K. Nelson et al., 1995). When preschoolers are given a choice, they would rather play with toys that they have not been exposed to than those that they have, and the preference for the novel toy increases with the amount of exposure they have with the competitor (Endsley, 1967; Schulz & Bonawitz, 2007). Preschoolers as well as 5th and 6th grade children, tend to like unfamiliar pictures or more complex ones over pictures that they have already been familiarized to (G. N. Cantor, 1968; B. Henderson & Moore, 1980). Alternatively, there is evidence that novelty preference is context dependent (Fiser & Aslin, 2002; Liao, Yeh, & Shimojo, 2011; Mather, 2013; Schulz & Bonawitz, 2007; Spence, 1996). In some situations children might exhibit a familiarity preference instead of a novelty preference.

Whether children display a novelty preference seems to depend on the complexity and amount of exposure of the stimuli provided. Children might prefer both novel objects and words, since they can use both the novelty of a word and the novelty of an object to learn words (Nameera Akhtar et al., 1996; Markman & Wachtel, 1988), but being able to use the novelty of words and objects does not mean that children prefer to explore novelty when given a choice. Therefore, it is unknown if there is a preference for both. On the other hand, novelty preference could be separate for novel words and novel objects. That is, children who exhibit the tendency to explore novel objects may not prefer to know more about a novel word. This could underlie individual differences in learning preference. Additionally, there may be different levels of processing demands between visual and auditory presentation of novelty. For example, identifying and preferring novel words requires processing speech in a potentially noisy environment, which may be more difficult for preschoolers than recognizing novelty in objects in their field of vision.

As mentioned above, epistemic curiosity can be conceptualized as both a trait—some children are more curious than others, and as a state—some situations elicit more curiosity (Berlyne, 1954, 1960; Day, 1971; Jirout & Klahr, 2012). Children with higher trait levels of curiosity are more likely to explore and ask questions (Jirout, 2011). Children who have the tendency to notice new things in their environment and are generally inquisitive and exploratory are displaying trait-curiosity. State-level curiosity is dependent on the situation and could be influenced by interest in a particular topic (e.g. dinosaurs) or prior knowledge and experience with the topic. For example, if children hear a word that they learn is a new type of food it may induce state curiosity as they know about food and it may spark more specific questions about what the food will look or taste like. Unfortunately, there are few robust measures of either state or trait level curiosity for preschool-aged children (see Jirout & Klahr, 2011).

One promising measure of trait curiosity described in more detail in Jirout and Klahr (2011) indexes variability in children's epistemic curiosity using their optimum uncertainty preference. In their measure, children who are more curious are those who prefer to explore more uncertainty in a forced-choice task, that is they explore wider information gaps . The task involves choosing between two different windows with different levels of information about what was behind them. They could either have no information (question marks), medium information (a range of possibilities), or maximum information (a picture of what would be behind the window). The game is adaptive and changes the size of the information gap presented to children as they make their decisions. Children who preferred more uncertainty in this task were better at judging the quality of questions and they asked more questions about a science topic even when controlling for verbal ability (Jirout, 2011). This task might help us determine which children are more likely to ask about the meanings of words because of their trait-level curiosity.

One way that children could demonstrate curiosity about word meaning is by asking an adult about the meaning of a word, however it has been found that only a minority of children seek information about novel words when embedded in a book. In one study, for example 37.5 % of children asked about the meanings of novel words spontaneously (Jimenez et al., 2018). This may be because asking questions about word meaning could require sophisticated mastery of receptive and expressive language that preschoolers do not yet possess. For example, estimates suggest that native speakers produce 4.43 – 3.93 words per second (Tomokiyo, 2000) or 4.92

syllables per second (Baese-Berk & Morrill, 2015), and preschoolers may struggle more than older children and adults in processing the linguistic information quickly. In addition to the difficulty comprehending rapid linguistic input, preschoolers would also need to formulate and produce a question. This process is likely cognitively intensive because it requires preschoolers to identify missing information, decide on the best way to obtain the information, identify a reliable informant, and then formulate the question in a way that the listener will understand and provide the missing information (Corriveau & Kurkul, 2014; K. Corriveau & Harris, 2009; Legare, Mills, Souza, Plummer, & Yasskin, 2013; Mills, Legare, Bills, & Mejias, 2010; Mills, Legare, Grant, & Landrum, 2011). Producing the question itself is also difficult because questions are syntactically complex (e.g. Valian & Casey, 2003), and questions comprise a small percentage of sentences uttered by children from 22 to 42 months (Vasilyeva, Waterfall, & Huttenlocher, 2008). Given the difficulties associated with asking a question about word meaning in a naturalistic context, what is needed is a controlled word-curiosity task that would bypass these difficulties.

Knowing what they do not know

To become curious about novel words, preschoolers may have to recognize that the words are new to them. To do so they have to realize when they do not know something. This requires children to reflect on their own mental states which requires metacognition. Although early studies that investigated the emergence of metacognitive ability suggested that preschoolers could not make reliable explicit judgments about their learning (e.g., Brown, 1978; Flavell, 1979; Flavell, Friedrichs, & Hoyt, 1970) more recent studies have shown that preschoolers make implicit judgments about what they do and do not know. For example, preschoolers can judge whether they would be able to remember a recently learned bit of information (Balcomb & Gerken, 2008) and have higher confidence for accurate responses during object naming tasks (Lyons & Ghetti, 2011). These and similar findings have been taken as an indication that preschoolers can sense when they are uncertain in what they know.

Children's ability to make accurate judgments about their uncertainty increases with age. Three-year-old children do not always show clear evidence of uncertainty monitoring (Hembacher & Ghetti, 2014) and are sometimes overconfident in their knowledge (e.g., Lipowski, Merriman, & Dunlosky, 2012). However, by 4-5-years of age, preschoolers use judgments about whether they know something to guide their decisions about whether to respond to questions or to seek help on memory tasks (Coughlin, Hembacher, Lyons, & Ghetti, 2014; Lyons & Ghetti, 2013). Additionally, preschoolers show evidence of exploring more in uncertain situations, such as when evidence is confounded. (Schulz & Bonawitz, 2007). These results clarify that preschoolers' uncertainty monitoring is related to control processes. That is, they not only monitor their understanding, but they can also use their metacognitive awareness to make decisions or act on their environment. With these emerging set of skills, preschoolers may also use these intuitions to guide their information seeking behaviors. They could potentially direct their information seeking towards novel words.

Such metacognitive monitoring skills have been revealed in studies of preschoolers' judgements of lexical ignorance. In particular, 4-year-old children can reliably determine whether words are known versus unknown (e.g., "Do you know what a hat/zav is?") and whether they can name familiar and novel objects (e.g., when shown pictures and asked, "Do you know what the name for this is?" Lipowski & Merriman, 2011; Merriman & Lipko, 2008), but three-year-olds tend to overestimate their knowledge of unknown words and novel objects (Merriman

& Marazita, 2004). Similar to uncertainty monitoring, across the preschool period, children become better able to recognize when a word is unknown and when they do not know the name of an object (Marazita & Merriman, 2004). Additionally, preschoolers show evidence of monitoring uncertainty about the meanings of words by socially referencing a speaker if a label is given in an ambiguous context, (Hembacher, DeMayo, & Frank, 2017). So children not only recognize when a word is unknown, but they can also act to resolve the uncertainty.

There is some evidence that metacognitive judgments, such as awareness of lexical ignorance, are related to inferences about word meaning. Merriman and colleagues have shown that children who make accurate judgments about a word or object being unknown (i.e. show higher levels of lexical awareness), were more likely to attach novel names to novel objects. In other words, children with more awareness of their own lexicon, avoided attaching a novel label to an already identifiable object. Preschoolers who answered "no" when asked "Do you know what a *dax* is?" asserted that a novel (e.g., garlic press) versus a familiar object (e.g., a cup) was a "dax" because the familiar object already had a name (Marazita & Merriman, 2004; Merriman & Schuster, 1991). A remaining question is whether recognition of lexical ignorance will be tied to curiosity about novel words.

Preschoolers' ability to identify an unknown word may or may not correlate with their preference to know more about the unknown word. For example, some children could be aware of their ignorance of a word's meaning, but not want to seek it out. Other children may not be explicitly aware that a word is one that they do not know, but have a preference to explore the word by some other motivation. Lastly, some children could use their lexical awareness to guide their novel word curiosity. Determining the role of preschoolers' metacognitive awareness relating to words, or lexical awareness, in novel word curiosity will require both testing the relationship between word curiosity and lexical awareness and examining evidence of metacognitive awareness in their explanations for why they want to see a novel word. For example, if a child wants to know about the word *shleb* and explicitly states that it is because they do not know what that word means, then this may provide evidence that they are using metacognitive awareness to guide their choice.

Executive function

Both uncertainty monitoring and lexical awareness increase from ages 3 to 5 (Hembacher & Ghetti, 2014; Lipowski, Merriman, & Dunlosky, 2012; Marazita & Merriman, 2004). Because of the developmental changes in metacognitive abilities during the preschool years, there may be a significant development in systematic information seeking about novel word meaning as well. Other processes such as cognitive control may similarly influence curiosity about word meaning in the preschool years as they are developing at a rapid pace from age 3-to-5 (Lyons & Ghetti, 2011; Zelazo et al., 2013). To determine which skills are important, children from the entirety of the preschool years (3-5-years-old) need to be tested to obtain the greatest variability in these skills.

For example, being able to control pre-prepotent responses (inhibition) and switching attention without losing focus (task switching), could play a role in the systematic information seeking about novel words at two levels. One way that executive function could help preschoolers seek novel words is by suppressing the overconfidence in knowledge that preschoolers typically exhibit (Destan & Roebers, 2015; Lipowski & Merriman, 2011) so that they can accurately assess their familiarity with words. Inhibition of the pre-potent overconfidence (e.g. a child thinking "I know every word") will aid preschoolers in determining whether a word is novel or not. Second, some curious children may engage in information seeking indiscriminately, and need sufficiently developed cognitive control to be able to switch between two options, evaluate them carefully, and decide to seek information about an unknown word.

Exploring the environment a lot is not the same as directing exploration to be systematic for optimal learning. For example, the child who asks questions about things that they already know, or the child who searches inside a shoe for a giant teddy bear is not systematic about seeking information. Similarly, seeking information about novel words may require children to be systematic as well, and this may be supported through their executive function skills. If children are presented with a novel word (e.g. *zav*) and a familiar word (e.g. *chair*) and asked to select which word they would like to learn about, to pick the novel word they may have to inhibit picturing the last chair they saw and becoming engrossed in the image, blurting out the word "chair" just because it is a word that they know, or simply repeating the last word that they heard. Being able to weigh the options and then choosing the option that leads to a gain in learning may require cognitive control or executive function.

The most common framework for conceptualizing executive function includes both a unitary construct and three differentiated components, namely inhibition, working memory, and task shifting (Miyake et al., 2000). Although we know that executive function goes through rapid rates of development in the preschool years (Carlson, 2005; Garon, Bryson, & Smith, 2008; Zelazo et al., 2013), it is unclear if executive function is a unitary construct in the preschool years or if preschoolers' exhibit adult-like differentiated components (Carlson, 2005; Garon et al., 2008). In particular, task-switching relies on the two other components of executive function, working memory and inhibition and has the longest developmental trajectory (Davidson, Amso, Anderson, & Diamond, 2006; Garon et al., 2008). Selecting a novel word to learn about could involve comparing between the two options, shifting attention from one option to the other, holding a goal in mind, and inhibiting the urge to say the word you are familiar with and have already said many times before. Therefore, a task that measures task-shifting like the Dimensional Change Card Sort Task could help determine if systematically choosing to learn about novel words is influenced by executive function, whether it presents as differentiated components in preschool or not. If a child is able to control their responses during the DCCST, they may be able to be more deliberate during a word-curiosity task.

Influence of language ability

Vocabulary size, and verbal fluency may also predict children's curiosity about word meaning. There is some evidence that they can be an indicator for children's potential for language learning (Fernald, Perfors, & Marchman, 2006). In particular, vocabulary size seems to predict preschoolers' likelihood of asking about a novel word in a storybook, and that language ability, word learning, and awareness of lexical ignorance are related (Jimenez, Sun & Saylor, 2018). Having a larger vocabulary size could be evidence of a greater interest in learning words, and that may include being curious about word meanings. On the other hand, vocabulary size could be more related to the quality of input a child receives (Cartmill et al., 2013; Dickinson, 2011; Farkas & Beron, 2004) and not whether they are interested in words. Additionally, receptive vocabulary size in adults signals better access to their lexicon (Bialystok, Craik, & Luk, 2008; Luo, Luk, & Bialystok, 2010), therefore the same might be true for children. The first step in determining how vocabulary size and word curiosity are related is to measure if they correlate with each other in preschoolers, and to what degree.

Another language ability that may be important to consider is verbal fluency. Verbal fluency measures the time it takes for children to retrieve a word from their lexicon (Berninger et al., 2006; Katz, Curtiss, & Tallal, 1992) and better performance on rapid naming in kindergarten has been linked to better reading outcomes at the end of 1st and 2nd grade (Schatschneider, et al., 2004). Children with more efficient access to their lexicon may be more likely to distinguish between known and unknown words more efficiently and accurately, and as a result become curious about a word's meaning more reliably. In regards to word curiosity, rapid picture naming may be an especially appropriate measure of verbal fluency because it requires participants to access semantic networks, more so than rapid letter naming and rapid digit naming (Berninger et al., 2006; Katz et al., 1992). Children with greater verbal ability, measured by receptive vocabulary size and rapid picture naming, may be more curious about word meaning because they have quicker access to their lexicon and might be more skilled language learners.

Summary

If given a choice, preschoolers might want information about a novel word over one that they are already familiar with. However, it is also possible that they might not, and there may be substantial variability in their likelihood to do so that is constrained by age related change in ancillary skills. For example, 5-year-olds might be systematic in their exploration of novel words, but 3-year-olds may not have developed the ancillary cognitive skills to support curiosity about novel words. Previous research has determined that preschoolers are developing the *ability* to recognize novel words, but has not explored if children have a *preference* for learning about novel words over familiar ones. Determining whether preschool children are curious about novel words, whether there is variability in their word-curiosity and if so, which factors are most predictive of preschoolers' information seeking about novel words will be important for understanding self-driven word learning. Especially in light of the relative mailability of word learning in the preschool years.

If it is found that word curiosity develops over the preschool years, *why* this developmental change happens still needs to be known. By testing factors that may support word curiosity, the mechanism behind the change can be probed. The factors that are of most interest are preschoolers' trait curiosity, novelty preference, lexical awareness, executive function, and language ability. As this particular set of abilities has not been tested before, this is a first step in understanding curiosity about word meaning in preschool and will lay the foundation for further uncovering the mechanisms responsible for self-driven word learning.

The current studies

The current studies investigate children's exploration of novel words. The first study determines whether preschoolers prefer to seek information about words that they do not know over words that they already know. This is done by presenting participants with two flaps, one that has a novel referent behind it and one that has a familiar referent behind, and asking them which one they want to see behind.

In Study 1, I also investigate whether abilities that emerge in the preschool years support the development of word curiosity from age 3 to 5 by testing trait-curiosity, novelty preference for objects, lexical awareness, cognitive control, and language ability. I will be testing trait curiosity with the measure developed by Jirout and Klahr (2011) that measures uncertainty preference in preschoolers. Novelty preference for objects will be tested by asking participants if they would rather play with a familiar toy or one they had never seen before. Lexical awareness will be measured by asking children to identify the word they do not know when given a novel-known word pair (Lipowski & Merriman, 2008; Merriman & Marazita, 2004). Cognitive control will be measured by the Dimensional Change Card Sort Task, which is a measure of task switching, but also involves inhibition and working memory for preschool participants (Zelazo et al., 2013). Finally language ability will be tested with a Picture Vocabulary Test to determine preschoolers receptive vocabulary and verbal fluency will be measured with a rapid picture naming task (Gershon et al., 2013).

In Study 2, I will consider if discourse context influences state-curiosity about word meaning. Children's curiosity may be influenced by individual traits, but there are likely to be situations in which all children become more curious about words. For example, if a child hears a word in a familiar context and can determine that the word is a type of food it may make them more curious about the novel word than if they do not know anything about it. Study 2 investigates this possibility.

CHAPTER II

STUDY 1

Introduction

Study 1 presents a newly developed measure of word curiosity. This measure may be a more direct way to test word curiosity than studying children's questions-asking about novel words. To measure children's curiosity about novel words participants were presented with a novel word and a familiar word that were depicted by two pictures occluded behind paper flaps and they were asked which one they would rather see. Children who selected the novel word more reliably were scored as having higher novel-word curiosity. The prediction was that there will be variability in children's curiosity about novel words that may be related to their age and other cognitive and dispositional factors. For example, children who have more word-curiosity may also show higher levels of trait curiosity and novel-object preference. Additionally, more developed lexical awareness, cognitive control, and verbal ability may lead to better systematic information seeking about novel words. Ultimately, there may be a combination of influences that drive the development of novel word curiosity.

Method

Participants

Eighty-six monolingual, English speaking children ranging in age from 3 years, 1 month to 5 years, 10 months (M = 4;1; SD = 7.88 months, 45 males, 51 females) participated in this study. Children were recruited from state birth records (n = 27) and from childcare centers (n = 59) in the Southeastern United States.

The information from the demographic survey was used to calculate the educational attainment of participants' parents. A numerical value from 1-7 was assigned to the educational categories from the survey. Demographic surveys revealed that 51% of mothers had a post-graduate degree (7) or some graduate school (6), 31% had a college degree (5), 8% had a technical/AA degree (4) or some college (3), and 3% had a high school diploma (2). Four parents did not respond to this question. 41% of fathers had a post-graduate degree (7) or some graduate school (6), 30% had a college degree (5), 15% had a technical/AA degree (4) or some college (3), and 4% had a high school diploma (2) or some high school (1). Nine participants' parents did not respond to this question. For children whose parents completed the demographic survey for two parents (e.g. a mom and a dad) an average of the two numerical values was calculated and for participants whose demographic survey indicated only one parent that score was used on its own. Although marital status was not collected, this approximates a conventional method of quantifying the education component of SES (Hollingshead, 2011).

The family demographics of participants were as follows: 76% of mothers identified as white, 14% identified as black or African American, and 1% identified as "other". Eight parents did not respond to this question. 70% of fathers identified as white, 13% identified as black or African American, 1% identified as Asian, and 1% identified as "other". Nine parents did not respond to this question. Family income was relatively high. 42% of families reported an income of $150,000 or more per year, 23% reported an income between $80,000 and $150,000 per year, 20% reported an income between $30,000 and $80,000 per year, 5% reported an income of less than $30,000. Ten parents did not respond to this question.

Materials

Word-curiosity task. Ten heavyweight-paper boards were created to measure children's curiosity about novel versus familiar words. Two flaps on each board covered a picture of a familiar or novel object. Pictures of novel objects were taken from the NOUN database (Horst & Hout, 2014) and pictures of familiar objects (e.g. chair, backpack, box) were gathered using a Google image search. Each novel object was given a novel label, such as *nilt*, *mox*, and *prum*. The novel and familiar word pairs were matched for the number of syllables. Each pair of flaps was the same color to prevent participants from making their choice based on color. Three additional boards that displayed two familiar objects (e.g., cat and dog) were used for training and for sustaining attention between trials. See *Table 2* for a full list of novel and familiar words and images.

Object-preference task. To measure children's tendency to want to explore novel versus familiar objects, six pairs of novel and familiar objects were presented to the participants. The novel and familiar objects were roughly equivalent in color and size. Two replacement novel objects and two replacement familiar objects were available if a parent indicated that the child was familiar with the novel objects or unfamiliar with the familiar objects on a pre-study questionnaire. See *Table 3* for the pictures of the novel and familiar objects used in the object-preference task.

Lexical awareness task. To determine the level of awareness participants have of words that they do not know, children were asked to complete a lexical awareness task modeled after a task used in Jimenez, Crawford, and Saylor (in prep). Participants were asked to identify an unknown word in twelve word pairs. The word pairs contained one unknown word (e.g. wex) and one familiar word (e.g. cat). The familiar words were chosen from the Macarthur-Bates

Communicative Development Inventory (2007). The unknown words were generated in the lab so that they followed the rules of English phonology and were the same number of syllables as their familiar-word counterparts.

Scientific Curiosity as Uncertainty Preference (SciCUP). Jirout and Klahr's (2011) Scientific Curiosity as Uncertainty Preference (SciCUP) Measure was used. This task measures children's curiosity by probing their preference for uncertainty. The task is administered on a laptop. Children see pictures next to two submarine windows. The pictures depict either question marks or between one to six fish that could appear behind the window. The task is adaptive based on a participant's selection. Question marks indicate that any fish could appear behind the submarine window (see *Figure 1* for an example).

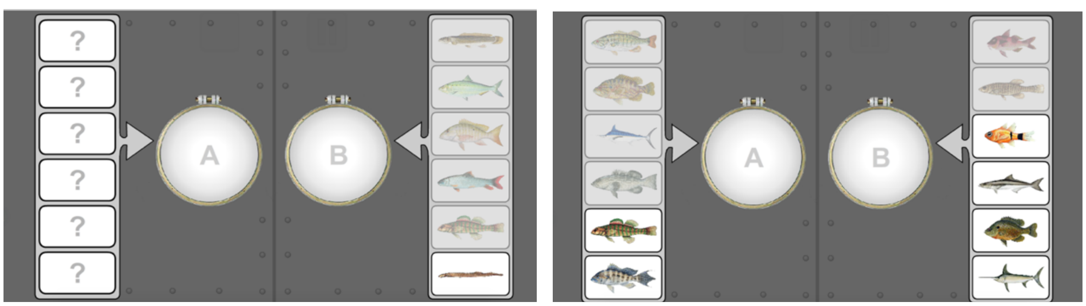


Figure 1: Screen shots of SciCUP created by Jirout & Klahr (2011).

Verbal Fluency. Participants completed the Rapid Picture Naming test portion of the Woodcock-Johnson IV Test of Oral Language (Schrank, Mather, & McGrew, 2014). The test-retest reliability was not reported in the Woodcock-Johnson IV Technical Manual for the 3-5 age range, but for the 7-11 age range it was $r_{12} = 0.90$ (McGrew, LaForte, & Schrank, 2014).

NIH toolbox Picture Vocabulary Test (PVT). This adaptive measure of receptive vocabulary is administered on an iPad mini (with a 7.9 inch screen) and uses the NIH toolbox app. It was developed and normed for children ages 3 to 6. The task was computer adaptive and there was a maximum of 25 items per child. The test-retest reliability for this task was high, as indicated by the intraclass correlation coefficient (ICC) of .81, n = 66 (Gershon et al., 2013).

NIH toolbox Dimensional Change Card Sort Task (DCCST). This measure of cognitive flexibility, also known as task switching, is administered on an iPad through the NIH toolbox app and is a component of executive function. Children in our study completed the developmental extension for ages three-seven, which included more training. The test-retest reliability of this task was high, ICC = .92, n = 48 (Zelazo et al., 2013).

Toy questionnaire. To ensure that the novel objects used in the *object-preference task* were unknown to the child, and the familiar objects were known, 71% of the parents of children in our study (25 of 27 lab participants, 36 of 59 childcare participants), were asked whether their child was familiar with each object used. This information was used to adjust stimuli for individual participants and, later, to determine if the items chosen were typically novel or familiar to children in this age range. The questionnaire was only administered to 61% of children tested in childcare centers because responses on the measure indicated that parents were showing the black and white photos of our stimuli to their children (e.g. parents writing their child's responses to the pictures in quotes and participants telling us that their mom had pictures of the toys at home). Parents did this even though they were instructed not to. Therefore, the sample of 61 questionnaires was used to determine that 87% of the time children were unfamiliar with our novel objects and 96% of the time they were familiar with the objects that we expected them to be familiar with.

Learning attitudes questionnaire. A 20-item questionnaire was given to parents to assess children's curiosity. Fifteen questions were created by Jamie Jirout (Jirout, 2017), five items were created for the purposes of this study to probe children's word-curiosity (three items), and to measure children's metacognition (two items). To measure word curiosity, items such as, my child "asks about the meanings of words," and "asks for names for things" were included. Items that were included to probe metacognition included: my child… "uses words like think, know, remember" and "realizes when they don't know the answer to a question." Other sample items from the original measure include: my child… "asks many questions, likes to explore new places, notices when there is something new in a room." Parents responded using a five-point Likert scale where the options were: rarely/never true, not often true, sometimes true, often true, and always true. This measure has high internal consistency with a Cronbach's alpha of .82.

Demographic questionnaire. Parents were asked questions about their education, occupation, and income. They also reported the languages spoken and number of children in the home.

Procedure

Word-curiosity task. For the *word-curiosity* task, participants were shown the practice board with the two flaps and were told that behind these two flaps were two different pictures. They were also informed that in this game they could only choose one flap to open, and they were told to think about what they wanted to see and to choose carefully. Participants were told what was behind the flaps twice before making their selection (e.g. "Behind this flap [experimenter pointed to one of the flaps] there is a box, and behind this flap [experimenter pointed to the other flap] there is a *nilt*. There's a box here [experimenter points] and a *nilt* here [experimenter points]"). After participants made their selection either verbally or by pointing, the experimenter opened the flap of their choosing, unless the children wanted to open the flap themselves in which case they were allowed to do so.

The first trial was a practice trial in which the participant was asked if they would rather see a cat and dog. After they made their selection, participants were reminded that they could only see beneath one of the flaps. Then, participants were told that some of the choices would be words that they had never heard before, but that they should choose what they wanted to see the most. Then they were presented with their first experimental board and were told, for example, that they can either see a *bucket* or a *dwanoo*; when they made their selection, participants were shown the item they asked for. Nine more experimental trials were completed for a total of 10 known-novel word pairs. There were two additional known-word pairs that came after the 3rd and 6th experimental trials to sustain their attention.

The order that the boards were presented, and the locations of the novel objects, were counterbalanced across participants. The novel object was on the right for half of the boards and on the left for the other half. The option on the left was presented first for half of the participants, and the option on the right was presented first for the other half. After each known-word pair, the experimenter would switch which option was presented first. This ensured that all participants heard the right-side option presented first for some trials and the left-side option presented first for others. For the final four items, children were asked to explain why they chose the word that they did after they made their selection, but before seeing the item. See *Figure 2* for an example of what the boards looked like.

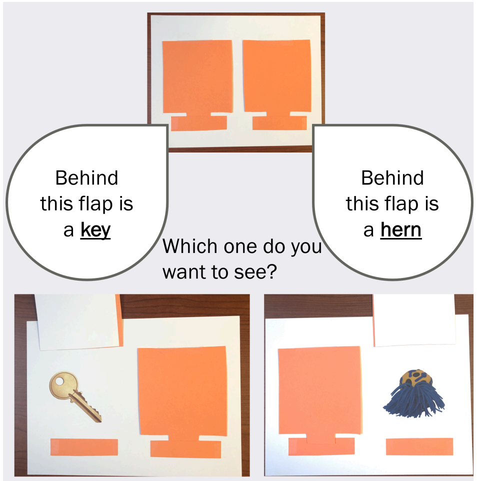


Figure 2: Board used during word-curiosity task.

Object-preference task. After the *word-curiosity task*, children completed the *object-preference* task. For this task, they were told that they would see two different toys and that they could pick one to play with. They were instructed to choose carefully as they could only pick one of the toys. The toys were held up in the experimenter's hands while the experimenter looked at the child so that there was no gaze information conveyed to the child, and the experimenter asked, "which of these would you like to play with?" The side that the novel object was on and the order in which the pairs were presented in were counterbalanced across participants. After participants made their selection, they were handed the toy. If they tried to select both, the experimenter told the child, "you can only pick one." After this reminder, all participants made a selection. If the participants changed their choice quickly, their second selection was recorded. Participants played with the toy they selected for 5-10 seconds and then the experimenter would hold out their hand for the toy and ask if they were ready for the next one. There were 6 novel-familiar toy pairs total.

Lexical awareness task. After the word-curiosity and object-preference tasks, children completed the *lexical awareness task*. Participants were told that they were going to play a game with words where they would hear two words: an old word that they already knew—like the word *book*—and a new word that they had never heard before, like the word *floopydoopy*. Then, they had two practice trials in which they were encouraged to tell the experimenter which word in the pair was the new word or the word they had never heard before (e.g. *sock* or *baloota*). If they provided the correct answer, then the experimenter told them they were right and moved to the next practice trial. If they provided an incorrect answer, for example, if they said sock was the new word, then the experimenter asked if they knew what a sock was. Participants typically would say yes, or would point to their socks. If they did not do that, the experimenter would ask, "What do you do with a sock?" The participants would respond, "You put socks on your foot." The experimenter then pointed out that they did know what a sock was and that sock was an old word. After participants provided the correct answer or were given the correct answer by the experimenter on the two practice trials, they progressed to the test trials.

There were twelve pairs of familiar and novel words in the test trials. Before each test trial the experimenter would ask the participant, for example "Which word is new, *cat* or *wex*?" while holding out their left hand for the first word and their right hand for the second word. Participants responded by saying the word, but if they were unable or unwilling to pronounce either word they could point to the hand that the experimenter held out while saying the word. Participants were reminded to choose the new word, the word that they did not know, after every four trials, but no other feedback was given.

Scientific Curiosity as Uncertainty Preference (SciCUP). Children were told that they were going to play a submarine game on the computer. In the game, children saw two submarine windows and could choose to open one of them and see a fish. The two windows had different levels of uncertainty as to what fish could be behind it. A pre-recorded voice delivered most of the instructions, with the experimenter providing supplementary instruction when necessary (see Jirout and Khlar (2012) for additional details about the procedure).

Children were first pre-trained on three possible submarine windows with varying uncertainty about what fish could be behind them. For example, a minimum uncertainty window showed one fish on the side of the screen near the submarine window. Participants were instructed that when there was only one fish on the side of the screen, they will see that fish when the window is opened. The second window showed a mid-level of uncertainty; there were several fish on the side of the screen, and participants were told that when they opened the window it could be any one of those fish. The third window type represented maximum uncertainty because there were no pictures of fish on the side of the screen. Instead, there were question marks, which meant that participants did not know what kind of fish would be behind the window—it could be any type of fish.

After being introduced to these three window types, participants were shown the three types of windows again, and the experimenter asked the participants questions to verify that they understood what each meant. After the pre-training, children proceeded onto the eighteen test trials where they chose between two windows with different levels of uncertainty. For example, they could choose between one window that had six possible fish behind it and one window that only had two possible fish behind it. The two windows that were presented to participant were determined by the participants' previous selections. For example, if a participant preferred to explore more uncertainty on previous trials, they would see the maximum uncertainty window as a choice more often than a participant that tended to choose a window with less uncertainty. The first three trials for every participant were the maximum uncertainty window (all question marks) against the minimum uncertainty window (only one possible fish).

Verbal Fluency. In the Woodcock-Johnson IV Tests of Oral Language subtest, Rapid Picture Naming, participants were asked to name as many black and white line drawings as they could in two minutes. They were shown ten black and white line drawings (e.g. a hat, a fish, a flower, etc.) and were told that they were going to play a game where they would tell the experimenter what the drawings were called as fast as they could. After completing the practice items, participants were shown a timer that was set for two minutes and were told to try and name the things on the next page as fast as possible until the timer beeped. If participants had trouble tracking the items from left to right and top to bottom, the experimenter pointed to the items to be named (Schrank, Mather, & McGrew, 2014).

The NIH Toolbox Picture Vocabulary Test. For the test of receptive vocabulary, children heard a word and were shown four pictures through the NIH Toolbox iPad application. They were asked to point to one in order to indicate their knowledge of that word. They completed two practice trials (banana and spoon) and were given feedback. After successfully completing the practice trials, they were told that some of the trials were going to be easy, some were going to be hard, and that they should try their best on all of them. The experimenter advised them that they could not get any hints, but that they could tell the experimenter if they needed to hear the word again or if they thought they made a mistake on the last trial, and the experimenter would play the word again or return to the last trial. The first items presented to children were based on their age, and subsequent items were presented based on participants' accuracy on previous trials. If children selected the correct referent for the word, the difficulty of the words they were presented would increase. Participants completed a maximum of 25 items and received a standard score based on the averages for the U.S. population and an age-corrected standard score based on age-norms (Gershon et al., 2013).

The NIH toolbox Dimensional Change Card Sort task. For the test of executive function, children completed the dimensional change card sort task on the NIH Toolbox iPad application. Participants were shown a sailboat and a rabbit that were either brown or white at the bottom of the screen. A third brown or white sailboat or rabbit appeared in the middle and the participants were instructed to match the third object either by color (brown and white) or by shape (boat or rabbit). After four practice trials, the instructions switched so that if they were first sorting by color they would then sort by shape (and vice versa) and they completed four more practice trials. If they were not accurate on three out of four practice trials, the block was repeated. They were provided with feedback after each practice trial. Participants who succeeded in completing the developmental extension training moved on to the test trials with different shapes and colors, yellow or blue balls and trucks. In the first test block of five test trials where they were told to sort by either shape or color and then the instructions switched for the next block of five test trials. Participants did not receive feedback on these trials. If participants responded accurately on four out of five of the post-switch block of trials, they proceeded to a mixed block of 50 trials where they were instructed by a pre-recorded voice to sort by shape or color. Participants who sorted based on shape and color when instructed to received points based on their correct responses. If participants were accurate on more than 80% of trials, reaction time was included in their score, however this is reported as unlikely for participants under the age of 6 (Zelazo et al., 2013). Participants received a raw score, a standard score based on the U.S. population, and an age-corrected standard score based on age norms. In this study the standard score was used.

Design

The participants tested in the lab completed all of the measures on the same day with breaks when needed. The tasks were administered in the following order: word-curiosity task, object-preference task, lexical awareness, curiosity measure, verbal fluency, picture vocabulary test, and dimensional change card sort task. For the participants tested in childcare centers, the word-choice task, the object-choice task, and the lexical awareness task were administered in the first session and the curiosity measure, the verbal fluency task, the picture vocabulary test, and the dimensional change card sort task were completed on a different day within three weeks of the first session (M = 4 days, SD = 4.22, range 0-22 days).

Coding and scoring

Word-curiosity task. Participants were asked which flap they wanted to open between the novel word and the familiar word. If they chose both (which happened very rarely) they were told they could only choose one; children's single word choice was scored. They earned a score of 1 for each novel word they selected either by pointing or by saying the novel word (for a range between 0 and 10). Children's likelihood of seeking information about a novel word was indicated by this score. 25% of participants' videos were re-coded by a research assistant who was not the experimenter, agreement was 99.99% and disagreements were resolved through consensus with two raters re-watching the video.

Object-preference. When participants were asked which toy they wanted to play with they received a score of 1 if they selected the novel object and a score of 0 if they selected the familiar object. Selections were primarily made by the participant pointing or reaching for the object, but occasionally they would name the object they wanted to play with. The minimum score was 0 and the maximum score was 6. Inter-rater agreement on a randomly scored 25% of participants' videos was 100%.

Lexical awareness task. The number of unknown words that they chose was recorded as the participants' score. Participants received one point for every unknown word that they selected. Scores ranged from 0 if a participant picked all familiar words to 12 if the participant picked all unknown words. Agreement was 99.98% on a randomly scored 25% of participants' videos and disagreements were resolved through consensus.

SciCUP. Participants' scores indicated their decisions to explore the most uncertainty. For each of the 18 trials their scores increased based on the amount of uncertainty that they chose to explore. For example, on one trial, if they chose the window with maximum uncertainty, they received 7 points; but if they chose to open the window where they already knew what fish was going to be behind it (minimum uncertainty), they only received 1 point for that trial. Scores could range from 18-126. This was scored online, automatically by the program.

Verbal fluency. During the rapid picture naming, participants were given one point for every item that they accurately labeled. If they provided a synonym, for example "kitten" or "kitty" instead of cat, they were counted as correct. Although some synonyms were provided on the Woodcock-Johnson IV Tests of Oral Language recording sheet, not all possibilities were entered; therefore we had to make some judgements ourselves. For synonyms not on the recording sheet, consistency in scoring across our sample was tracked by recording the responses that were accepted and rejected in a spreadsheet. The number of items that participants correctly named in two minutes was recorded as their score. This task was difficult to score in person because of the speed of the task. Therefore, all participants were re-coded using the video of this task. The video coding was used as the final score. 20% of the videos were re-coded by a separate coder and reliability was 99.996%. Discrepancies were resolved by the first author watching the videos and deciding the correct coding.

Exploratory analysis of word-curiosity explanations. For the word-curiosity task, the last four trials involved participants explaining why they made their choice. Participants' explanations were coded into five categories: mental state, function, preference, features, and no explanation.

When preschoolers referred to their own cognition by using perceptual or mental state verbs such as know, see, hear, etc. this was coded as *mental state explanations*. If explanations mentioned what the item was typically used for, they were categorized as *function explanations*. If participants referred to features of the items like color or attractiveness in their explanations, they were coded as *feature explanations.* Explanations that included either liking or owning something were coded as *preference explanations.* Lastly, some participants did not provide a meaningful explanation and those responses were coded as *no explanation.* See *Table 1* for examples of all explanation types. Additionally, explanations could have more than one code. For example, if a child explained that they wanted to see the glark, "because I love glarks but I don't have one at my house but I still want to see it," it would be coded as both a *preference* and a *mental state* explanation.

All explanations were coded by the first author and an independent coder. Agreement was 98.2% and disagreements were resolved by consensus.

Table 1: Examples of explanation coding.

Explanation label	Word	Example responses to "why do you want to see the ____?"	Age (months)
Mental state	Redda	*I want to know what it looks like*	66
	Nilt	*Because I don't know what it is*	49
	Prum	*I never remember one before*	64
Function	Shoe	*Because I put shoes on*	40
	Book	*Because I read the book*	52
Feature	Shill	*Because they're beautiful*	44
	Shoe	*Because it's so dirty*	45
Preference	Glasses	*My mommy has some glasses*	45
	Nilts	*I like nilts!*	52
No Explanation	Prum	*Because*	42
	Glark	*I don't know*	50
	Key	*Because I want to*	50
	Mox	[blank stare]	57
	Hern	[shrug]	44

Results

Descriptive statistics

Most participants completed the entire battery of tasks. See *Table 2* for information about how many children completed each task, the minimum and maximum scores observed, the means and standard deviation for our total sample and for the youngest and oldest children in our sample.

Table 2: Descriptive statistics of measures in Study 1.

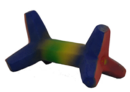
	n's	Min	Max	All Participants Means (SD)	Youngest (n = 43)	Oldest (n = 43)
Age	86	37	71	51.26 (7.88)	44.9 (3.93)	57.62 (5.22)
Word curiosity	86	1	10	6.27 (2.70)	5.42 (2.38)	7.12 (2.75)
Object preference	86	1	5	2.84 (1.18)	2.81 (1.03)	2.86 (1.32)
Lexical Awareness	84	0	12	8.37 (3.73)	6.93 (3.9)	9.81 (2.95)
Trait Curiosity	85	18	126	73.02 (21.47)	66.93 (20.42)	78.98 (21.01)
Verbal Fluency	85	9	96	57.02 (15.65)	49.4 (14.00)	64.83 (13.32)
PVT standard	85	43	77	60.47 (7.55)	57.23 (7.61)	63.79 (5.94)
PVT age corrected	85	73	138	105.58 (12.71)	103.02 (13.49)	108.19 (11.43)
DCCST standard	85	0	92	50.91 (20.06)	45.65 (18.91)	56.29 (19.96)
DCCST age corrected	85	0	120	97.87 (24.60)	95.60 (28.59)	100.19 (19.78)
Learning attributes	79	46	110	73.03 (8.25)	73.02 (7.93)	73.03 (8.69)
Parental Education	82	2	7	5.56 (1.35)	5.39 (1.32)	5.72 (1.37)

Novel word curiosity.

To determine if children prefer to learn about referents of novel words over referents of familiar words we tested whether they picked the novel word at above chance rates. A one-sample t-test revealed that, children explored the novel word (M = .627; SD = .27) at above chance levels, $t(85) = 4.36$, $p < .001$, Cohen's d = .47 (medium effect size) This demonstrates that on average, children in our sample were more interested in exploring the referent of the novel word that they heard than that of the words they were already familiar with.

Our participants could have used what they learned about the task early-on to guide their decisions about which word to explore in later trials. For example, if early on they decided that the novel referents were not as visually appealing as the familiar ones, or vice versa, they could have changed their responding accordingly. However, this did not seem to be the case, as the Cronbach's $\alpha = .74$ demonstrates acceptable internal consistency and there were no order effects. Order effects were probed by comparing preschoolers' preference for novel words in the first 5 items ($M = .63$, $SD = .30$) and the last 5 items ($M = .63$, $SD = .28$; $t(85) = .18$, $p = .86$). This measure of children's curiosity about novel words that I developed was reliable in terms of internal consistency and did not show order effects, or varied performance from beginning to end. See *Table 3* for means and standard deviations of participants selection of each novel item in a pair.

Table 3: Novel and familiar pictures used in the word-curiosity task.

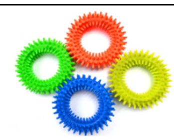
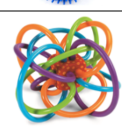
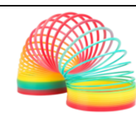
	Novel word	Known word	Mean novel selection (SD)
Training pair	 Cat	 Dog	
Pair 1	 Mox	 Pen	.56 (.50)
Pair 2	 Glark	 Chair	.67 (.47)
Pair 3	 Shill	 Cup	.67 (.47)
Pair 4	 Redda	 Glasses	.66 (.48)
Pair 5	 Prum	 Book	.67 (.47)
Pair 6	 Bimp	 Shoe	.62 (.49)
Pair 7	 Hern	 Key	.56 (.50)
Pair 8	 Coodle	 Backpack	.57 (.50)
Pair 9	 Smub	 Brush	.56 (.48)
Pair 10	 Nilt	 Box	.66 (.48)

Novel word and novel object curiosity

To determine whether children in our sample preferred to play with toys that were novel to them over toys that they were familiar with, we tested whether they chose the novel toy above chance. To improve the internal consistency of the measure, one item that proved to be an outlier was excluded. In the pair where the familiar item was a slinky, children picked the novel item only 14% of the time ($SD = .35$). This was more than one standard deviation outside of all the other items (See *Table 4* for means and standard deviations of all items).

It was found that children chose to play with the novel object ($M = .57$, $SD = .24$) above chance ($t(85) = 2.66$, $p = .009$). The effect size was small (Cohen's $d = .29$).

Table 4: Novel and familiar objects used for the object-preference task.

Pair	Novel object	Familiar object	Mean novel selection (SD)
Pair 1			.69 (.47)
Pair 2			.58 (.50)
Pair 3			.62 (.49)
Pair 4			.35 (.48)
Pair 5			.64 (.48)
Pair 6			.14 (.35)
Alternates	 Used 8 times	 Used 2 times	
Alternates	 Used 2 times	 Used 1 time	

The procedure for the novel-object preference task changed when we stopped administering the toy questionnaire to parents. This questionnaire was used to verify that participants were unfamiliar with the novel toys and familiar with the toys that were thought to be familiar to them. Therefore, it needed to be determined if this change influenced the responding of our participants. There were no differences in choosing a novel toy between the participants whose parents filled out a toy questionnaire (n = 61, $M = 2.95$, $SD = 1.19$) and participants whose parents did not (n = 25, $M = 2.60$, $SD = 1.12$, $t(84) = 1.26$, $p = .21$).

Another goal of this study was to test the possibility that novel-word curiosity was related to novelty preference for objects. To test this, a bivariate correlation was conducted and found that novel word curiosity was not related to novel object preference ($r(86) = -.06$, $p = .57$) in our sample. Further, novel object preference did not correlate with age ($r(86) = -.12$, $p = .27$), so this might point to a consistent recognition of novelty across our age range.

Novel word curiosity, on the other hand, did correlate with age ($r(86) = .38$, $p < .001$). Because of this, and because children had variable levels of lexical awareness, it may be that some participants (particularly the younger ones) had difficulty recognizing when the words was unfamiliar. Not recognizing novelty in words may influence the relationship between novel word curiosity and novel object preference. Specifically, participants' lexical awareness could have been a confounding factor that prevented us from finding a relationship between novel word curiosity and novel object preference. To determine if participants' awareness of words' novelty influenced the lack of a correlation between novel object preference and novel word curiosity, this correlation was tested only in participants who had higher than average ($M = 8.37$) lexical awareness (min = 0, max = 12). In other words, when given a pair of novel and familiar words, this subset of participants correctly identified the novel word 70% of the time or more. It was found that even in the sub-sample of participants (n = 49) there was no relationship between word-curiosity and object preference ($r(49) = -.13$, $p = .38$).

The development of word curiosity

To test the relationship between children's development and word curiosity, we explored the variables that were identified as being important for becoming curious about novel words: age, verbal ability (PVT, rapid naming), executive function (DCCST), metacognition (lexical awareness), and epistemic curiosity (curiosity task, learning attitudes questionnaire), and parental education.

Positive correlations were found between word curiosity and age, lexical awareness, rapid naming, and vocabulary. Trait curiosity, executive function, learning attitudes, and parental education were not correlated with word curiosity (See Table 5).

Table 5: Correlations between measures and word curiosity.

Measures	1	2	3	4	5	6	7	8
1. Word Curiosity	—	.38**	.28**	.18	.28**	.31**	.09	.08
2. Age	.38**	—	.50**	.24*	.58**	.56**	.31**	.18
3. Lexical Awareness	.28**	.50**	—	.03	.44**	.60**	.35**	.01
4. Trait Curiosity	.18	.24*	.03	—	.14	.11	.19	-.07
5. Rapid naming	.28**	.58**	.44**	.14	—	.51**	.34**	-.04
6. Vocabulary	.31**	.56**	.60**	.11	.51**	—	.47**	.15
7. Executive Function	.09	.31**	.35**	.19	.34**	.47**	—	.27*
8. Learning Attitudes	.08	.18	.01	-.07	-.04	.15	.27*	__
9. Parental education	.08	.16	.18	-.02	.34**	.22*	.26*	.03

Note: ** $p < .01$ (2-tailed), * $p < .05$ (2-tailed)

To probe the factors that influence word curiosity further, a hierarchical regression was conducted with the variables that were correlated with word curiosity as predictors. This set of variables that were correlated with word curiosity were also correlated with age. To disentangle the effects of age it was included in the first block of the hierarchical regression, while lexical awareness, rapid naming, and vocabulary were in the second block. It was found that the initial model predicting word curiosity was significant ($F(1,81) = 13.05$, $p < .001$) in the first block age accounted for a significant amount of variability $R^2 = .14$ ($\beta = .373$, $t(82) = 3.61$, $p = .001$). In the second block the addition of lexical awareness, rapid naming, and vocabulary did not result in a significant R^2 change ($\Delta R^2 = .02$, $F(3,78) = .61$, $p = .61$), and none of the variables in the second block were significant independent predictors of word curiosity. The regression showed that age was the only independent predictor of word curiosity in the first block. However, when age was included in the regression with the three other variables, it became a non-significant predictor of word curiosity ($t(82) = 1.83$, $p = .072$). This could suggest either that lexical awareness, rapid naming, and vocabulary mediated the relationship between age and word curiosity, or that the addition of three variables to the model resulted in a loss of power and potential issues with collinearity.

To explore the possibility that lexical awareness, rapid naming, and vocabulary mediated the relationship between word curiosity and age, while avoiding issues of power and collinearity, three separate regressions were conducted to reduce the number of predictors in each regression. Each regression included age and one of the three variables mentioned above entered simultaneously. The model with age and lexical awareness was significant ($F(2,81) = 7.52$, $p < .001$), and age remained a significant predictor ($t(83) = 2.78$, $p = .007$) while lexical awareness was not ($t(83) = .95$, $p = .343$). Similarly, the model with rapid naming and age was significant

(*F*(2,83) = 6.76, *p* = .002), and age remained a significant predictor (t(84) = 2.50, p = . 014) while rapid naming was not (t(84) = .76, p = .449). And again, the model with vocabulary and age was significant (*F*(2,82) = 7.27, *p* < .001), and age remained a significant predictor (t(84) = 2.34, p = . 022) while vocabulary was not (t(84) = 1.21, p = . 230). These regressions show that when we account for issues of power by only including two predictors at a time, lexical awareness, rapid naming, or vocabulary are not mediating the relationship between age and word curiosity.

Word-choice explanations

The factors that influence children's preference for which word to learn about could be probed further by examining the explanations for why they chose the word that they did. The explanations were coded as using mental state, function of the item, preference or ownership, features of the item, and no explanation (See *Table 1* for examples). The explanations that participants used for wanting to know about novel versus known words differed. As shown in *Table 6*, participants used mental state explanations (e.g., I don't know it) more often for novel words than for known words. Explanations that participants gave for wanting to see referents of known words were most commonly object function (e.g., [wanting to see the brush] because it makes your hair better) or participants' preference (e.g., [wanting to see the backpack] because I have a superman backpack). Children's use of feature explanations and their likelihood of providing no explanation was roughly equivalent for known and novel words.

Table 6: Percentage of explanations by word type.

	Known word		Novel word	
Explanation type	Percentage	Count (total = 142)	Percentage	Count (total = 208)
Mental state	5.6	8	46.2	96
Function	16.9	24	1.9	4
Preference	28.9	41	8.2	17
Features	9.2	13	6.7	14
No explanation	39.4	56	37.0	77

Participants' explanations also varied by age. A median split by age (Median = 51.55 months) was used to compare the oldest (n = 43, *M* age = 57.6) to the youngest (n = 43, *M* age = 44.90) participants. As shown in *Figure 3*, older participants used over twice as many mental state explanations for novel words than younger participants, conversely when younger participant chose a novel word, they were more likely than older participants to not be able to explain their reasoning (e.g., they shrugged, said "because," or "because I want to," etc.). For known words, younger and older participants were roughly equivalent in the proportion of explanations that they used except that young participants relied more on preference and ownership explanations than older participants.

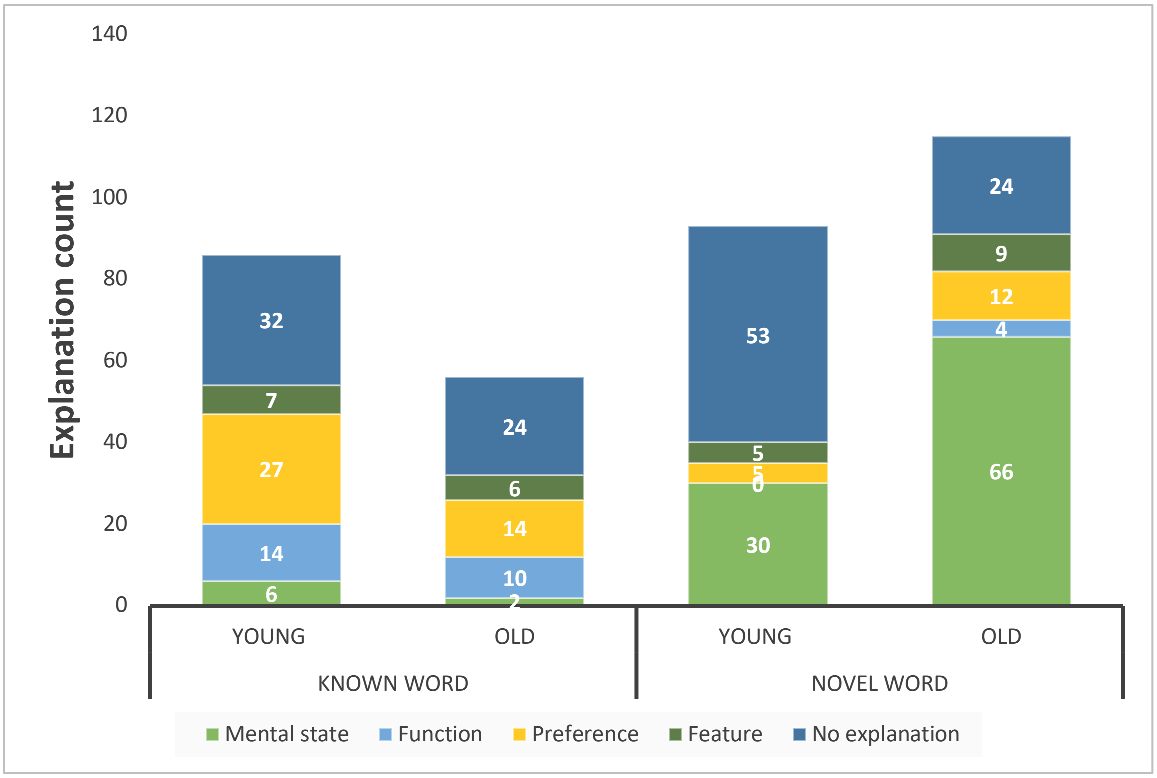


Figure 3: A count of the types of explanations used by younger and older participants for wanting to see novel and known referents. The explanation types from bottom to top are mental state, function, preference, feature and no explanation.

Participants who used mental state explanations showed the clearest evidence of being able to use metacognitive judgements to guide curiosity about word meaning. Roughly half of the participants (n = 40) used a mental state explanation at least once, while half did not (n = 45). Children who used mental state explanations, when compared to those who did not, were on average 6 months older ($t(83) = 3.77$, $p < .001$, $d = .81$), were more curious about words as they picked 2.13 more novel words to learn about ($t(83) = 3.95$, $p < .001$, $d = .86$), and had better lexical awareness ($t(83) = 3.77$, $p < .001$, $d = 1.03$) as they could identify the novel word on 3.45 more trials. However, children who used mental state explanations did not pick more novel toys than children who did not ($t(83) = 1.08$, $p = .28$), and there were no differences in vocabulary size ($t(83) = 1.78$, $p = .08$), executive function ($t(83) = .54$, $p = .59$), verbal fluency ($t(83) = 1.77$, $p = .08$), trait curiosity ($t(83) = .46$, $p = .65$), or parental education ($t(79) = .60$, $p = .55$) between the two groups. See *Table 7* for means and standard deviations of study measures between children who did and did not use mental state explanations. These results show that children who used mental state explanations were older, had more developed lexical awareness and explored more novel words. Since these participants used metacognitive explanations for choosing to explore the words that they did, and their metacognitive awareness specific to words (measured by the lexical awareness task) was more robust, the data suggest that participants used their metacognitive abilities to guide their word curiosity.

Exploratory mediation analysis

In fact, the role of lexical awareness on word curiosity would only make sense if children were using their metacognitive judgements to choose which word to explore. In other words, the use of mental state explanations may mediate the relationship between lexical awareness and word curiosity. To explore this possibility, I conducted an exploratory mediation analysis, that should only be cautiously interpreted because of issues described below. The simple regression with lexical awareness predicting word curiosity was significant $\beta = .276$, $t(83) = 2.602$, $p = .011$. Additionally lexical awareness was a significant predictor of mental state explanations (coded dichotomously) $\beta = .462$, $t(82) = 4.69$, $p < .001$, and mental state explanation was a significant predictor of word curiosity $\beta = .398$, $t(84) = 3.954$, $p < .001$. Critically when a multiple regression was conducted predicting word curiosity with both lexical awareness and mental state explanations, mental state explanations ($\beta = .347$, $t(82) = 3.022$, $p = .003$) fully mediated the relationship between lexical awareness and word curiosity (β = .116, t(82) = 1.012, p = .315). One caveat is that this mediation analysis may violate the assumption of independence. That is, children were more likely to provide mental state explanations if they were choosing a novel word and would therefore have a higher score on the word curiosity task. Because of this confound, I propose that the results of this mediation should be treated as exploratory.

Table 7: Participants' scores by mental state explanation use.

	Participants who used mental state explanations (n = 40)	Participants who did not use mental state explanations (n = 45)
Age*	54.3 months (8.3)	48.3 months (6.3)
Word curiosity*	7.35 (2.54)	5.22 (2.42)
Object preference	2.70 (1.29)	2.98 (1.08)
Lexical Awareness*	10.15 (2.98)	6.70 (3.66)
Vocabulary Size^	108.15 (11.51)	103.29 (13.29)
Verbal Fluency	60.18 (16.06)	54.22 (14.90)
Trait Curiosity	73.68 (22.83)	71.55 (19.75)
Executive Function^	96.33 (29.84)	99.24 (19.02)
Parental Education	5.45 (1.40)	5.63 (1.32)

Note: Standard deviations are in parenthesis

* significantly different between two groups p < .01

^ age corrected score (note: the Vocabulary standard score uncorrected for age, does show a difference between groups).

Parental education is a numerical value described above.

Discussion

The aim of this study was to learn about novel word curiosity in the preschool years, understand its developmental trajectory, and determine how it may correlate with individual differences. The task that I designed to test children's word curiosity bypassed the difficulties of question-asking and is the only controlled task of word curiosity (measured by interest in novel words over familiar ones) in the current literature. Curiosity can be defined as the liking and wanting of *new* information, so this task that measures the preference to learn about novel words qualifies as word curiosity. There was enough variability in preschoolers responding for the word curiosity task to be informative about the development of word curiosity in the preschool years and allow individual differences to be explored. The age range that was chosen seemed to be appropriate for studying word curiosity as there were no ceiling or floor effects. Overall, preschoolers did prefer to seek information about novel words over familiar words, but there was variability in children's word curiosity that correlated with age.

Even though overall, participants showed a novelty preference for objects and for words, novel object curiosity was not correlated with word curiosity, even when just the participants who recognized when words were novel were included. This indicates that in preschoolers, there might be domain-specific types of curiosity or children's individual preferences are driving their curiosity. Previous studies have shown that, novelty preference might be affected by the context that stimuli are presented in (Liao et al., 2011; Spence, 1996). The context of novelty in a toy and in a word might distinct enough that they were unrelated. Some children may favor novel toys, while others would rather learn about novel words, and then there's children that prefer novelty in both or neither.

Relatedly, the finding that trait curiosity, measured by both a behavioral measure and by parent report did not correlate with word curiosity is surprising. One issue is that the three measures of curiosity—novel object preference, the behavioral measure of trait curiosity, and the learning attitudes questionnaire that was parent-reported trait curiosity—show no correlations between themselves. If they were all measuring the same construct, they should be correlated. A potential issue is that the questionnaire and trait curiosity measure are relatively new. The learning attitudes questionnaire has yet to be validated and the trait curiosity task was only validated with a low SES population (Jirout & Klahr, 2011), and no test-retest reliability has been reported. Another issue might be that the three tasks are measuring different types of curiosity. The trait curiosity task measures uncertainty preference whereas the children who scored highly on the object choice task may not be as motivated by uncertainty as they are by experiencing something new. Curiosity is a challenging construct to define and test (Bonawitz, Bass, & Lapidow, 2018; Jirout & Klahr, 2012; Kidd & Hayden, 2015; Loewenstein, 1994), so future studies will need to more carefully validate measures of curiosity before clarifying how word curiosity relates to other types of curiosity.

The older participants were more curious about the novel words, or less curious about the familiar words, than the younger participants. The effect of age accounted for 14% of the variance in word curiosity. While there were other variables that correlated with word curiosity—lexical awareness, rapid naming and vocabulary—these did not account for significantly more variance in word curiosity than age. In at least one previous study, children who had larger vocabularies were more likely to ask questions about words that they did not know (Jimenez et al., 2018) when controlling for age. In this study, verbal abilities like vocabulary and verbal fluency correlated with word curiosity but were not predictors independent of age. Since asking a question requires children to rely on their language skills more so than pointing at a word to explore, this finding makes some sense. It may be that by controlling for the difficulty of question-asking the influence of language ability on word curiosity was reduced as well.

Additionally, parental education, executive function, and as mentioned before trait/object curiosity did not correlate with word curiosity. The Dimensional Card Change Card Sort task used to study the effect of executive function might have not been the right one to choose. It may be that word curiosity is more related to an inhibitory task because they have to inhibit the appeal of learning about the familiar word to learn about the new word. Alternatively, it may be that children do not use executive function to direct their learning to novel words. A future study that includes an expanded battery of executive function tests would be necessary to reach this strong conclusion.

This study has revealed that there are developmental changes in word curiosity, but the reason for these changes is unclear. Other factors that were not included in the current study could account for more of the variability in children's word curiosity, for example one possible factor is children's theory of mind skills. Evidence from children's explanations of their word preference show that children do reflect on their mental states to make the decision to learn about novel words. One way to determine if a child's understanding of mental states has solidified is with a theory of mind task. For example, a theory of mind task that measures children's understanding of how knowledge is acquired both for themselves and in others could provide insight on children's word curiosity (Symons, 2004). Children who score highly on this type of theory of mind task may be more likely to seek information about a novel word.

Through an exploratory analysis of participants' explanations for why they chose to see the referent of the word that they did, it was found that children used distinct explanations for seeing the referent of the novel word and the referent of the familiar word. Furthermore participants' explanations varied by age, and participants who used mental state explanations were significantly older, had better lexical awareness, and were more curious about novel words than those who did not use mental state explanations. These analyses suggest that children were using metacognitive awareness to guide their curiosity about novel words. When participants explained why they chose the familiar word they were not likely to use mental state explanations, rather they focused on whether they like or own an object, or about its function. An exploratory analysis found that children's use of mental state explanations mediated the relationship between lexical awareness and word curiosity. This may be because only children that explicitly say that they want to see a word because they do not know it (or some variant) are using their lexical awareness to determine which word they want to explore. Conversely, other children may know that they do not know the meaning of a word, but do not use this judgment to make their decision. These children may not use lexical awareness to decide what word to explore, so lexical awareness may not directly influence word curiosity.

This study is a first pass at investigating children's curiosity about novel words over familiar words. Preschoolers do show a preference to explore words that they do not know and this preference becomes more reliable with age. The factors that were tested did not predict word curiosity, but they may still interact in complex ways that lead to the emergence of novel-word curiosity. Because of the importance of word learning in preschool and the changes happening in many potentially relevant cognitive processes, the preschool years are an important period for studying curiosity about novel words.

An additional question about word curiosity is how the context a word is presented in affects children's interest in novel words. In Study 1 the novel word is presented in isolation. However, in a naturalistic situation children will most likely have some context for the novel word that may let them infer something about the word. In Study 2 the addition of discourse context will allow further investigation of children's word curiosity.

CHAPTER III

STUDY 2

Introduction

One possibility is that the child characteristics that predict curiosity about words have less of an effect on curiosity than the contexts in which words are provided. Children may be more curious about novel words that they know some information about over novel words that they do not have any information on. Berlyne alluded to the notion of an information seeking sweet spot – "optimum dosages" of novelty and complexity at which information seeking is most likely to occur (1966, pg. 32). Thus, there may be an optimal amount of information about a novel word for inducing curiosity.

More recent investigations of children's interest in visual stimuli and self-guided exploration have supported Berlyne's proposals about curiosity. Infants seem more inclined to direct attention to visual stimuli that have just the right amount of complexity – they selectively attend to patterns that are neither too simple nor too complex (e.g., Kidd & Pelz, in press; Kidd, Piantadosi, & Aslin, 2012). In other related work, Bonawitz and colleagues have shown that preschoolers were more likely to explore an object that violated their beliefs about balance relationships (Bonawitz, Bass, & Lapidow, 2018; Bonawitz, van Schijndel, Friel, & Schulz, 2012). This finding suggests that a mismatch between what one believes and available evidence encourages self-guided exploration. Although most, if not all, of these studies are done in the visual domain, there may be a way to create an optimal level of uncertainty so that children become curious about the meaning of a novel word.

A related contemporary theory of curiosity is Lowenstein's (1994) information gap theory (for more extensive discussions see Jirout & Klahr, 2012; Kidd & Hayden, 2015). Lowenstein (1994) proposed that gaps between what one knows and what one would like to know engender a sense of deprivation that learners are motivated to reduce. Loewenstein (1994) argued that when an information gap in a particular knowledge network is made salient, curiosity is induced. In Loewenstein's (1994) model, the size of the information gap predicts how curious an individual will be about something. Under this view, larger gaps between what one knows and what one could know lead to low levels of curiosity while smaller gaps lead to high levels of curiosity. Large information-gaps do not engender curiosity because there is too much information to assimilate.

An optimal information gap might be a stronger motivator for learning than novelty on its own. Other studies have found that novelty is not always the strongest driver for information-seeking. For example, (Schulz & Bonawitz, 2007) found that when children did not receive complete information about how a toy worked they preferred exploring that toy further over exploring a new toy. On the other hand, children who had received complete information about how the old toy worked preferred to play with the new toy. These results imply that if children are familiar with an object, but do not know everything about it, they are more curious about the object than a completely novel or completely familiar object. It is unknown if the same preference extends to novel words. Study 1 determined that children do have a novelty preference for words in the absence of other information. Study 2 investigates whether children prefer words that they know some, but not all the information about to words that are more novel. For example, they might be more curious about a novel word that they know is a type of fruit than a novel word that they have no information about.

The information-gap theory supports the idea that knowing some, but not all the information about a word will induce curiosity. For example, a 4-year-old who hears the word "quantum" in the context of an adult conversation (about physics, presumably) may not have the same level of interest in finding out what the word means as a child who hears a parent discussing "fetlocks" in the context of a discussion of a well-known farm animal (a horse). That is, if a child hears a novel word in a context that is far removed from what they know about they may be less curious about its meaning than if the word is presented in a context that is relevant to an area of interest.

Children might determine whether a new word is relevant to an area of interest through the surrounding discourse. That is, new words that are offered in the context of known words may be more likely to engender curiosity than new words offered with no context. Additionally, in a familiar context, children may not only be more interested in learning a novel word, but they might also experience stronger feelings of deprivation. Litman and Jimerson (2004) built on Lowenstein's information gap theory by proposing that curiosity had two dimensions that motivate exploration: deprivation and interest. The deprivation dimension is associated with feeling like there is crucial missing information and an aversive feeling of uncertainty, whereas the interest dimension is driven by the enjoyment of obtaining new information. Children who are curious about the meaning of a word could be motivated by the desire to reduce feelings of deprivation or the pleasurable feeling that results from learning something new. For example, they might need to know the meaning of the word to understand their speaking partner (deprivation-type), or they may have heard an unknown word while reading about their favorite animal, horses, and feel pleasure or satisfaction when they learn new horse-related words (interest-type). Of course it may be possible to feel both types of curiosity at the same time.

Additionally, when preschoolers hear information about a novel word that they understand, the word might become more meaningful for them and they can assimilate it into their knowledge more easily. The principle of relevance asserts that people learn words that are relevant to them and it has been shown that 4-year-olds selectively learn words based on this principle. For example, they are more likely to learn the labels for toys that were found “nearby” than those found “far-away” (Henderson, Sabbagh, & Woodward, 2013). Providing contextual information may make a novel word more relevant to children’s prior experiences. Other research has found that when preschoolers know causal information about a novel tool, they are more likely to remember the word than children who were not taught the same causal information (Bauer, Booth, & McGroarty-Torres, 2016). Knowing related words might also encourage children to learn more about a novel word and remember it better than children who do not have that experience.

Preschool-aged children are developing the ability to distinguish between known and unknown words. There may be factors about the discourse context that they hear the words in that could help children either realize that it is an unknown word or become more curious about the meaning of the word. For example, the familiar context may motivate a child to try to reduce their uncertainty, and in contrast, with no context children might be content with not understanding the novel word because cannot attach meaning to it. Alternatively, it may be that very curious children prefer to explore a word with no context as it resolves the most uncertainty.

In Study 2, the aim is to determine if detection and interest in novelty can be increased by changing the context. Children were asked which novel word they want to learn about, the one that is a type of furniture, for example, or the one that they have no information about. Familiar context could make a novel word more obvious and increase curiosity. The age range was slightly older than in Study 1 and did not include 3-year-olds since their novel word curiosity is not as reliable as 4- and 5-year-olds. Additionally the memory demands of this task might be greater for preschoolers with two unfamiliar words and one context. For this reason, a short-term memory task was included as a covariate. To learn about the relationship between vocabulary size and word curiosity further, participants also completed the NIH toolbox Picture Vocabulary Test (Gershon et al., 2013).

Method

Participants

Twenty-eight monolingual, English speaking children participated in this study. They ranged in age from 4 years, 0 months to 5 years, 10 months (M = 5;0; SD = 6.68 months, 16 males, 12 females). Participants were recruited from state birth records (n = 8) and from childcare centers (n = 20) in the South Eastern United States. Six additional children participated in this study but were excluded for receptive vocabulary size less than one standard deviation below the mean (n = 3), which could have impacted how well the participants understood the task, and exhibiting biased responding on the dependent measure (n = 3), for example only selecting items on the right side for every trial including the practice trial.

Demographic surveys revealed that 54% of mothers had a post-graduate degree or some graduate school, 32% had a college degree or some college, and 4% had a high school diploma. Three participants' parents did not respond to this question. 86% of mothers identified as white and 7% identified as black or African American. Two participants' parents did not respond to this question. 46% of fathers had a post-graduate degree or some graduate school, 36% had a college degree or some college, and 4% had a high school diploma. Four participants' parents did not respond to this question. 75% of fathers identified as white, 11% identified as black or African American, and 4% identified as Asian. Three participants' parents did not respond to this question. 31% of participants' families reported an income of $150,000 or more per year, 25% reported an income between $80,000 and $150,000 per year, 18% reported an income between $30,000 and $80,000 per year, and 7% of families reported an income between $15,000 and $30,000 per year. Five participants' parents did not respond to this question.

Materials

Word-Curiosity Task. The materials for the word-curiosity task were similar to those used in Study I for the word-curiosity task. However, instead of one novel object and one familiar object behind the flaps the two objects were novel and had novel labels and there were 6 boards. The pictures behind the flaps were the same for each board. They were chosen to be ambiguous so that children could reason it would be part of the category (e.g. food) but not automatically assume that it was. The images were selected using a Google search. See *Table 9* for the novel labels, categories, and pictures of all items used.

Forward Digit Span. Random sequences of numbers were used for the Forward Digit Span. The number sequences are presented in blocks with two sequences per block. The trials start with a two digit block and each subsequent block increases by one digit. The last block has two sequences of 8 digits.

NIH Toolbox-Picture Vocabulary Test. Same as Study 1.

Learning attitudes questionnaire. Same as Study 1.

Demographic questionnaire. Same as Study 1.

Procedure

Word-Curiosity Task. To begin, participants were trained with a word curiosity board with two words that they already knew, cat and dog. The training procedure was the same as in Study 1. They were told that they can see behind one of the flaps so they have to make a careful choice.

After training, children were shown 6 experimental boards with two flaps on them. Participants were told that they were going to see more things, but they were things that they had never seen before. The experimenter told children that she knew some things about some of the objects but for some of the things she only knew what they were called. Then the experimenter presented participants with the option of seeing behind one of the two flaps. Participants were told category-level information about one of the novel words, but not the other. For example, the experimenter said "This is a *zivit*, it's a type of food" while pointing to one of the flaps, "and this is a *ferner*" while pointing to the other flap. See *Table 9* for more examples of stimuli. To help with memory load, participants were told what is behind each flap twice. After participants were presented with both options, they were asked to choose to see one of the objects behind the flap. For the last two trials of this task children were asked to explain their word selection before the flap was opened. These explanations were coded in the with the same categories as in Study 1: mental state, preference, function, feature, and no explanation, with one additional category added specifically for Study 2 paradigm—*Familiar context*. Children were coded as using *familiar context* if they used the information provided about the novel word type in their explanation. For example, if they said they wanted to see the *zivit* because it's a type of food it would be categorized as a *familiar context* explanation.

Digit Span. After the *Word-Curiosity Task*, children also completed the forward digit span. Children were told that they were going to play a game with numbers. For practice, they were presented with a two-digit sequence, "8—2," and asked if they could repeat that. If they succeeded the experimenter would progress to the test trials, if not the experimenter would repeat the practice with another two digit sequence. The test trials were organized in blocks of two trials with equal numbers of digits, and began with a block of two two-digit sequences, and increased by one digit every block. Children progressed through the trials until they either failed to respond (e.g. "I forgot") or incorrectly repeated two trials in one block. Their final score was the number of digit sequences that they could accurately repeat back.

Picture Vocabulary Test on the NIH toolbox. Lastly, they completed the receptive vocabulary test on the iPad. The procedure for administering this task was the same as in Study 1.

Reliability

An independent coder that did not run any participants in this study watched 25% of participants videos and re-coded the *word-curiosity* task and the *digit span.* Agreement was 97.2% for the *word-curiosity task* and 100% for digit span. Disagreements were resolved by the first author and the independent coder re-watching the video together and coming to a consensus. Additionally, all explanations in the *word-curiosity* task were coded by the first author and an independent coder, agreement was 94.6% and disagreements were resolved by consensus.

Results

Descriptive statistics

Participants in this study completed all the measures, excluding three participants for whom parental education is not reported. Please see *Table 8* for a list of all measures means, standard deviations, and range of scores.

Table 8: Descriptive statistics of measures in Study 2.

	n's	Min	Max	Means (SD)
Age	28	48	71	60.18 (6.68)
Word curiosity	28	0	6	2.96 (1.55)
PVT standard	28	54	82	66.18 (7.93)
PVT age corrected	28	85	134	111.89 (14.68)
Digit Span	28	2	11	7.50 (1.95)
Learning attributes	28	55	86	73.29 (7.23)
Parental Education	25	2	7	5.70 (1.40)

Word curiosity by context

To determine if children were more curious about novel words presented in a familiar context, a one-sample t-test against chance was conducted. It was found that participants selected the novel word in the familiar context an average of 2.96 (SD = 1.55) times out of 6, which was not different from chance, which was 3 ($t(27) = .122$, $p = .90$). This indicates that children were not influenced by the familiarity of the context when making their decision about which novel word to learn about. See *Figure 4* for the distribution of participants' scores.

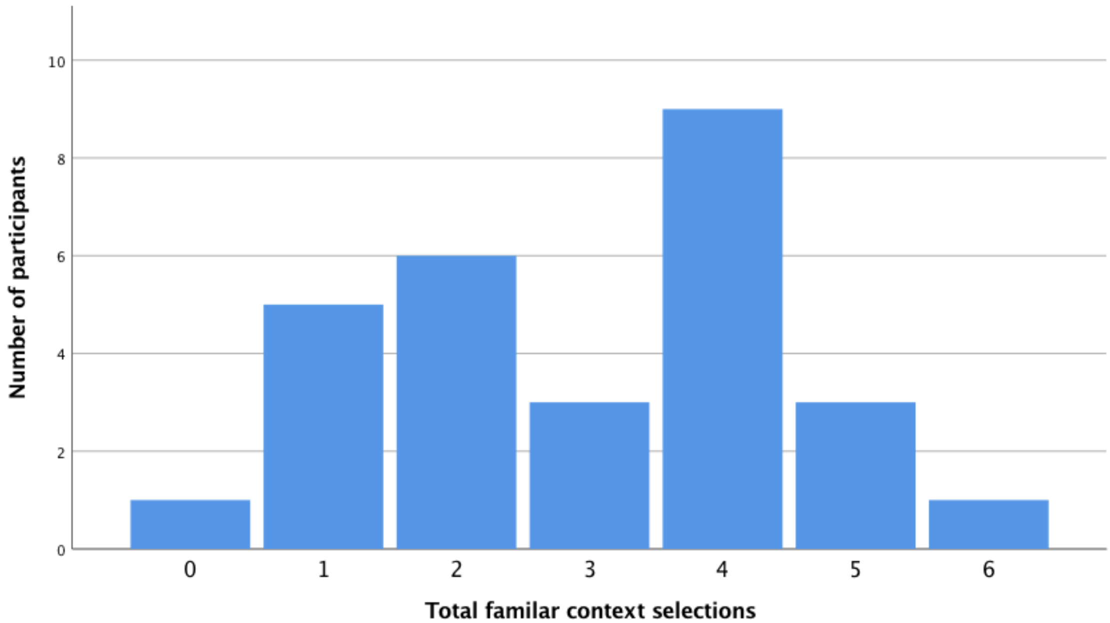


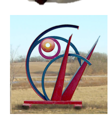
Figure 4: The distribution of scores for the word-curiosity task. A score of 6 indicates 6 familiar contexts selected.

To determine if variables such as age, short-term memory and vocabulary size influenced children's curiosity about a novel word in a familiar context, a correlation was conducted. It was found that the participants selection of which novel word to learn was not correlated with age ($r(28) = .10$, $p = .60$), digit span ($r(28) = .13$, $p = .52$), the picture vocabulary test ($r(28) = -.01$, $p = .98$), the learning attitudes questionnaire ($r(28) = -.15$, $p = .43$) or parental education ($r(25) = -.07$, $p = .73$).

Item analysis

Children could prefer some familiar contexts to others. For example, if a child liked dinosaurs and they heard a novel word that they were told was a type of dinosaur, then they may be more likely to choose to learn about it. Since the "familiar context" items might have varied in terms of attractiveness to our participants an item analysis was conducted. It was found that our measure has low internal consistency Cronbach's α = .46, so it can inferred that the stimuli chosen were not consistent in their appeal to our participants. For example, the *zivit* which was a type of food was selected an average of .68 of the time while the *shelb* which was a type of instrument was only selected .36 of the time. This discrepancy shows that some of the items might have caught children's attention, or been more preferable to them than others. Table *9* shows the means and standard deviations of participants' selection of the familiar context.

Table 9: Discourse contexts and stimuli for Study 2.

Familiar context	No context	Picture	Mean selection of familiar context (SD)
This is a **zivet**. It's a type of food.	This is a **ferner**		.68 (.48)
This is a **coodle**. It's a type of art	This is a **tragger**		.54 (.51)
This is a **shleb.** It's a type of instrument.	This is a **ferp**		.36 (49)
This is a **dwanoo.** It's a type of kitchen tool	This is a **lawnie**		.50 (.51)
This is a **yerno.** It's a type of clothing	This is a **doddig**		.43 (.50)
This is a **kleezie.** It's a type of furniture	This is a **redda**		.46 (.51)

Word-choice explanations

Children were asked to explain why they wanted to see the word they chose for the last two items to probe their reasoning further. The same coding system as in *Study 1* was used, explanations were classified as: mental state, function, preference, feature, and no explanation, with the addition of one classification to investigate participants' use of the familiar context. For example, if the familiar context was a kitchen tool and participants said, "I want to see it because it is a kitchen tool," the explanation would be coded as *Familiar context.*

Participants used mental state explanations for both novel words with familiar context and with no context, however the mental state explanations were not as informative as in Study 1 as both words were unknown to them. Regardless, rates of using a mental state explanation were similar to Study 1. Children provided no explanation for wanting to see the word with no context more often than for wanting to see the word in the familiar context. The familiar context was only used 4 times, this may indicate that participants did not often make use of the context information provided by the experimenter. See *Table 10* for more information about children's explanations.

Table 10: Percentage and counts of explanation types for wanting to see novel words in familiar or no context.

	Familiar context		No context	
Explanation type	Percentage	Count (total = 27)	Percentage	Count (total = 30)
Mental state	51.9	14	53.3	16
Function	0.0	0	3.3	1
Preference	0.0	0	6.7	2
Features	22.2	6	6.7	2
No explanation	11.1	3	30.0	9
Familiar context	14.8	4	0.0	0

Study 2 Discussion

Results from Study 2 suggest that presenting a novel word in a familiar context does not encourage more curiosity than if they are presented without context. The participants were at chance for selecting the novel words in familiar contexts. This could be due to the way that they interpreted the contexts, the specific contexts that were chosen for the stimuli, or it might have been important to highlight the contexts further. In what follows, these three possibilities will be explored and possible next steps will be proposed.

The information-gap theory predicts that people will be more curious about something with a mid-size information gap; that is, information that is outside but not far outside, their base of knowledge (Loewenstein, 1994). As shown in *Figure 4* the distribution of scores appears bi-modal, which could indicate that participants approached the task in two distinct ways. The two different ways of responding, might be explained by the way that children treated the information in the familiar context. For the set of participants that were more likely to select the novel word with no context, the familiar context might have been enough information for them and they wanted to see the item that they did not have any information about. They could have conceptualized the novel word in the familiar context as already far enough in their base of knowledge to not elicit curiosity. They were curious about the word completely outside of that base. On the other hand, the participants that selected the familiar context more often might have treated the familiar context as more ambiguous, and it could have provoked more curiosity because they realized they knew something about it but not everything. For these participants the novel word in the familiar context was treated as outside of their base of knowledge, thus it provoked curiosity. Alternatively, this group could have selected the novel word in the familiar context more because the researcher spent more time talking about it. Given the pattern of the results, it may be that children vary in their judgements of a stimuli's uncertainty, which in turn influences the amount of curiosity they feel. In a future study children could be asked to rate the amount of information they know about each word before being asked to pick to see if the degree of uncertainty is influencing their selections.

Our results also indicate that there may have been problems with our stimuli and design of the experiment. For example, the word-curiosity task had low internal consistency, so some contexts (e.g. food) provoked more curiosity than others (e.g. instrument, clothing, furniture). Since the aim of the study was to determine how the discourse context influenced children's choices, a variety of contexts were chosen and not just the contexts that might be the most appealing. If the stimuli were more targeted to appeal to children's interests (e.g. type of toy, type of candy) participants might have been more likely to pick the familiar context, but it would have been more difficult to judge whether their preference was due to the discourse context itself or because of the *appeal* of the context. It may be that only appealing contexts increase children's state curiosity, that possibility would have to be explored in a future study where ratings of how much children like certain contexts are included. Further, the current set of stimuli was inconsistent from item to item, so a future study could select items that have equivalent levels of appeal, while still being familiar enough to induce curiosity.

Another consideration is that participants in our study rarely referenced the discourse context that they were provided with when explaining why they wanted to see the novel word that they chose. The familiar context was only referenced 4 times and most explanations were about the novel word itself. Further, the pattern of responding was *almost* the same as you would expect if two novel words without context were pitted against each other (with the exception of the bimodal distribution). These results may indicate that the context needs to be emphasized more for participants to make use of it. A future study could insure that participants were mindful of the familiar context by asking children questions about the context and scaffolding their attention. This would eliminate the possibility that children were simply ignoring the familiar context.

To fully determine the role of discourse context on preschoolers' word curiosity, more studies will have to be conducted. This study is a first step in investigating the role of context in novel word curiosity. If future studies find a context that encourages novel word curiosity, the findings could be used to create situations in which children are the most curious about words and most likely to engage in systematic information seeking behaviors.

CHAPTER IV

GENERAL DISCUSSION

Preschoolers are adept at learning words from linguistic input by using word-learning constraints (e.g. Markman, 1994), conceptual information (e.g. Booth & Waxman, 2002), social or pragmatic cues (Nameera Akhtar et al., 1996; Saylor, Sabbagh, & Baldwin, 2002; Saylor, Sabbagh, Fortuna, & Troseth, 2009; Tomasello, 2000), and supportive learning environments (Dickinson, 2011; Dickinson & Smith, 1994). However, it is unknown whether their curiosity about a novel word motivates them to seek information about it. Previous research suggests that some preschoolers are curious about novel words' meaning, and make active attempts at word learning. For example, preschoolers have been known to ask questions to drive general learning (Legare et al., 2013; Mills et al., 2010) and they ask specifically about word meaning (Chouinard et al., 2007; Jimenez et al., 2018).

These questions might be driven by novel word curiosity, but gauging such curiosity solely through whether or not preschoolers' ask questions is problematic. For preschoolers, asking questions can be difficult (Legare et al., 2013; Mills et al., 2011; Valian & Casey, 2003) and in experimental settings, only about a third of children ask questions about novel words (Jimenez et al., 2018). Therefore, children's question-asking as a dependent measure potentially underestimates novel word curiosity. Study 1 provides the first measure of preschoolers' word curiosity independent of question-asking. That is, the measure allows preschoolers to demonstrate their novel word curiosity without having to formulate a question. The newly constructed task determined that preschoolers exhibit word curiosity by explicitly choosing to uncover information about words that they do not know. When given a choice between learning about a novel word or a familiar word, preschoolers chose the novel word 63% of the time. The findings from the current study suggest that word curiosity is common among preschoolers, even though many preschoolers do not ask questions about novel words in a book (Jimenez et al., 2018). Further, when children choose to see the novel word referent over the familiar word referent, they are exploring the most uncertain option, which may indicate this type of curiosity is of the epistemic type. This epistemic curiosity could be the first step toward self-driven learning, allowing children to fill a knowledge gap.

In addition to testing whether preschoolers were curious about novel words and developing a measure to test this, Study 1 investigated the developmental trajectory of word curiosity and the individual processes that may contribute to it. While word curiosity did become more robust across the preschool years, the abilities that were hypothesized to influence word curiosity—epistemic curiosity, metacognition, executive function, and language ability—were not independent predictors of word curiosity. However, when preschoolers were asked why they wanted to see the word that they chose, they referenced their mental states. These explanations of children's choice to explore a new word did reveal that children may be using their awareness of their mental states. This metacognitive skill may be related to lexical awareness.

In Study 2, a similar word curiosity task was used to measure the influence of discourse context on children's preference to learn about novel words. Providing information about a novel word, such as saying it was a type of food did not influence children's curiosity about that word in either direction when compared to a novel word with no contextual information.

In what follows I will outline how the included studies contribute to our knowledge about the development of word curiosity. Next, I will explore the links between our word curiosity task and other curiosity tasks, the role of metacognition in word curiosity, and the value of children's explanations for learning about word curiosity. Further, I will cover what has been learned about the influence of discourse context on word curiosity. Throughout I will discuss the limitations of these studies and how future research might address these. Lastly the conclusions that can be drawn from this research will be laid out.

The development of word curiosity

From age 3 to age 5, at the same time as they are developing word curiosity, children's cognitive process also develop in many areas. The many changes that preschoolers are going through may lead to the consolidation in their preference for novel words. Preschoolers vocabularies are expanding, their executive function is becoming more refined (Marcovitch & Zelazo, 2009), they are becoming more aware of their uncertainty (Hembacher et al., 2017; Lyons & Ghetti, 2011; Merriman & Marazita, 2004), and they are improving in their ability self-direct their learning (Gureckis & Markant, 2012; Mills et al., 2011; Partridge et al., 2015; Ruggeri, Sim, & Xu, 2017). The current study adds to the list of abilities that are developing in the preschool years and shows that children's preference to learn about novel words becomes more reliable with age.

The logic for Study 1 was that the abilities that are developing during preschool significantly contribute to exploration of novel words over familiar words. But it may be that the development of word curiosity in the preschool years is more complex than previously hypothesized and involves interactions of abilities that are difficult to test with the current methods and sample size. Since so many changes are happening at the same time, that the developmental trajectories are uneven across the abilities tested. This may make it difficult to determine which abilities are most important for children's word curiosity. Relatedly, the abilities that were tested, novelty preference for objects, trait curiosity, lexical awareness, receptive vocabulary, verbal fluency, and task-switching, may contribute to word curiosity but their influence may not be detectible until later in development when word curiosity may be more stable.

Alternatively, the sample in our current study may have not shown enough variability in the measures to be able to detect a contribution to word curiosity. Despite efforts to recruit from a large age range to increase variability in individual differences, it might be that there was not enough variability in the cognitive and linguistic measures to detect their influence. Parental education was not correlated with word curiosity in our sample, but on the whole, our sample was a privileged one. Results might have been different with a sample that was more reflective of the general public, which could have shown more variability in the cognitive processes that were tested.

Novelty preference, curiosity, and word curiosity

Participants' curiosity was measured in several different tasks in Study 1. The object preference task showed that children prefer to play with toys that are novel over toys that are familiar. Children's trait curiosity was measured through both a behavioral task, the SciCUP (Jirout & Klahr, 2012), and through a parent questionnaire of children's learning attitudes. The goal was to determine how these measures of curiosity related to word curiosity. In this section, the similarities and differences between word curiosity and the other measures will be explored to situate the contributions of the word curiosity task in the current literature on children's curiosity.

Participants showed a preference to play with toys that were novel to them, but it was unrelated to their preference to explore novel words. The commonality between these two tasks is the reward of exploring novelty. But, as previous research has shown novelty preference can be task dependent (Fiser & Aslin, 2002; Liao et al., 2011; Mather, 2013; Schulz & Bonawitz, 2007; Spence, 1996). One potentially crucial difference between playing with new toys and exploring the referent of a new word is each tasks' potential for learning. Children who prefer predictable learning outcomes might choose to explore the novel word, whereas for the novel toy it may be difficult to predict a learning outcome and children may use different criteria to make their decision.

For the novel word curiosity task the learning outcome is more straightforward—attaching a label to a referent. The amount of learning is consistent across trials and can be predictable to the participants, whereas for exploring new objects or toys the amount that one can learn from a new toy is uncertain. Some of the toys chosen for stimuli in this study could reveal causal mechanisms—for example for one novel toy they could figure out how to make it spin, while another toy, a spiky ring, did not provide opportunities for causal learning. Causal information has been shown to support learning by making novel items more memorable (Booth, 2009, 2015). Therefore, the potential for learning for the objects that children could "figure out" would be greater than the objects that did not have such opportunities. In a future study an object preference task that has more consistent learning-gains could be used to determine if the potential for learning is the crucial difference that obscured the relationship between novel word curiosity and novel object curiosity.

Some evidence that children were attending to the amount of information they could gain from the word curiosity task comes from the explanation data. The explanations given for the word curiosity task indicated that some participants were selecting the novel word because they did not know it. This implies that their goal was to learn about the novel word. Because children were not asked about their reason for picking the objects that they chose in the novel object task it cannot known if their motivation differed. However, they might have been motivated to pick a novel toy because of the potential for learning, but they could also have just liked the way it looked or wanted to feel it. The latter possibility is supported by children's explanations for choosing a familiar word, where children used explanations that related to preference or function. The explanations for wanting to see known objects (as in the word curiosity task) and visually-available novel objects (as in the object preference task) may be more similar than the explanations for novel objects and novel words. Asking children to explain their choices may reveal differences in their motivation for each task.

Another possibility is that novel word preference was motivated by epistemic curiosity and novel object preference in our current task was motivated by perceptual curiosity. In the 1950's Berlyne made a distinction between "perceptual" or sensation-seeking curiosity (e.g. a cat exploring a new environment) and "epistemic" or desire for knowledge filling curiosity (e.g. a boy wondering how life originated on Earth). If the two tasks primarily measured different types of curiosity, it is not surprising that they were unrelated to each other. This could also be clarified by asking children to explain their object choice. If they say they are motivated by learning about it or understanding how it works then they might be using epistemic curiosity, otherwise it may be that they are primarily using perceptual curiosity for novel object preference.

Additionally, there may be a difference between verbally and visually presented stimuli. There is evidence that it is easier for 3-year-olds to monitor their uncertainty about stimuli that is visually presented than verbally presented stimuli, (Ghetti, Hembacher, & Coughlin, 2013). This may be because of the difference in memory load or salience. Visually presented stimuli remain in a child's field of vision until the child looks away so the child does not need to use her memory to make a judgment about uncertainty, whereas verbally presented stimuli do not remain present and do need to be recalled. It might have been easier for our participants to identify novelty of objects than of words because they can see them. To explore this possibility, a novelty awareness task for toys analogous to the lexical awareness task could be developed. In this task, children could be asked if the object is new to them or if they have seen it before. That way the relationship between identification of novelty and preference for novelty can be explored for objects as it was for words. Some support for the possibility that novel object detection is easier comes from the finding that novel object preference did not correlate with age, while novel word curiosity did. This may mean the detection of novelty for visually presented objects does not rely on the development of other processes.

Similarly to novel object preference, broader measures of curiosity also did not relate to word curiosity. Trait curiosity measured by both a behavioral and by a parent questionnaire did not explain variability in word curiosity. For the behavioral measure of curiosity, children were asked to pick between windows that had different levels of uncertainty and the more uncertainty that a child chose to explore, the higher their trait curiosity score was. Again, the uncertainty was manipulated by visually presenting fish that could be behind the window. The visually presented uncertainty might not have translated to the verbally presented stimuli of the word curiosity task. This may indicate that curiosity may be distinct in different domains. However, children might have been choosing to explore the window based on the type of fish that they wanted to see. During this task, children would often point to the fish that they liked best, comment on the fishes' coloring, or try to guess which fish was going to appear behind the window. This anecdotal evidence implies that some children were not making their choices based on their assessment of the levels of uncertainty, rather they were choosing which fish they wanted to see.

The parent-reported curiosity might have crossed domains and it specifically asked whether children asked questions about word meaning, but did not show a correlation with word curiosity. It is possible that children are changing so rapidly that parents have a hard time accurately reporting their children's curiosity in the current moment. Other parent-reports have shown inconsistent validity when compared to behavioral measures (e.g. Chaffee, Cunningham, Secord-Gilbert, Elbard, & Richards, 1990). Additionally the points of reference that parents have to fill out the questionnaire might be quite different. It may be better to ask a preschool teacher that has a larger comparison base to fill out the questionnaire about children's curiosity.

Lexical awareness and word curiosity

The relationship between lexical awareness and novel word curiosity was examined because lexical awareness seemed to be the metacognitive ability most relevant to novel word curiosity. The surface characteristics of the word curiosity task and the lexical awareness task were designed to be similar as they both involved choosing between a novel and familiar word. However, the goals of the tasks were different. In the word curiosity task children were asked which word they wanted to learn about, whereas in the lexical awareness task participants were asked to identify the unknown word. Even though the tasks were similar on the surface, children might have had more difficulty identifying novelty with the lexical awareness task since there were no visual cues and there was no feedback.

An untested possibility is that in the word curiosity task, the paper flaps might have acted as a cue for preschoolers to imagine what might be behind the flaps and visualize the representation of the word. Merriman and Lipko (2008) propose that there are two different routes for children's awareness of lexical ignorance: cue recognition and target generation. Children who use cue recognition focus on the familiarity of the word form that they are hearing whereas using target generation involves bringing the meaning of the word to mind. Children who use cue recognition can be led astray by pre-exposure to the word, thus cue recognition is the more immature form of lexical awareness. The presence of the flaps as a cue to represent the word could encourage preschoolers to use target generation as a way to make judgements of word novelty, which could make the word curiosity task easier than the lexical awareness task. The flaps could function as a support for representing the unfamiliar referent. To test the possibility that a cue to represent the object leads to increased lexical awareness, the lexical awareness task could be done in the presence of flaps and the change in children's performance could be measured.

Another possible explanation for lexical awareness being unrelated to word curiosity is that some children might be able to identify an unknown word, but not be able to take action to seek that word out. The dual process model of metacognition proposed by Nelson and Narens (1990) distinguishes between metacognitive monitoring (determining if something is one's knowledge) and metacognitive control (acting on the metacognitive reflection). In research on children's metacognitive abilities preschoolers have been found to develop the ability to monitor uncertainty but the development of metacognitive control, or acting on uncertainty does not develop until later (Ghetti et al., 2013). Since lexical awareness, like uncertainty monitoring, is related to metacognitive processes, there may be a similar developmental trajectory. Children may first develop the ability to identify that a word is unknown, and translating that knowledge to choosing to explore an unknown word may take a little longer. This would mean that the time course of lexical awareness and word curiosity is distinct and explain why there was not a tighter correlation between the two.

Additional evidence for metacognitive control developing later in the preschool years comes from children's explanations. Study 1 found that the ability to explain why a word was chosen develops from ages 3 to 5. The older participants were more reliable at providing explanations that referenced their mental state than the younger participants, even when they both selected the novel word to learn about. The younger children might have had difficulty with verbalizing their metacognitive judgements because of underdeveloped metacognitive control. As mentioned above, acting on metacognitive judgements can be more difficult than making them (Ghetti et al., 2013), so younger children might have been able to point at the word that they did not know, but not explicitly state that the reason they chose it was because they did not know what it meant. Many young participants failed to explain why they chose to learn about a novel word. Understanding what qualifies as an explanation, and being able to explain a metacognitive judgement might show a similar developmental trajectory to uncertainty monitoring.

Because I wanted to compare across children in the sample, the order of tasks needed to remain constant across participants. To know more about the relationship between lexical awareness and word curiosity we could see if word curiosity could be increased if participants do the lexical awareness task first. This might have primed children to think about novelty and perhaps realize that they could learn more if they chose the novel word. Evidence from previous research suggests that pre-exposure to novel and familiar objects increases children's awareness of lexical ignorance especially in children with lower vocabulary (Hartin, Stevenson, & Merriman, 2016). This training effect could also work in a word curiosity task.

An even more direct way to test the relationship between word curiosity and lexical awareness is to combine them into the same task. After presenting the novel and familiar word with the two flaps, an experimenter could ask the child to identify the word that they do not know and then ask them to choose which word they want to learn about, or vice versa. The current word curiosity task is potentially confounded with the question of whether the child is aware of the novelty. To isolate the drive to know about a word that is novel, only using the trials in which a participant recognized that a word was novel could be used.

Our findings show that some children can not only report on their metacognitive judgements about novel words, but also use their judgements to make the decision to learn about a word. As this process becomes automatized, children could use it to ask questions about word meaning. When it becomes more consolidated they will also be able to use this process in situations outside of the lab where the verbal information is presented more rapidly and in a more noisy environment. By reflecting on gaps in their lexicon and taking action to fill them, they can drive their own word learning. Finding ways to encourage more children to do this could increase their self-driven word learning.

Familiar word choice

In the word-curiosity task children chose to learn about novel words most of the time, nevertheless 28% of children (n = 24) displayed a familiar word preference, that is they chose to learn about the familiar word in over half the trials. Thus far this discussion has focused on why children might pick the novel word with an implicit assumption that not selecting it is a result of children not being curious, being unable to identify novelty, or not having the ancillary skills necessary to drive novel word curiosity. All of these explanations avoid the presence of the familiar word as a competitor. An alternative explanation is that sometimes children were interested in choosing the familiar word because they prefer certainty, they like the familiar object, or they are curious about the token.

A familiar word preference might emerge out of a child wanting to be "right" about what is behind the flap. On a few occasions when children selected the familiar word and the flap was opened they exclaimed, "yes!" or "I got it." This demonstrates that they might have constructed a personal goal of predicting what is behind the flap. If the familiar words had been more low-frequency, abstract, or newly-learned by the participants, this might be an adaptive strategy to study and solidify their knowledge of the word. However, the words chosen in this task were high-frequency, and during the entire course of the study there was never an indication that children did not know what the familiar words meant. Therefore, this preference to be right and always choose what is known is counter to curiosity. It does not encourage exploration and probably will not lead to self-driven learning. Put in Piagetian terms, picking the familiar word is avoiding *disequilibrium* and as a result avoiding the process of learning the new material (Piaget, 1964).

Another reason children might choose the familiar word is that they simply prefer seeing the known referent over learning a new word. For example, they might have positive associations with keys or backpacks. Evidence for this possibility comes from children explicitly stating that the reason they want to see the familiar item is because they like it. The goal that these children might have is to see the item that they like best, and not learning new words. They might have viewed picking the *hern* to be riskier than the known reward of picking the *key*. Determining that the potential for learning outweighs the risks involved in making a choice to explore an unknown may be a characteristic of curious children. On the whole, preschoolers choosing to see something that they like is another instance of sticking to what they know, avoiding uncertainty, and thus avoiding learning.

Preschoolers also could have been curious about the specific token of the familiar word. For example, some kids might have wanted to see the book because they are curious about which book was behind the flap (they did not know that it was a non-descript book with a solid brown cover). In this case the child *is* choosing to explore uncertainty. There are many different kinds of chairs, for example, and there is no way for the participant to know which kind of chair it is until the flap is lifted. The information gap theory of curiosity proposes that people feel the most curiosity about things that are just outside of the base of knowledge (Loewenstein, 1994), and for some children exploring the novel object might have been too far from their base of knowledge, especially since it was decontextualized, and finding out what the familiar word token was could have induced more curiosity because it was more relevant to their base of knowledge. Nonetheless, the degree of uncertainty for novel words is much higher and information seeking about novel words leads to more learning than seeking information about familiar words. So even though children who picked the familiar word could have been driven by curiosity about the token, novel word curiosity is more likely to lead to self-driven learning. One way to control for curiosity about the token would be to pre-expose all the stimuli pictures to the participant before the start of the task. This way they will have seen all experimental stimuli, but they will not know the novel word-referent pairings, so they may be more likely to be solely driven by the epistemic curiosity of learning a word, and not by the perceptual curiosity of seeing a picture.

To explore novel word curiosity independently of familiar words a different test of word curiosity could be created. For example, instead of setting up a dichotomy between exploring novel or familiar words, children could be read a story that includes novel words and at the end of the page they could be asked if they want to know what the word means or keep going. That way they can gain information about the word, but doing so would disrupt the telling of the story and there is a time-cost to children's curiosity. This task has more external validity because curiosity can be disruptive and people that are very curious spend a great deal of time exploring their curiosity—just ask anyone with a Ph.D.! Children may have difficulty conceptualizing the time cost, and if the task is tested in preschool, children might be heavily influenced by the daily activities. To avoid this, children could be asked to complete a boring task like the one used in Alvarez and Booth (2014) before they can hear what the word means or see a referent.

The influence of discourse context

In Study 1 both the novel word and the familiar word were devoid of the context that children would normally have when hearing words. For Study 2, children were given some information about one of the novel words and none about the other. The minimal information given about one of the novel words did not seem to be enough to influence children's responding. There is some admittedly weak evidence that children were not completely ignoring the context they were given because of the bimodal distribution of responding (See *Figure 4*). If children had been completely ignoring the context, the scores on the word curiosity task of Study 2 would be expected to be unimodal. As a result of this mixed evidence, the role context plays in children's word curiosity remains unknown.

Future directions

The words in Study 1, and to some extent in Study 2 were decontextualized and there was no evidence that preschoolers would need to use these words in the future. The context used in

Study 2 might not have been believable or relevant enough. There was one participant in Study 2 that remarked that the words were "not real." Providing relevant, rich context for children could influence children's word curiosity. This possibility could be tested in a future study with novel words that need to be known to grasp the plot of a story or understand a lesson. For example, if children were told that they would have to learn the words so that they could know about the life cycle of a frog, they may be more motivated than if they are provided a novel word in isolation. Demonstrating the value of learning a novel word could increase children's intrinsic motivation for learning. If children's motivation for exploring a novel word is increased, the prevalence of novel word curiosity, and self-driven word learning may also be increased.

Another factor to explore in future studies are children's theory of mind abilities. In both studies children referenced their mental states when giving explanations of why they wanted to see a novel word. It might be that the development of understanding one's own mental states contributes to novel word curiosity. A theory of mind battery could be used to understand the link between knowledge of one's own and others' mental states and the ability to selectively learn about novel words. Children who perform better on theory of mind tasks (such as the see-know tasks) will understand the relationship between seeing something and knowing about it. This may translate to them being better at determining when they do not know a word and understanding that they must ask to see the novel word to be able to know about it. Therefore, children with more consolidated theory of mind abilities may have higher levels of novel word curiosity than children with under-developed theory of mind abilities.

To determine the influence of children's curiosity about words on word learning, children's word learning would need to be tested. A future longitudinal study could determine if children's word curiosity predicts later vocabulary size. Children who are more curious about word meanings are probably more likely to attend to and learn those words. Additionally, future studies could use the word curiosity task to find ways to increase word curiosity. It could be used to establish a baseline of children's curiosity about word meaning and to detect the situations that increase or decrease information seeking about novel words. For example, an engaging demonstration of how learning novel words can open the door to learning new ideas and about different subject areas could increase novel word curiosity.

Conclusions

The current research determined that when given a choice between familiar and novel words preschoolers will choose to learn about the novel word. Older preschoolers are more reliable at picking the novel word and being able to explain their choice by reflecting on their mental states. Informative context did not influence children's curiosity about novel words. Children's explanations about their motive for selecting the word they did revealed that preschoolers use epistemic curiosity to fill knowledge gaps about word meaning. These studies provide a foundation for learning more about this potential motivator for active, self-driven word learning. Eventually this research could be used to help understand the developmental trajectory of children's active word learning more clearly.

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Appendix

Learning Attitudes Questionnaire

We are interested in knowing more about your child's behavior in everyday situations. Please respond to the following statements by indicating how true each one is of your child.

My child…	**Rarely /never true**	**Not often true**	**Some-times true**	**Often true**	**Always true**
1. asks many questions					
2. moves on when an activity is too challenging					
3. likes to take things apart to see how they work					
4. stays close to me when encountering something or somewhere new					
5. asks questions before making a decision					
6. is adventurous					
7. waits until someone else performs a new activity before trying it					
8. likes to try new things					
9. likes to explore new places					
10. talks to people s/he has just met					
11. likes to be the first one to try something new					
12. likes to discover new things					
13. asks for help when s/he can't figure something out					
14. notices when there is something new in a room					
15. approaches or explores something new					
16. asks about the meanings of words					
17. asks for names for things					

18. becomes deeply interested in some topics					
19. uses words like think, know, remember					
20. realizes when they don't know the answer to a question					