Assessing two-year-olds' knowledge of number agreement morphology

By

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Submitted to the graduate degree program in Child Language and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Date approved: August 29, 2013

Abstract

Previous research in the area of children's knowledge of number agreement morphology has yielded mixed results. Some researchers have found evidence for sensitivity to agreement morphology at as early as 16 months, while others report that children do not comprehend number agreement morphology until as late as five or six years old. Studies of children's production of these forms suggest that while children go through a period of optionally using agreement morphemes as part of the Optional Infinitive stage of development, they show productive use of these morphemes at age two. Therefore, some researchers have concluded that this is an area of the grammar where production precedes comprehension. This general pattern of findings has several possible explanations, three of which will be described here. The general goal of the current study was to provide new information to this area of inquiry, with a particular focus on children's comprehension of "is" and "are" as well as plural –s marking on nouns. To address possible methodological issues with picture selection and looking-time studies, a manual search task was used to tap receptive knowledge of these forms.

Forty-eight 30- to 36-month-old children were tested on their receptive knowledge if "is," "are," and singular/plural distinctions on nous. Additionally, these children were given multiple assessments of their language production abilities and their non-verbal mental abilities. Results indicated that two-year-olds can comprehend noun morphology indicating number, but failed to show comprehension of "is" and "are." Additionally, when provided with both noun and verb information, the presence of the verb provided no added benefit to the children in terms strengthening their interpretation of the verbal prompts, suggesting that noun information regarding number is sufficient for sentence interpretation in two-year-olds. Analyses of

relationships between production abilities and receptive knowledge of verb morphology found no correlations between these sets of variables.

These findings contribute new information regarding the development of receptive knowledge of noun agreement morphology, and contribute new data to the ongoing debate regarding the development of sensitivity to and comprehension of verb agreement morphology. Methodological issues are addressed and potential theoretical implications of this work are discussed.

Acknowledgements

I would first like to thank my advisor, Dr. John Colombo, for taking me on and seeing me through to the completion of this study. I have benefited enormously from your straightforward feedback on this project, as well as your expertise in working with very young children. I would also like to acknowledge the contributions of Dr. Mabel Rice to the early stages of development of this work. Your mentorship during the piloting stage of this project was very helpful. I thank Dr. Susan Kemper not only for her service on my committee, but also for her encouragement and advice throughout my graduate school years. I thank Dr. Robert Fiorentino, Dr. Nancy Brady, and Dr. Harold Torrence for their individual contributions to this work and for their service on my committee.

This work would not have been possible without the wonderful parents and children who generously contributed their time to participate in the study. I also thank the daycare center directors and teachers who were so welcoming and eager to contribute to research on child language development. To my undergraduate research assistant, Caitlin Ireland, thank you for your many hours of data coding. I would also like to acknowledge Dr. Kandace Fleming for her assistance with the statistical analyses reported here.

I would also like to thank a number of individuals who have been instrumental in helping me reach this milestone. To my graduate school friends: Alyson Abel, Leah Kapa, and Ellen Rozek, I thank you for always being there to listen, for commiserating with me during the darker days, and celebrating with me during the bright ones. Alyson, sharing an office with you for almost five years was one of the unexpected joys of graduate school. Leah and Ellen, I'm not sure I would have made it this past year without our weekly dissertation improvement meetings!

To my family, I thank you for your constant encouragement and admiration. In particular, this work would not have been possible without the devotion of my mother who flew out to Kansas at a moment's notice when I needed her to watch my children so that I could focus on work. To my in-laws, thank you for being my local support system. You have been an enormous help and I am so lucky to have you in my life.

To Mateo and Daphne, thank you for keeping me grounded. Even on the most trying days in the past year, it brought me immense joy to be your mama. Mateo, the past six years have been the most precious years of my life because I got to watch you grow from infant to toddler to little boy. I am so proud of you. Thank you for helping me practice my procedures for this study and for being so patient with me when I had to work.

To Brady, you have been beyond amazingly supportive. I am at a loss for words to describe the gratitude I feel to you. Thank you for your constant love, strength, and support throughout every single day of this process.

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Chapter I: Introduction

The central purpose of the study presented here is to examine very young children's receptive knowledge of some of the grammatical morphemes involved in subject-verb agreement in English, as well as to probe the relationship between their receptive knowledge and their production of these forms. Although there is a rich literature both on the role of agreement in adult sentence processing as well as the production of agreement morphology in typically developing children and children with language impairments, there are still open questions regarding the nature of young children's receptive knowledge of agreement morphology, for both nouns and verbs. The sections that follow briefly review what is already known about the role of the agreement system in adult sentence processing, as well as the acquisition of the agreement system. In particular an area of controversy in the literature is highlighted with regard to children's comprehension of number agreement morphology on verbs, which has been extended into languages other than English. Then, the methods and findings from a study designed to address some of the remaining open questions will be presented.

The Agreement System

The agreement system in English is relatively impoverished compared to the agreement systems of other languages. In English, only number agreement between the subject and the verb is overtly marked (case is indicated only the use of pronouns) and for much of the paradigm, number agreement is zero-marked. The only overt markings for subject-verb agreement occur in third person singular verbs (he/she/it run*s*) and in the irregular verb BE, which has different forms for first and third person singular. The number agreement system is part of the broader finiteness marking system, which comprises tense and agreement marking on verbs. Tense is similarly impoverished in English where only the past tense is overtly expressed. Present tense is

zero-marked, with the exception of third person singular –s which also signifies present tense. Because of these properties of English, it has been proposed that agreement morphology may not be very informative for listeners. Indeed, early work pitting agreement information against other cues such as word order revealed that adult English speakers largely ignore agreement information when making judgments about the agent and patient of sentences, relying on the more reliable and valid cue of word order (MacWhinney, Bates, & Kliegl, 1984). In contrast, adult speakers of languages where the agreement system is more fully realized, such as Italian, favor agreement information over word order when making the same judgments.

Background

Children's production of number agreement morphemes. Much of what we know about the early acquisition of agreement morphology in English comes from studies of children's productions. A large body of work has demonstrated that children learning English as a first language go through a period of development where they use tense and agreement (finiteness) morphology on verbs optionally. This period is referred to as the Optional Infinitive stage of development (Wexler, 1998). During this time children will produce well-formed sentences such as "mommy is home" or "doggie wants it" as well as sentences where the morpheme carrying finiteness is omitted, as in "mommy home" or "doggie want it." Crucially, during this period children almost never produce sentences where a finiteness morpheme is inappropriately inserted such as "mommy are home" (Wexler, 1998). The large majority of the time, when they produce a finiteness morpheme, it is used correctly. This lack of overt finiteness errors suggests that children are not generally confused about the use of these forms. Rather, they appear to be working with a grammatical system that allows for omission of finiteness morphology. Snyder (2008) argues that children are conservative in their productions, and do not produce syntactic

constructions that are not part of their grammar. He argues that the presence of correctly used finiteness morphology during the OI stage, is evidence of abstract grammatical knowledge about the proper use of these forms.

There is some controversy surrounding the interpretation of children's productions at this age. Some researchers argue that children's productions are evidence that they are relying only on limited scope formulae, or item-based constructions, and lack any abstract knowledge (e.g. Leiven, Salomo, & Tomasello, 2009; Tomasello, 2000; 2003). These studies repeatedly demonstrate that very young children rely on item-based constructions in their productions. However, it is important to note that the presence of constructions in a young child's productions does not indicate that they possess no abstract knowledge (Fisher, 2000; see also Rowland & Theaskton, 2009). Rispoli, Hadley, and Holt (2009) have shown that with the correct computations on production data it is possible to see that children are using these forms productively prior to 30 months of age. So, while it is true that children will use constructions in their early productions, constructivist theories cannot account for the full range of data available on children's early use of agreement morphology. It is reasonable to infer from children's early productions that they possess some abstract knowledge of the agreement system. Therefore, the body of work on young children's productions of agreement morphology suggests that from the earliest stages of production of these morphemes, children appear to possess receptive knowledge of the use of these forms.

The nature of the OI period of development makes it difficult to make inferences about children's receptive knowledge based only on their productions. The controversy surrounding the interpretation of child productions during the OI period highlights why relying on child productions to draw conclusions about receptive knowledge of grammar can be problematic.

Within the literature on the language development of pre-linguistic infants, it is not controversial to suggest that children know more than they can say. In fact, the entire subfield of infant language acquisition is predicated on this very notion (Hirsh-Pasek & Golinkoff, 1996). However, once children begin producing language, researchers tend to shift their focus to productive abilities. One reason for this shift is the fact that the infant methods such as preferential looking, head turn preference, and habituation become challenging to administer and interpret with children over two years old (e.g. Chan, Meints, Lieven, & Tomasello, 2010). Directly measuring receptive knowledge in children who are over age two, but still too young for grammaticality judgment tasks, is therefore a major hurdle in this line of research.

Children's comprehension of number agreement morphology

Picture selection studies. In contrast to the conclusions of work on children's production of subject-verb morphology, early work on the role of agreement morphology in sentence processing in children led researchers to conclude that comprehension of the agreement system in English is acquired late and is not actively involved in sentence processing. Multiple early studies used a picture selection task with four- to five-year-old children to test whether children use agreement morphology on verbs to disambiguate sentences. In this task, children were presented with one picture of a single animal, and one picture of multiple animals, and were given verbal prompts where the noun was ambiguous and the presence of either "is" or "are" was the only cue to subject number. For example, Fraser, Bellugi, and Brown (1963) used prompts such as "the sheep is/are jumping over the fence." Keeney and Smith (1971) trained children on nonwords that were zero-marked in the plural and used prompts such as "the snup is/are verb-ing." Keeney and Wolfe (1972) also tested children's comprehension of "is," "are," and third person singular –s using picture selection as well as their production of these forms. In each of

these early studies, children as old as four and a half years old performed at chance levels on comprehension measures, which was interpreted as evidence that they did not comprehend that "is" signified singular and "are" signified plural. Keeney and Wolfe (1972) found that children were proficient in their spontaneous productions, leading them to conclude that children's knowledge of agreement morphology was limited to a formal syntactic rule with no knowledge of meaning.

In more recent work, Johnson, de Villiers, and Seymour (2005) examined three- to six-year-old children's sensitivity to the third person singular –s marking as a cue to subject number. Similar to previous experiments, they presented children with a picture selection task and used verbal prompts where the plural marker on the noun was phonologically masked and the verb ending was the only audible cue to subject number (e.g. the ducks swim/swims, where the word initial –s on swims masks the word final –s on ducks in the plural condition). Similar to the earlier work, Johnson et al. (2005) found that three- and four-year-old children performed at chance levels. Only five- and six-year-olds succeeded on the task.

In addition to this work from English, cross-linguistic work in some languages has yielded similar findings. Using a picture selection task with children speaking a Caribbean dialect of Spanish, Pérez-Leroux (2005) found a similar pattern of findings where five-year-old children showed limited comprehension of number agreement morphology on verbs. Given that Spanish is a pro-drop language, verbs are often the only cue to number in a sentence. However, children were still unable to rely on this cue in sentence comprehension. Gxilishe, Smouse, Xhalisa, and de Villiers (2009) found that in Xhosa, a Bantu language with a complex agreement system, children tested using a picture selection task did not show comprehension of number agreement morphology on verbs until age six. Additionally, Brandt-Kobele and Höhle (2010)

found that for German speaking three- and four-year-old children, although their eye movements suggested some sensitivity to verb agreement morphology, when they were asked to point to the picture that matched the prompt, they were at chance with regards to distinguishing between singular and plural where verb agreement morphology was manipulated.

The findings from this set of studies, combined with the early findings from the cue validity work in adult sentence processing suggest that receptive knowledge of agreement may not be necessary for sentence processing in English and may be acquired very late in development cross-linguistically- possibly as late as six years. The problem with this conclusion, however, is reconciling these findings with findings from studies on children's production abilities. Although Johnson et al. (2005) put forth the possibility that this may be a rare example of a component of the grammar where production precedes comprehension, it is also possible that picture selection tasks simply did not succeed in tapping young children's receptive knowledge of agreement morphology. In fact, there are several studies both from English-speaking children as well as some cross-linguistic work that provide counter evidence to the possibility that production of subject-verb agreement morphology precedes comprehension.

Looking-time studies. Some data show that children as young as 16 months are sensitive to the grammaticality of passages where agreement morphology is manipulated. In a series of studies, Soderstrom and colleagues have shown that 16- and 19-month-olds prefer to listen to grammatical passages over ungrammatical passages where only agreement morphology is manipulated (Soderstrom, Wexler, & Jusczyk, 2002; Soderstrom, White, Conwell, & Morgan, 2007). They carefully controlled the phonological properties of the passages, suggesting that the effect was truly driven by a preference for grammatical passages. This line of work strongly suggests that receptive knowledge of agreement morphology begins to develop long before

children produce these forms, in contrast to the conclusions drawn in Johnson et al. (2005) (for further discussion see Soderstrom, 2008). To reconcile these two findings, it is necessary to carefully probe whether early sensitivity to grammaticality translates to conscious knowledge of the meanings of agreement morphology during the third year of life.

In order examine early knowledge of grammar, many researchers continue to push the upper age limit on looking preference methods. By using time-course analyses and eye tracking in preferential looking studies, rather than only analyzing overall looking preference, recent work has found some evidence that three-year-old children may be sensitive to number agreement morphology on verbs, both in English as well as cross-linguistically.

Note that the picture-selection studies described above had a possible methodological flaw. In each of these studies, the verb came after the ambiguous noun in the verbal prompt. From a cue validity perspective, noun morphology is a much more valid cue to subject number than verb morphology, since for most of the verb system, number agreement is zero-marked in English, while plural morphology on nouns is highly regular. Therefore, it is highly possible that children in these studies were trying to rely on an ambiguous noun to discern subject number, which led to chance performance. In support of this possibility, Johnson et al. (2005) note that when they asked the children how they decided which picture to point to, children either said "I don't know" or mentioned the noun morphology (e.g. "you said ducks" after hearing "the duck swims"), but they never mentioned the verb morphology. Since the sentences were crafted to make the plurality on the noun phonologically masked, the children were at chance performance- half the time they thought the heard the –s and half the time they did not. Moreover, by placing the more valid cue- the noun- before the verb, demonstrating sensitivity to the verb information would have required children to revise their initial interpretation of the sentence. It has been well

established that children do not readily revise their initial interpretation of syntactically ambiguous sentences (“the kindergarten path effect”; Trueswell, Sekerina, Hill, & Logrip, 1999). In the looking-time studies described below the verbal prompts did not have this issue: all noun morphology came after the verb in the verbal prompts.

Kouider, Halberda, Wood, and Carey (2006) conducted a looking time study where children were shown pictures of multiple novel objects and single novel objects. They found that when children had multiple cues to number (e.g. "there are some blickets/is a blicket") 24-month-olds looked longer to the target. When only noun morphology was provided (e.g. "look at the blicket/s") 24-month-olds did not look significantly longer to the target. When time-course data from this looking time study were analyzed, they observed that children shifted their gaze toward the target just after hearing the verb. They report that it takes a 24-month-old about 675 ms to shift gaze to the matching stimulus. Therefore, the children were most likely making their gaze shift to the target based on the "are" and maybe the "some," but certainly not the noun morphology. This suggested that children were able to use verb morphology alone to determine subject number.

To confirm their findings from the looking time study, Wood, Kouider, and Carey (2009) examined how children interpret plural and singular sentences using a manual search procedure. In this procedure, children are presented with a box into which they can reach, but they cannot see. On each trial, the experimenter places a single object into the box and provides the child with verbal cues to indicate that there is either one object or multiple objects in the box. After the child retrieves the first object, the dependent variable is how long he or she continues to search in the box for a second object. Presumably, if the child comprehends the verbal cues regarding the number of objects in the box, he or she will search longer after hearing that that there are

multiple objects in the box (plural trials) than after hearing that there is only one object in the box (singular trials). By varying the verbal cues provided by the experimenter, it is possible to determine which cues are necessary for children to show differential search times to singular versus plural trials. Wood et al. (2009) used verbal prompts such “there is/are a/some car/cars in my box” where verb agreement morphology, quantifier, and noun morphology were available to the child. They also tested a noun-only condition where only the noun information was available (e.g. “I see my car/cars in my box”). Wood et al. (2009) tested 20- and 24-month-old children on this task and found that the 24-month-olds searched significantly longer on the plural trials when there were multiple cues to subject number, but neither age group searched longer on plural trials in the noun-only condition. This study confirmed the findings from Kouider et al. (2006) using a different paradigm and with real words (note that Kouider et al., 2006 tested nonwords). Children’s success on the multiple cue condition, but not the noun-only condition suggests that noun-only information is not sufficient for children to distinguish between singular and plural trials. The 24-month-olds’ success on the multiple cue condition leaves open the question of whether the quantifier or verb morphology cues would provide sufficient information for the child to distinguish between singular and plural.

Following up on that work, Lukyanenko (2011) examined whether 36-month-olds could use verb morphology alone to anticipate subject number using a looking time procedure. Children were shown a picture of a single object and a picture of multiple objects and heard "where are the Xs?" or "where is the X?" She found that the children shifted toward the target when they heard the verb information, although this effect was only significant for plural trials. This indicates for the first time that English-speaking children younger than 5 are sensitive to the meaning of “are” with respect to number during online sentence processing. In addition to being

more likely to shift to the target after hearing "are," Lukyanenko also reports that children were more accurate, in terms of overall proportion of looks to the target, on trials where they heard both informative noun and verb information than on trials where only noun information was available. This suggests that not only did children engage in predictive sentence processing by shifting to the target after hearing only the verb, their understanding of the noun was strengthened by the presence of informative verb information.

Similarly, looking time studies conducted in other languages have found evidence that young children are sensitive to the meanings of verb agreement morphology. As discussed above, eye-tracking data from German speaking three and four year olds suggest that they comprehend number agreement morphology on verbs (Brandt-Kobele & Höhle, 2010). Additionally, looking time data from French-speaking children also shows that they are sensitive to liason-based verb agreement morphology by 30 months of age[1] (Legendre, Barrière, Goyet, & Nazzi, 2010; Legendre, Culbertson, Zaroukian, Hsin, Barrière, & Nazzi, in press).

Although this set of looking-time studies provides some promising evidence of early knowledge of verb agreement morphology, some recent work has reported some mixed findings. In addition to reporting findings from French speaking toddlers, Legendre et al. (in press) also tested Spanish-speaking (mean age 36 months) and English-speaking children (mean age 35

[1] Recent research on the process of liason in French shows that although the pre-fixal /z/ is technically part of the preceding subject clitic, it is perceived and treated as a verb prefix on vowel-initial verbs (e.g. "ils arrivent" is pronounced /i(l).za.riv/). A full exploration of the research supporting this is beyond the scope of this work. See Culbertson, 2010; Legendre, Culbertson, Barrière, Nazzi, & Goyet, 2010 for further details.

months) using a video selection task for the Spanish speaking children and a looking time measure for the English speaking children, although the videos were the same in each language. The Spanish speaking children showed sensitivity to the plural cue on verbs (-n). The English speaking children did not show differentiation of singular and plural trials, even though they were provided with both noun and verb information (e.g. "the boy/boys kisses/kiss the /naj/"). Their looking times were slightly longer to the target video on plural trials, but there were no significant differences. Attempts at time-course analyses, and considering the age of the children also yielded no significant results.

Possible explanations for the pattern of findings in previous research on acquisition of subject-verb agreement morphology. Clearly, the past research in the area of young children's receptive knowledge of number agreement morphology has yielded conflicting information. On one hand, evidence from studies of infant sensitivity to these forms combined with research on children's very early productions of these forms suggest that children have abstract knowledge of the agreement system beginning in the 2nd year of life. On the other hand, research on older children suggests that they do not demonstrate that they know the meanings of the verb agreement morphemes until five or six, and this may be true for languages with very different agreement systems from the English system. To complicate matters, more recent work using looking time measures has also yielded inconsistent findings, with some researchers finding that English speaking children are sensitive to the verb agreement morphology during online sentence processing, while some recent findings suggest that English speaking children are not sensitive to agreement morphology, even when provided with both noun and verb information. Several possible explanations for this pattern of results have been put forth. Three plausible explanations are summarized below. These are relatively similar, but they make

different predictions. First, it is possible that children possess knowledge of subject-verb agreement morphemes from a very young age and that failures to show this knowledge are methodological artifacts. Secondly, it is possible that children know the form, but not the form-to-meaning mapping, originally suggested by Keeney and Wolfe (1972). Thirdly, it is possible that cue validity and possibly cue salience can explain the data reported to date in this area.

First, it is possible that there is no paradox: children actually do possess knowledge of verb agreement morphology; but that previous studies suggesting they do not possess such knowledge had methodological problems (e.g. the presence of noun information preceding the verb information in the verbal prompts, and possible issues with the task demands of picture selection). It is important to note that all of the picture selection tasks that have attempted to test knowledge of agreement morphology have shown that children do not possess this knowledge until age five or six, across multiple languages. If it is true that there is no paradox, and previous findings suggesting a paradox were due to methodological artifacts, then it follows that if we make the appropriate adjustments to the methods used to test knowledge of verb agreement morphology, we should find that children are able to demonstrate knowledge of verb agreement morphology at the very earliest ages of productive use of these morphemes in their spontaneous language use (around age two) or earlier.

A second possible explanation for the current set of findings in this area is that young children possess knowledge of syntactic and/or distributional properties of verb agreement morphology, but not the form-to-meaning mapping (see Soderstrom, 2008). Under this explanation, the knowledge demonstrated in looking time studies is different from what is tested during picture selection. de Villiers and others have argued that because young children can succeed on picture selection tasks with forms they clearly know (such as pronouns) picture

selection should be used for assessing morphological knowledge. However, it is possible that looking time studies and picture selection tap different processes (Shady & Gerken 1996; Brandt-Kobele & Höhle, 2010). One obvious difference between these two tasks is that looking measures, particularly time-course analyses and eye-tracking methods in addition to overall looking preference measures, tap online sentence processing and have been shown to be sensitive to infants' and toddlers' sensitivity to distributional information (e.g. Soderstrom et al., 2003). In contrast, during a picture selection task, the child must make a choice which requires conscious thought and is inherently a semantic task. While looking measures tap sensitivity to distributional knowledge and knowledge of language form, picture selection requires linking that knowledge of form with meanings, an arguably much more challenging process (Naigles, 2002). Under this explanation, there is nothing methodologically "wrong" with the picture selection measures described above, they simply tap a different process than looking measures. One challenge for this explanation is fully accounting for how children are able to productively use agreement morphology in spontaneous productions without at least some emergent knowledge of the form-meaning mapping.

A third possibility is the cue validity explanation. It may be that very young children possess abstract knowledge of both the form and the meaning of verb agreement morphology, and they are sensitive to this information during online sentence processing and are able to access it during language production. However, they do not attend to verb information during sentence comprehension/interpretation in situations where the task involves identifying the number of objects referred to because children are sensitive to the fact that verb agreement morphology in English is not reliable for providing this kind of information. This explanation makes strong predictions for cross-linguistic study in this area; namely that children learning

languages where verb agreement morphology is highly reliable, should show comprehension before children learning languages where verb agreement morphology is not reliable. In fact, recent cross-linguistic research in this area supports this possibility; Legendre et al (in press) found that the most reliable cue, French liason-based subject-verb agreement, was comprehended at the earliest age (30 months) compared to cues in other languages. The Spanish plural ending –n, which is more regular and more valid a cue to number than third person singular –s, but less reliable than liason-based agreement in French, was comprehended by 36 month old Spanish speaking children, although they did not show comprehension of the zero-marked singular forms with regard to number. English-speaking children did not show sensitivity to either third person singular –s or the zero-marked plural verb, and these cues are arguably the least salient and the least reliable of the ones tested by Legendre et al (in press). More research in this area is needed to confirm that cue validity and salience are driving these cross-linguistic differences.

A single study cannot adequately address each of these possibilities, but the study presented here was designed to contribute new information to this ongoing debate. The results of the study will be discussed taking each of these possibilities into consideration.

The Current Study

The current study was designed to examine the receptive knowledge of subject-verb agreement morphology in two-year-old children and to examine how that knowledge is or is not related to language production abilities. For this study, only knowledge of "is" and "are" were tested, as these are the forms examined in studies reporting possible early comprehension of verb agreement morphology (Kouider et al., 2005; Wood et al., 2009; Lukyanenko, 2011), although others have found conflicting results (Fraser et al., 1963; Keeney & Smith, 1971). Additionally, pilot work (described below) established that the proposed study would be feasible with "is" and

"are" as the primary targets. Examining "is" and "are" also has the potential to shed some light on some of the possible explanations for the previously reported findings in this area. If young children truly do not possess knowledge of form-to-meaning mappings of verb agreement morphology as described in the second possibility, they should not be sensitive to the meanings of "is" and "are." However, if failure to show comprehension in previous work is cue-specific, it is possible that children will differentiate between the meanings of "is" and "are" as these are arguably more reliable and salient than third person singular –s.

General goals. One challenge in interpreting the pattern of findings summarized above relates to potential problems with the methodologies used in previous work. Most of the studies examining comprehension of subject-verb agreement morphology have used either picture selection or looking time studies. Neither of these tasks is ideal for two- to three-year-old children. In the current study, the manual search task used by Wood et al. (2009) will be used to assess receptive knowledge of the subject verb agreement morphemes of interest. This task offers some logistical benefits: it is portable, allowing for testing outside the lab, and the dependent variable of search time is more interpretable than looking time measures would be for the specific stimuli items to be tested here. The manual search task also has the benefit of directly engaging the child in the task which may reduce the attrition rate often seen in looking time studies. Importantly, this task is not completely passive, as looking time measures are, but it also does not require a forced choice as a picture selection task would. To succeed on the manual search task, the child must access meaning of the forms being tested; that is, they cannot rely only on distributional properties of language. But, because the dependent variable is search time (rather than simply accuracy) it may be sensitive to degrees of comprehension in a way that a forced choice picture selection task is not. For these reasons, one purpose of the study reported

here was to explore the robustness of the manual search task for the purpose of examining young children's knowledge of agreement morphology. Additionally, in the current study, when verb morphology is provided with an ambiguous noun, the verb always precedes the noun in the verbal prompt so that children do not have to revise an initial interpretation of the sentence once they hear the verb information. If the first possible explanation for the data presented above is correct, then children should show comprehension of verb agreement morphology once the methodological problems of earlier work are addressed.

One question that remains open is how early comprehension of verb information about number develops. The findings from Kouider et al. (2005) and Wood et al. (2009) leave open the possibility that the verb information present in the multiple cue conditions enabled 24-month-old children to distinguish between singular and plural trials, since children were unable to make the distinction when only noun morphology was provided. Lukyanenko (2011) found that by 36 months, children are sensitive to verb-only information, at least for the plural (i.e. "are") and that presence of the verb information strengthened their overall sentence comprehension. Additionally, if it is the case that children possess abstract knowledge of subject-verb agreement morphology at the onset of their production of these forms, then they should show comprehension of these forms during the third year of life. The primary goal of this proposed study is to explore if comprehension of verb morphology cues to number is present at the very earliest stages of production of these forms by testing 2-year-olds on their receptive knowledge of "is" and "are."

A secondary purpose of the study proposed here is to examine the utility of verb information for child sentence processing relative to other cues in the sentence. Although the debate regarding children's comprehension of agreement morphology has focused exclusively on

verb morphemes, there are still open questions regarding when children are able to show comprehension of noun number morphology in sentence comprehension tasks. Kouider et al. (2006) and Wood et al (2009) found that 24-month-olds are not able to differentiate between singular and plural trials based on the presence or absence of plural –s marking on verbs in both a looking study and a manual search study. Kouider et al. (2006) used a looking time measure and found that 36-month-olds were able to distinguish between singular and plural trials when only noun information was available, but interestingly this effect was only significant for the /s/ allomorph of the English plural marking on nouns, and not for the /z/ or the /ɨz/ allomorphs. Recall also that Legendre et al. (in press) found that English speaking children between 28-46 months could not differentiate between singular and plural trials in a looking preference procedure when both noun and verb information was provided. It is currently unknown when comprehension of noun number morphology develops and how that knowledge may interact with comprehension of verb number morphology.

To address these questions, children's interpretations of sentences where only the verb provides information about number were compared to 3 other conditions: 1) only noun information is provided, 2) noun and verb information is provided and 3) a completely ambiguous condition. The goal for this part of the study is to tease apart the relative added benefit of noun and verb information for children's interpretations of sentences as well as to examine comprehension of noun plural morphology. One possibility is that two-year-olds are not sensitive to single cues, but require multiple redundant cues to interpret number information during sentence processing. Thus children tested in the current study may not show comprehension of verb and noun information alone, but might show some added benefit of verb

information when it is presented with noun information. Only by comparing performance across conditions with varying cues will it be possible to tease apart these possibilities.

The final goal of the current study is to examine how receptive knowledge of verb agreement information is related to children's production of these forms as well as their expressive vocabulary. Note that a major issue in the debate on children's comprehension of verb morphology is whether or not this is an example of production preceding comprehension in language acquisition. However, to date, very few researchers have collected both measures of comprehension and measures of production of these forms in the same children.

It is possible that receptive knowledge of verb agreement information and production of these forms develop in synchrony. If this is the case, children who comprehend the verb-only cue should have higher scores on measures of production abilities compared to children who do not comprehend the verb-only cue. However, another possibility is that children's early productions may not match their receptive abilities. If this is the case, the children who comprehend the verb-only cue might not have significantly different scores on production measures from the children who do not comprehend the verb-only cue. Of particular interest is whether there is a subset of children who score low on measures of production but demonstrate comprehension of the verb cue. Such a finding might be clinically relevant. Vocabulary ability at age two is often used to identify language delayed toddlers (e.g. Rescorla, 1989). However, numerous studies have demonstrated that many children classified as Late Language Emergent (LLE) based on vocabulary scores at age two eventually "catch up" with their peers (Feldman, Dale, Campbell, Kolborn, Kurs-Laskey, Rockette, & Paradise, 2005; Fenson, Bates, Dale, Goodman, Reznick, & Thal, 2000; Rice, Taylor, & Zubrick, 2008). It may be that those who "catch up" with their peers are the ones who comprehend the verb cue, but score low on measures of vocabulary. Likewise,

there may be a subset of children who do not comprehend the verb-only cue, but appear relatively similar to their peers on production measures; these may be the children who are at most risk for later language impairment. To probe these possibilities, both production measures in addition to comprehension measures of verb agreement morphology were collected in the current study.

Research questions. The broad research goals outlined above can be distilled into the following specific research questions:

1. Can two-year-old children demonstrate knowledge that "is" signifies singular and "are" signifies plural? Can two-year-old children demonstrate knowledge of number marking on nouns (plural –s)?
2. What is the added benefit of each cue (noun information and verb information)? Is one cue more informative for children?
3. What is the relationship between children's performance on a receptive task of their knowledge of subject-verb agreement and general measures of the language ability and non-verbal mental ability? What is the relationship between children's performance on a receptive task of their knowledge of "is" and "are" and measures of their production of "is" and "are"?

To address these research questions, 30- to 36-month-old children were given an experimental measure of receptive knowledge of "is" and "are", three measures of their production of "is" and "are", the MacArthur-Bates Communicative Development Inventory, as a benchmark measure of productive language ability, and Visual Reception subscale of the Mullen Scales of Early Learning, as a measure of their non-verbal mental abilities. Each of these,

including any methodological issues that were addressed in piloting is described in the following sections.

Chapter II: Pilot Studies

Receptive Measure: The Manual Search Task

The receptive measure used in this study was the manual search paradigm described and used by Wood et al. (2009). The success of this procedure is dependent on multiple factors. Although Carey and colleagues have successfully used this procedure to examine a variety of research questions (e.g. Wood et al, 2009; see also Feigenson & Carey, 2003; 2005), it was important to establish the feasibility of this method to address the research questions presented here in a different setting, with different materials and subjects, and a different experimenter.

In this procedure, it is crucial that children believe that it is possible that there could be multiple objects in the box. In this series of pilot studies, multiple factors that affect this basic premise were examined. In addition, these pilots addressed questions relating to the appropriate number of trials, what age ranges could comprehend the task, the ideal size of the box, what objects worked best, what kind of familiarization introduced the task most effectively and the most effective way to keep children engaged in the task. Here first basic methodological decisions that were made based on piloting are described, followed by the methods and results of the pilots that motivated the current study.

Methodological decisions based on piloting. Across the various versions of the pilot, multiple boxes were tested. The size of the box is important because it must be large enough that it is reasonable that a child could search inside for ten seconds and not find an object that was really there. Several options for the child's opening of the box were also tested. The central issue was discouraging children from trying to peer into the box. Other basic methodological issues that were addressed during piloting were the age range of children that could comprehend and

perform the task and the maximum number of trials that children could complete in a single session. Based on this work, the following decisions were made:

1. A 12’’x12’’x12’’ box was sufficiently large for the purposes here.
2. The child’s opening the in box consisted of a 5’ opening with a spandex slit with a flap of black felt hung behind it inside the box. The purpose of the flap was to deter children from trying to peer into the box.
3. A total of four test trials per session (condition) were administered.
4. Children between 24 and 36 months of age were capable of completing this task. Children under 24 months performed unreliably on the task.

These methodological decisions were made over the course of several pilot studies. After a preliminary phase of piloting to determine the basic feasibility of the task, four formal pilot versions were carried out. A summary of these, including the number of children tested in each version and the mean search times for singular and plural trials is presented in Table 2 at the conclusion of this chapter. The primary focus of the current study was to determine whether children are able to demonstrate receptive knowledge of verb morphology marking subject number. Therefore, the first three pilot versions were focused on eliciting differential search times to singular vs. plural trials when only verb information was provided.

Pilot version 1. Pilot version 1 tested three different conditions where only verb information was provided to determine which was most likely to elicit the expected response of longer search times on plural trials compared to singular trials. Both novel and familiar nouns were used in the Pilot version 1. In order to provide only verb information in the prompts, the nouns used were ones that do not change in the plural: fish and sheep. The novel nouns were deet and nup and children were shown that these were non-changing in the plural during a

familiarization period where the child was shown the objects (or pictures of the objects) and told "Here I have one nup/deet. Now I have two! I have two nup/deet. Two nup/deet." This familiarization procedure was also used for the familiar objects.

Three conditions were tested: Main Verb, where third person singular –s on the main verb was manipulated, copula BE in a full sentence (abbreviated here as BE-full), and copula BE in an elliptical sentence (BE-ellip). Examples of each of these are provided in Table 1. For each condition, there were two singular trials and two plural trials, as in Wood et al. (2009), for a total of 12 test trials per child. Trial order within in condition was either Singular, Plural, Plural, Singular or Plural, Singular, Singular, Plural.

Table 1

Pilot Version 1 Example Prompts

Condition	Example Prompt
Main Verb	Here go/goes the sheep into my box!
BE-full	There is/are the sheep in my box!
BE-ellip	Anything in my box? There is/are!

Eleven children between 24-33 months old were tested in this version of the pilot. Not all children successfully completed all 12 trials, and although the experimenter varied the order of conditions across participants, there were unequal numbers of participants who completed each condition. Because several children were unable to complete all 12 trials, in subsequent piloting, the number of trials was reduced to four, and only one condition was tested.

Overall, the Main Verb condition was deemed too subtle or difficult as evidenced by the short search times for plural trials on this condition. For both the BE-full and BE-ellip

conditions, children generally searched longer on plural trials than on singular trials, but this difference was not statistically significant. When combined into one BE condition, the mean difference in search time between singular and plural trials was sizable (M = 1422.28 ms), but not statistically significant. One complicating factor here was the use of novel nouns. Wood et al. (2009) reported a significant trial type × noun type interaction in their study, where children showed a difference in search time for plural vs. singular trials when familiar nouns were used, but not when novel nouns were used. Similarly, in this version of the pilot, children searched the longest on plural familiar trials. Children generally searched less, on both singular and plural trials, when novel nouns were used. For this reason, in subsequent pilots, only familiar nouns were used.

In Pilot version 1, some children simply never searched again in the box after retrieving one object. It seemed as if they interpreted the task as reaching in to the box after being prompted by the experimenter. Since the experimenter remained silent during the search period, the children did not reach back into the box during this time. This pattern of behavior was interpreted as due to problems with the task itself rather than evidence of children not comprehending the verbal cues. Pilot version 2 was designed to more fully engage children in the task, with the goal of eliminating this behavior.

Pilot version 2. In Pilot Version 2, only familiar nouns were used, the number of test trials were reduced to four, and only the BE-ellip condition was tested. In Pilot Version 1, both BE conditions showed the expected pattern of longer search times on plural compared to singular trials. The BE-ellip condition was chosen for subsequent piloting because in this condition, there was no risk that the child is interpreting the unmarked noun as singular, as it was not provided at all in the prompt. This choice may have been misguided, however, because the prompt, “Hmm,

anything in my box? There is!" does not unequivocally indicate that there is only one object in the box.

The primary goal of the second pilot was to better engage children in the task. To do this, the task was couched within a game. An interlocutor, Bear, was introduced and the box was made to look like a house, using a façade affixed to the outside of the box. Children were told that Bear needed help feeding his pets. They were told that the animals would come into the house when they were hungry and the child's job was to reach into the house to find out how many animals needed to be fed. On experimental trials, the experimenter said "Oh! It's breakfast (lunch/snack/dinner) time for the fish/sheep. Let's see how many fish/sheep want breakfast. Hmm, anything in the house? Oh! There is/are!"

All of the 12 children tested in this version of the pilot willingly reached back into the box during the search period, and were generally very engaged in the task. However, they showed roughly equivalent search times on singular and plural trials, with slightly longer search times on the singular trials overall. The storyline employed here may have been problematic. It was clear to the experimenter that children were very eager to feed the animals and they did not appear to be attending to the experimenter prompts. The storyline may have made the task of reaching into the box too enjoyable for the children. Additionally, the phrase "it's breakfast time for the fish!" could have implied that all the fish would be getting breakfast, regardless of whether they were hungry. It is therefore not unreasonable to think that the children wanted to feed every fish, regardless of the experimenter prompt.

Pilot version 3. In the third version of the pilot, the storyline was scaled back to a simple hiding game. Again, the children were instructed to find how many of Bear's animals were hiding in the house. Additionally, a pre-test period was added where children were given a

simple comprehension task where they had to point to the larger of two objects, identify objects, etc. The purpose of this pre-test was to establish pacing of the experiment and to accustom the child to attending the experimenter prompts. These modifications did not appear to make a difference. The first four children tested showed no evidence of longer search times on plural trials and piloting of this version was halted.

Pilot version 4. The final version of the pilot was designed as a close replication of the Wood et al. (2009) study to be certain that this method was replicable. In this version, children were provided with verb, quantifier, and noun information (e.g. "There is/are a/some car/cars in my box!"). Children received two singular and two plural test trials, as in Wood et al. (2009). Sixteen children between 24- and 35-months old were tested in Pilot Version 4.

Pilot Version 4 differed from Wood et al. (2009) in a few important ways. First, only familiar nouns were used, due to the problems Wood at al. (2009) had with novel nouns, and the similar problems that occurred in Pilot Version 1 here. Secondly, both a singular and plural familiarization trial was provided, while Wood et al. (2009) used only a singular familiarization trial. The addition of a plural familiarization during earlier pilots appeared to help children understand that there could be multiple objects in the box. Finally, Pilot Version 4 differed from Wood et al. (2009) in how feedback on plural trials was handled. Wood et al. (2009) reported that after the search period was over on plural trials, they said to the child "Let me see if I can help you out" and then surreptitiously placed a second object in the box and reached in to retrieve a second object. In Pilot Version 1 however, offering "help" in this way on the first plural trial resulted in many children requesting help on all subsequent trials. This was especially problematic given that the dependent variable is defined as how long the child is actively searching in the box, and requesting help prevents the child from searching. Rather than offer to

"help" in Pilot Version 4, the experimenter silently removed a second object and placed it with the first object before moving on to the next trial. This tacit feedback confirmed for the child that there were two objects in the box (i.e. the experimenter prompts were true statements), but the child had been unsuccessful in finding it. This was effective in deterring children from requesting help during the experiment.

Children searched significantly longer on plural trials (M=3355.48 ms) compared to singular trials (M=1106.06 ms; $p < .05$), as in Wood et al. (2009). Pilot Version 4 established the validity of the task for the purpose here. Additionally, it established that the modifications to the procedure developed during piloting were successful in eliciting the predicted response in children. Based on this finding, combined with the promising results from Pilot Version 1 for the BE conditions, it was determined that this task would suit the purposes for the current study and could be used to address the research questions presented above.

Table 2

Means (SD) for singular and plural search trials for Pilot Versions 1-4

Version	Condition	N	Singular	Plural
Pilot version 1	BE-ellip	8	3520.48 (2901.63)	4337.07 (2881.97)
	BE-full	3	1422.08 (2217.55)	4532.88 (4314.76)
	Main verb	6	2494.2 (3578.08)	741.59 (2052.54)
	BE-combined (BE-ellip + BE-full)	11	2948.19 (2831.69)	4390.47 (3233.35)
Pilot version 2	BE-ellip	12	4396.78 (3368.3)	3617.69 (3678.69)
Pilot version 3	BE-ellip	4	5932.74 (3675.08)	3824.62 (2909.94)
Pilot version 4	BE-ellip	13	1106.06 (2354.56)	3355.48 (3365.75)

Although the BE-ellip condition was most extensively piloted, as mentioned, this condition may have been problematic. In conversational English, saying "Anything in my box? There is!" does not unambiguously indicate that there is only a single object in the box. So, although this condition was intended to be a pure test of sensitivity to verb-only information, it may not have been successful. In Pilot Version 1, children showed longer search times in both the BE-full and BE-ellip conditions. Because the phrase "there is!" does not unambiguously convey that there is only one object in the box, the full clause version of the copula BE condition was used for the Verb-only condition in the main study.

Elicitation Measures

One goal of the proposed study is to determine to what degree children's production of subject-verb agreement morphology aligns with their performance on the manual search task, which taps receptive knowledge. While an elicited production measure, similar to a wug test (Berko, 1958) would appear to be ideal here, piloting with four two-year-olds established that such a test is not feasible with this age group for the morphemes under investigation. Children were presented with side by side pictures showing a single animal on one side, and multiple animals on the other side. Multiple versions of a cloze procedure were presented in an attempt to elicit the words "is" and "are." The children tested in this procedure were very unreliable during this task and were not able to complete the cloze procedure. However, they were engaged with the pictures and happily talked about them with the experimenter. When the experimenter asked the child to "say what I say" all four children willingly repeated after the experimenter. Crucially, their imitations mirrored the complexity of their spontaneous language. For example, one child only produced one or two word utterances when talking to the experimenter. When asked to repeat sentences such as "this frog is green," he produced "frog green." In contrast, another child was using utterances with four and sometimes more words with ease when conversing with the experimenter. She readily imitated sentences such as "these goats are babies" and "this is yellow."

Based on this piloting, it was determined that a formal elicitation procedure would not be appropriate for this age range. In order to estimate children's production abilities with "is" and "are" a combination of procedures were developed. First, a semi-structured picture book activity was used to estimate children's use of these words spontaneously. Second, an imitation task was used to estimate children's use of these words in a structured procedure. Imitation tasks have

been shown to tap children's underlying grammatical knowledge and have been used with two-year-old children (Lust, Flynn, & Foley, 1998; Valian & Aubrey, 2005). Additionally, a parent survey was developed asking the parent to choose which sentences sound the most like what their child would produce with "is" and "are" manipulated. This multi-pronged approach was deemed the most likely to yield informative data about children's use of "is" and "are."

Chapter III: Methods

Participants

A total of 48 children (28 males) between 29 months 10 days and 38 months 3 days (Mean age = 32 months 25 days, *SD* = 2 months 10 days) were tested in the study. All children attended daycare centers where English was the primary language spoken. Two children came from homes where an alternate language was spoken about 50% of the time (Urdu and Swahili), but these parents reported that their children only used English to communicate. This sample was primarily of mid-to-high socio-economic status based on maternal education. On a 1-6 scale, with some high school at the bottom and graduate degree at the top, the average maternal education level was 5.1 (*SD* = 1.21). Data from the first two children tested were discarded because modifications to the manual search procedure were implemented after they had been tested. Data from one child were discarded due to the child's noncompliance. Therefore, data from 45 children were included in the study. Of those, 40 participants completed all four conditions of the manual search task, which was the central task in this study and 36 participants contributed complete data sets including all parent questionnaires. Nine participants had some missing data which was due to the child refusing to participate on given day (2), parents failing to return some (2) or all (2) of the parent questionnaires, or equipment failure (3).

Power Analysis

The target number of participants for this study was 40, based on a power analysis exploring the necessary number of subjects to detect significant effects in the manual search task. Wood et al. (2009) report the main effect size for trial type as η^2=.25. For the purposes of a power analysis (Cohen, 1977/1988), this translates to f=.577. To establish power for a hypothesized trial type (2) × condition (3) interaction, Cohen's (1977/1988) power table yields

u=2. Using the Wood et al. (2009) effect size as a basis for the power analysis, a cell size of n=20 yields power exceeding .95. If the possibility of a reduced effect size (e.g., η^2=.125) for this study is considered, power drops to slightly below .80 for this interaction. Given this, a target of 40 participants yielded more than adequate power. See Table 3.

Table 3

Power Analysis

		Hypothesized effect size	
	u	η^2=.25 f=.577	η^2=.125 f=.37
Trial Type × Condition interaction	2	.9762	.7267

Manual Search Task

Apparatus and stimuli. Children were presented with a 12" x 12" x 12" cardboard box, covered inside and out with black felt. The box had two openings, one in the front for the child to reach into, and one in the back for the experimenter to secretly place objects into the box. The child's opening was a five by five inch square cut out of the box with a piece of black spandex stretched across it. The spandex contained a horizontal slit in the middle for the child to reach into the box. Behind the child's opening, inside the box, there was a flap of black felt. The back opening, for the experimenter, was approximately four inches square and is covered by black felt.

Six different nouns that are likely to be familiar to two year olds were tested in this experiment: sheep, fish, spoon, duck, frog, and shoe. "Sheep" and "fish" were chosen because

they are the only two nouns that are not marked for plural in English that were likely to be familiar to two-year-old children. The other nouns were matched to "sheep" and "fish" on word frequency using a calculator of word frequencies in corpora of words spoken by kindergarteners (Storkel & Hoover, 2010). Frequencies for all of the nouns used in this study and the conditions they were used for are listed in Table 4. Each condition had one noun with a log base 10 frequency between 2.61 and 2.78 and one noun with a log base 10 frequency between 3.31 and 3.34. Two identical toy versions of each of these nouns were used in the experiment. Each of these toys was between two and four inches long so that it could be easily retrieved through the spandex slit in the front of the box.

Table 4

Word Frequency (log base 10) of Stimuli Items

Word	Frequency	Condition
Sheep	2.62	Verb-only
Fish	3.34	Verb-only
Spoon	2.78	Noun-only
Duck	3.32	Noun-only
Frog	2.61	Noun+Verb
Shoe	3.31	Noun+Verb

During the experiment, the child was seated at a table across from the experimenter. A camera on a tripod was placed approximately three feet away from the child, perpendicular to the child so that the child's hands were clearly visible for data coding purposes.

Design and procedure. All children were tested on three conditions (Verb-only, Noun-only, and Noun+Verb) with four experimental trials per condition (two singular and two plural trials). In order to counterbalance trial type (singular vs. plural) and condition order, children were assigned to one of four groups (see Table 5). For each condition, half of the children

received the experimental trials in the following order: singular, plural, plural, singular. The other half of the children received the experimental trials in the opposite order: plural, singular, singular, plural. In each condition, two nouns were tested. The nouns differed in each condition, but trials always tested nouns in the following order: noun A, noun B, noun A, noun B, so that each noun was tested in one singular trial and one plural trial per condition. Additionally, all children were tested on one condition (Ambiguous) with only two experimental trials. In this condition, the verbal prompt was ambiguous with regards to the number of objects being placed in the box, therefore there was no singular/plural distinction. Half of the children received trials for the Ambiguous condition in the following order: noun A, noun B. Half received trials for the Ambiguous condition in the reverse order. All children received the Ambiguous condition first, as it is a baseline measure of search behavior, and the Noun+Verb condition last, as it contains the cues present in the other two conditions. Noun-only and Verb-only were both presented on the second day of data collection. Initially, all children received the Verb-only condition before the Noun-only condition. However, in order to determine if performance on these two conditions was influenced by order of presentation, a subset of children (N=16) received the Noun-only condition before the Verb-only condition.

Table 5

Trial and Noun Order for Each Condition by Group Assignment

Group	Condition	Trial Order	Noun order
1 & 3	Verb-only	Singular	Sheep
		Plural	Fish
		Plural	Sheep
		Singular	Fish
	Noun-only	Plural	Spoon
		Singular	Duck
		Singular	Spoon
		Plural	Duck
	Noun+Verb	Singular	Frog
		Plural	Shoe
		Plural	Frog
		Singular	Shoe
	Ambiguous	Ambiguous	Fish
		Ambiguous	Sheep
2 & 4	Verb-only	Plural	Sheep
		Singular	Fish
		Singular	Sheep
		Plural	Fish
	Noun-only	Singular	Spoon
		Plural	Duck
		Plural	Spoon
		Singular	Duck
	Noun+Verb	Plural	Frog
		Singular	Shoe
		Singular	Frog
		Plural	Shoe
	Ambiguous	Ambiguous	Sheep
		Ambiguous	Fish

Note: Children in groups 1 & 2 received the Verb-only condition before the Noun-only condition and children in groups 3 & 4 received the Noun-only condition before the Verb-only condition.

For all conditions, a familiarization period, consisting of one singular and one plural trial, preceded the experimental trials. The familiarization trials were identical to experimental trials

(described below) except in two important ways. First, during familiarization, children were given overt feedback following the search period and they were encouraged to continue searching if they had not yet retrieved the object(s). Secondly, on plural familiarization trials, two objects were placed in the box for the children to find, while on plural experimental trials only one object was placed in the box.

The procedure began with the examiner introducing the child to the box, demonstrating how to put one's hand into the box, and telling the child that in this "game" the experimenter will hide toys in the box for the child to find. This was followed by two familiarization trials which made clear that sometimes the experimenter would hide one toy and sometimes two toys. On the first familiarization trial, the experimenter said "What's in my box? Can you reach?" After the child retrieved an object (a beanbag ball) and a ten-second search period had elapsed, the experimenter said "That time I only hid one toy in the box. No more toys in there!" The second familiarization trial was a plural trial. The experimenter said "This time I'm going to hide two toys in the box. Can you get the toys for me?" The experimenter then placed two blocks into the box and gave the child ten seconds to search. If the child retrieved only a single block, the experimenter encouraged him or her to keep searching for the other block until he or she retrieved it. The experimenter then said "Great job! That time I put two toys in the box and you found both blocks. Remember in our game, sometimes I will hide one toy [holding up one finger] and sometimes I will hide two toys [holding up two fingers]. Ready to get started?"

Procedure for singular and plural manual search trials. Each trial of each condition contained a total of four meaningful cues to number. Verbal prompts for each condition are provided in Table 6 (bold text indicates meaningful cues to number) and full experimental scripts that were used during data collection are provided in Appendix A.

On each trial, the experimenter picked up the box indicated that she was going to hide something in the box (Prompt 1). The experimenter then moved the box out of view of the child, and quietly placed one object into the box. Bringing the box back into view, the experimenter indicated she had placed something in the box and asked the child to retrieve what was inside (Prompt 2).

Table 6

Manual Search Task Verbal Prompts

Condition	Prompt 1	Prompt 2
Noun-only	*I am going to put the **spoon/spoons/duck/ducks** in my box. I am going to put the **spoon/spoons/duck/ducks** in my box.*	*Wow! I put the **spoon/spoons/duck/ducks** in my box! I put the **spoon/spoons/duck/ducks** in my box! Can you reach?*
Verb-only	*Hmm... what will I hide in the box? Oh! Here **is/are** the fish/sheep! Oh! Here **is/are** the fish/sheep!*	*Wow! Here **is/are** the fish/sheep in my box! Here **is/are** the fish/sheep in my box! Can you reach?*
Noun+Verb	*Hmm... what will I hide in the box?*	*Wow! Here **is/are** the **frog/frogs/shoe/shoes** in my box! Here **is/are** the **frog/frogs/shoe/shoes** in my box! Can you reach?*

The box was then placed directly in front of the child and the child reached into the box to retrieve the object. After the child retrieved the object, the experimenter presented the child with a bowl in which to place the object. If the child did not immediately relinquish the object, the experimenter took it from the child and placed it in the bowl. Once the child had relinquished the object, the examiner made sure the box was still directly in front of the child and a ten second search period began. During this period, the experimenter kept her gaze averted from the child

and remained silent. This was the period which was coded offline, frame-by-frame, to determine when the child began searching and how long he or she searched. Details on the data coding procedure are provided in a subsequent section. On singular trials, once ten seconds had elapsed, the trial was over and the experimenter moved on to the next. On plural trials, at the end of the search period, the experimenter secretly placed an additional object in the box through the back opening and then reached in through the front opening, silently retrieved it, and placed it in the bowl.

Procedure for ambiguous trials. The ambiguous condition was intended as a benchmark of search behavior for each child and is not used in all analyses. For this condition, there were two experimental trials which were ambiguous to subject number. The nouns "fish" and "sheep" were used in this condition so that there was no noun information regarding subject number. The procedure was the same as what is described above, except the verbal prompt was as follows: "I am going to put the fish/sheep in my box. I'm going to put the fish/sheep in my box. Here I go! ... I put the fish/sheep in my box. I put the fish/sheep in my box. Can you reach?" Since these trials were intended to be ambiguous to subject number, the examiner did not retrieve a second object from the box as tacit feedback. Rather, after the search period, the examiner looked at the child and shrugged her shoulders before moving on to the next trial.

Data coding. The dependent variable for this task is search time during the search period on each trial. Therefore it is critical that both the search period and search behavior are carefully defined. All manual search sessions were coded offline, frame-by-frame. The majority of these (60%) were coded by a coder who was blind to the purpose of the study. The remaining 40% of sessions were coded by the author. To establish reliability, 20 sessions (approximately 10% of

the total number of sessions) were coded by both coders. Inter-coder reliability at the level of the frame was 98%.

The search period was coded as beginning the moment the child relinquished the toy, either by dropping it into the bowl, or when the examiner took it from the child. Once the search period began, the data coder advanced the video frame-by-frame, indicating the frame when any search behavior began and ended, until exactly ten seconds had elapsed from the beginning of the search period.

Search behavior was defined as the child having a hand in the box, with at least the second knuckle inside the box. Additionally, the child had to be moving his/her hand, or otherwise demonstrating that he/she was intentionally searching in the box. If the child was sitting with his/her hand in the box but he/she showed no signs of moving his/her hand, this was not coded as search behavior. Additionally, playing with the elastic fabric of the spandex opening was not coded as search behavior. Children occasionally displayed other behaviors that indicated that they thought there should be another object in the box such as trying to peer into the box through the opening, looking around the box, trying to pick up the box to search under it, and asking the experimenter for help or where the other object was. However, none of these behaviors were coded as searching.

Administration reliability. To establish the reliability of administration of the manual search task, the author viewed 50% of the sessions from video and made notes of any deviations from the experimental script or procedures. The manual search task was administered exactly as written in the script for 83 sessions out of 86. Three deviations occurred. In a Noun-only session, the experimenter provided one extra cue on one trial by saying “Can you get the ducks for me?” instead of “Can you reach?” In a Noun+Verb session, the experimenter administered one trial

twice because the child was afraid to reach into the box after hearing that there were frogs inside. The experimenter paused the trial, showed the child all of the toys including the frogs, and then re-administered the trial. Finally, for one Noun-only session the frogs were used instead of the ducks because the ducks had been temporarily misplaced. As a quantitative measure of administration consistency, the total time for each session was measured from the beginning of trial 1 to the end of trial 4 (or trial 2 for the Ambiguous condition) following familiarization. The mean lengths of each condition are presented in Table 7.

Table 7

Mean, SD, and Range of Manual Search Task Length in Seconds

	Ambig	V-only	N-only	N+V
Mean	53.36818	157.9517	157.7325	150.5899
Min	39.83333	119.2333	124.3333	113.0667
Max	93.5	194.1	210.6667	199.3667
SD	9.061912	18.10629	21.29587	20.53119

Semi-structured Picture Book Activity

A 10-page book called “Animals on the Farm” was presented to the child. On each page, there are two pictures—one with a single animal and one with multiple animals. The book has no words. On each page the experimenter prompted the child to talk about each picture with a standard set of prompts (see Appendix B). The child was not required to respond to these prompts. Rather these prompts were used to ensure that each child was given similar opportunities to use the target forms “is” and “are.” The experimenter kept track of how many obligatory contexts for “is” and “are” the child produced. For this measure, both copula (e.g. the cow is big) and auxiliary (e.g. the cats are sleeping) BE forms were targeted. To ensure the

validity of this measure, the experimenter aimed for a minimum of five obligatory contexts for "is" and five obligatory contexts for "are" during this task (Ingram, 1989). These language samples lasted between 7-20 minutes. Sessions were videotaped and audio recorded for later transcription and coding.

Language samples were transcribed and coded by the author using transcription conventions consistent with the Systematic Analysis of Language Transcripts (SALT) software (Miller & Iglesias, 2012). Language samples were coded so that correct uses, omissions, and errors of copula and auxiliary BE forms could be easily retrieved. Outcome measures such as mean length of utterance (MLU), percent correct usage of "is" and "are" in obligatory contexts, and omitted and erred "is" and "are" use were generated using SALT. To establish transcription and coding reliability, four language samples (approximately 10% of the total) were transcribed and coded by another transcriber. Reliability at the word level was 90% and at the code level was 98% .

Imitation Task

Administration. For the imitation task, children were presented with eight pairs of pictures and were asked to imitate 16 sentences. All of these sentences targeted copula "is" and "are." The sentences were presented in the same order for all children. Prior the experimental sentences, children were familiarized to the task. The cover of the book "Animals Around the Farm," which depicts a cat, a pig, a cow, and a barn was presented to the child. The child was told to "say what I say." The experimenter then pointed to the pictures and labeled them (e.g. "pig" "red barn") or said a short sentence (e.g. "kitty is hiding"). The familiarization period continued until the child successfully and reliably imitated the experimenter. Generally, children

clearly understood the task after repeating the experimenter three times, although some children required additional practice.

During the experimental trials, the child was presented with eight pairs of contrasting pictures to accompany the verbal prompts. Half of the sentences had three words, and half had four words. Children were presented with the three-word sentences first, followed by the four-word sentences. For two of the picture pairs, "is" was targeted for both pictures, for another two pairs, "are" was targeted for both pictures, and for four of the pairs, "is" was targeted for one picture, and "are" was targeted for the other. The targets were presented in a fixed order for all children. All of the sentences are listed in Appendix C.

If the child did not respond to the first prompt, the experimenter repeated it a maximum of two additional times. If the child responded with a completely new sentence (e.g. for the prompt "those are blue" the child might say "no those are purple."), the experimenter re-prompted. Prior to every prompt, the experimenter reminded the children to "say what I say" except in cases where the child very clearly understood the task and imitated without issue.

Data coding. Imitations were transcribed online. A second scorer doubled checked approximately 90% (41 out of 45) of the imitation transcriptions by listening to the audio and/or watching the video and noting any disagreements. All items that had a disagreement were re-checked by the first transcriber. Items that remained in disagreement after this checking procedure were deemed unscorable.

Imitations were coded so that overall accuracy and percent correct use of "is" and "are" in obligatory contexts could be analyzed. Imitations that were coded as accurate had to be exact imitations of the examiner prompt, although mispronunciations were permitted (i.e. /fwa/ for "frog" or /mal/ for "small"). Imitations that were coded as inaccurate either had an omitted word,

or a different word from what was produced in the prompt. Many children did not produce clearly articulated words. For "is" and "are," these were occasionally produced as an underspecified syllable (e.g. "joe uh happy" for "joe is happy"). These received a special code so that they can be retrieved and examined in the future, but for the purposes of the analyses presented here, these were coded as accurate imitations, and counted as using "is"/ "are" correctly in obligatory contexts. If a child omitted the "is" or "are," this was coded as an omission in obligatory context only if the child had produced a subject that set up the obligatory context. For example, if the child said "happy" in response to "joe is happy" this would not count as an omission of "is" in obligatory context. However, if the child said "joe happy" or "he happy," these would both count as omitted "is" in obligatory context. If a child produced the wrong form of the BE verb, this was coded as an error. For example, if a child said "bears is big" for "bears are big" this would be coded as an error of "are" use, since "are" was the target. If a child produced forms that were very unusual or uninterpretable, these were coded as unscorable. For example one child produced "hap ap" instead of "is." This was coded as unscorable.

Occasionally, children would change the plurality of the noun. In these instances, is/are coding was conducted based on the subject that child actually produced. Therefore, if a child said "bear is big" in response to "bears are big," this was coded as correct use of "is," although the overall imitation was scored as inaccurate. Some children clearly had difficulty with word-final consonant clusters and word-final –s. In these cases, if a child said "bear are big" in response to "bears are big," the child's tendency to produce word final –s was taken into consideration when deciding if "bear are big" reflected an agreement error of commission (i.e. "are" for "is") or if the child intended to produce a plural subject, in which case, the "are" would be considered correct. These cases were relatively rare.

Measure of non-verbal mental ability

The Visual Reception Subscale of the Mullen Scales of Early Learning (Mullen, 1995) was given to each child as a measure of non-verbal mental ability. This subscale assesses visual discrimination and visual memory using tasks where the child responses involve minimal motor requirements and no verbal requirements. Tasks include matching pictures and/or objects, remembering and identifying pictures and/or objects, and completing tasks such as nesting cups, sorting shapes by color and/or size, etc. This is a standardized measure which allows for comparison to normative data.

Parental Report Measures

Parent questionnaire. In addition to the production measures of "is" and "are" described above, children's parents were given a questionnaire to fill out that specifically assessed children's use of these words. The questionnaire presents six sentence pairs that differ in whether "is" or "are" are correctly used. Parents were asked to circle which sentence of each pair is the most similar to their child's spontaneous speech. For each pair where the parent circled the correct version, the child received one point. Therefore, children received a score between zero and six on the questionnaire. The parent questionnaire is included in Appendix D.

The MacArthur-Bates Communicative Development Inventory III. The MB-CDI III is a parent report checklist of vocabulary items and questions about language use developed for use with children age 30-37 months (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2006). This measure allows for comparison with age expectations for both boys and girls separately and combined. The MB-CDI III serves as a benchmark for the child's productive language development compared to age equivalent peers.

Summary of Procedures

Each participant received the semi-structured picture book activity, the imitation task, the four conditions of the manual search task, and the Visual Reception subscale of the Mullen, and the parents completed the MB-CDI III and the parent questionnaire. Parents also completed a demographic questionnaire that asked about exposure to languages other than English, premature birth, and mother's education as a proxy for socio-economic status. Children were tested once per day on three days. On average, the length of time between session one and session three was ten days. Data collection proceeded as follows:

Day 1: Ambiguous condition of Manual Search Task, Visual Reception subscale of the Mullen

Day 2: Manual Search Task (Groups 1 and 2: Verb-only; Groups 3 and 4: Noun-only), Imitation task, Manual Search Task (Groups 1 and 2: Noun-only; Groups 3 and 4: Verb-only)

Day 3: Manual Search Task (Noun+Verb) and Picture book activity

Occasionally the Visual Reception subscale of Mullen was given on a day 2 or 3 due to time constraints. The order of conditions of the manual search task did not deviate from the schedule described above for any children. Each session lasted between 15 and 30 minutes. All testing was done during the children's day at daycare or preschool, with the exception of one child who was tested at home. Children were rewarded with stickers for their participation.

Chapter IV: Results

Three separate analyses were conducted to address each of the research questions. First, the question of whether children search longer on plural trials compared to singular trials for each condition was addressed using a mixed model analysis (Analysis 1). Secondly, the added benefit of the noun and verb cues were probed in a subsequent mixed model with follow-up pairwise comparisons of each condition (Analysis 2). Finally, the possible relationship between language production abilities, non-verbal ability and performance on the manual search task was addressed by correlating the performance on the manual search task with the scores on the Visual Reception subscale of the Mullen Scales and performance on the production measures the collected in the study (Analysis 3).

Analysis 1. *Can two-year-old children demonstrate knowledge that "is" signifies singular and "are" signifies plural? Can two-year-old children demonstrate knowledge of number marking on nouns (plural –s)?*

For this analysis, mean search times on singular and plural trials were computed for each child for the Noun-only, Verb-only, and Noun+Verb conditions. Since the Ambiguous condition did not have a singular/plural distinction, it was not included in this analysis. Data were analyzed using a condition (3) × trial type (2) mixed model. In this design, condition and trial type were within subjects factors (trial type refers to singular and plural trials). Maximum likelihood estimation was used and the covariance matrix was set to a variance components structure.

Prior to examining the effects of condition and trial type on mean search time, a series of mixed model analyses were conducted to determine if there were significant effects of sex, counterbalancing group assignment, or noun on search times. There were no significant effects of noun and no significant noun × trial type interaction for any of the conditions. Thus, the noun

used in each trial (sheep vs. fish for Verb-only, duck vs. spoon for Noun-only, and frog vs. shoe for Noun+Verb) did not influence search time. For all subsequent analyses, search time was averaged for singular and plural trials for each child and each condition, collapsing across nouns. There also were no significant effect of sex, nor sex × condition × trial type interactions, indicating that search time on singular vs. plural trials did not differ across boys and girls. Therefore, for all subsequent analysis data from both sexes were collapsed.

In analyzing the effects of group, of particular interest was whether there were any order effects on search time which would be evident in a significant counterbalancing group × trial type × condition interaction. Recall that there were four counterbalancing groups which differed in whether singular vs. plural trials were presented first within a condition and in the order of conditions presented. The first mixed model analysis revealed a main effect of counterbalancing group, but no counterbalancing group × trial type × condition interaction. Children in one counterbalancing group (group 3) had longer search times in general than children in the other groups, but the lack of interaction with trial type and condition indicates that this effect did not affect other, more critical, factors in the study.

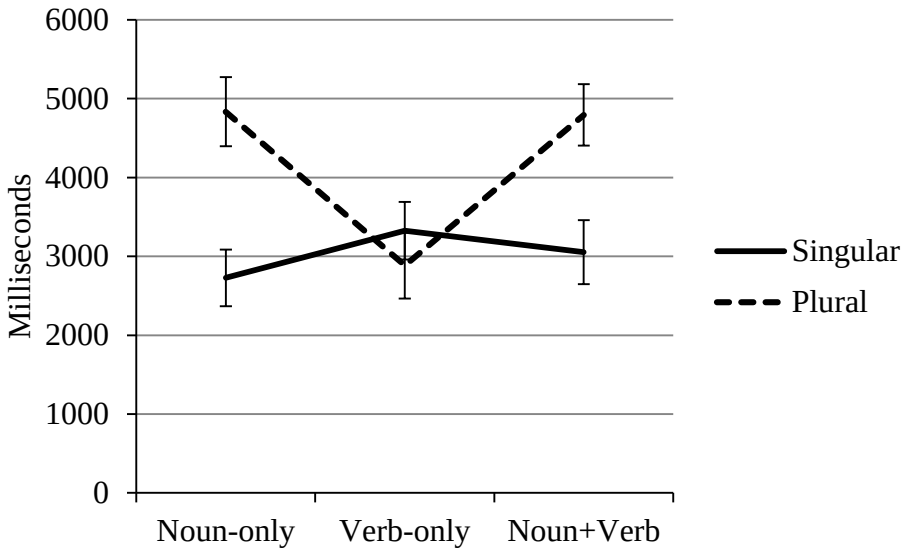
While the previous analysis considered each counterbalancing group separately, recall that counterbalancing groups one and two received the Verb-only condition before the Noun-only condition on the second day of data collection and counterbalancing groups three and four received these conditions in the reverse order. The purpose of this design feature was to control for the possibility that children might show practice effects and thus improve on conditions administered later in the protocol during the second session. To test for this, another mixed model analysis was conducted where data from counterbalancing groups one and two were combined and data from counterbalancing groups three and four were combined. This analysis

revealed no significant effect of combined group and no significant trial type × condition × combined group interaction. This means that order of presentation of conditions did not influence search times on singular vs. plural trials. Therefore, in all subsequent analyses reported here, data were collapsed across all counterbalancing groups.

Having established that group, sex, and noun did not influence search time, the trial type (2) × condition (3) mixed model analyses was conducted without these factors in the model. As predicted, this analysis yielded a significant trial type × condition interaction, $F(2, 167.09) = 6.24$, $p = .002$, indicating that children's difference in search time on singular vs. plural trials varied by condition. See Figure 1.

Figure 1

Mean Search Time; error bars represent standard error



To follow up the significant interaction, separate mixed models for each condition were conducted to determine which conditions had significant differences between singular trial search times and plural trial search times. For the Noun-only condition, there was a significant

effect of trial type, $F(1, 78.88) = 14.18$, $p < .001$. Children searched longer on plural trials (M = 4832.93 ms, SD = 2246.10) than on singular trials (M = 2727.64 ms, SD = 2966.18) for the Noun-only condition.

For the Noun+Verb condition, there was a significant effect of trial type, $F(1, 87.85) = 9.72$, $p = .002$. Children search longer on plural trials (M = 4793.56 ms, SD = 3388.21) than on singular trials (M = 3053.03 ms, SD = 3149.51) for the Noun+Verb condition. This indicates that for the Noun-only and Noun+Verb conditions, children understood the verbal cues indicating the number of objects in the box. After retrieving the first object from the box, they continued to search significantly longer on plural trials ("I put the spoons/ducks in my box" or "here are the frogs/shoes in my box") than on singular trials ("I put the spoon/duck in my box" or "here is the frog/shoe in my box"). For the Verb-only condition, there was no significant effect of trial type, $F(1, 82.40) = 0.65$, $p = .42$. Children searched roughly equivalently in the singular and plural trials (M = 3325.15 ms, SD = 3184.54; M = 2918.47, SD = 3178.37, respectively). This means that in the Verb-only condition, children did not search significantly longer on plural vs. singular trials, indicating that the verb cue was not informative for the children in this task.

Analysis 2. *What is the added benefit of each cue (noun information and verb information)? Is one cue more informative for children?*

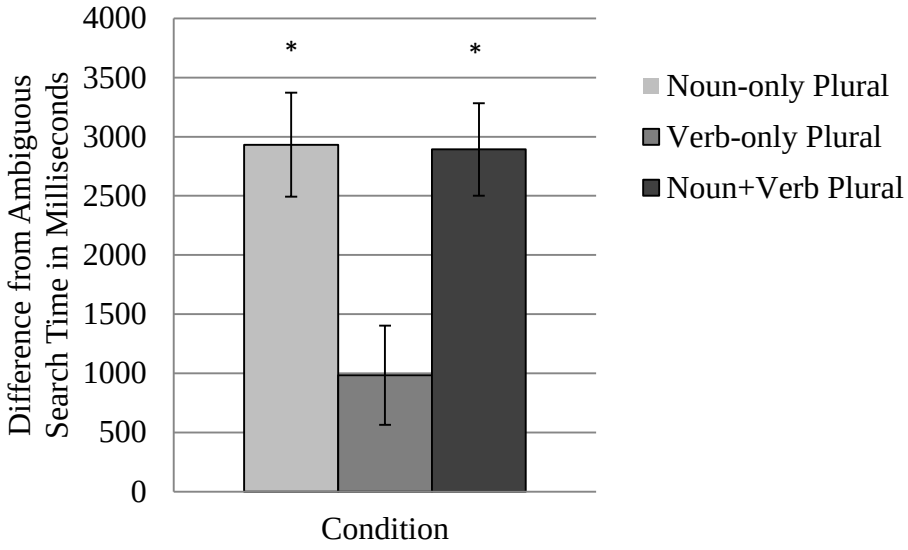
The purpose of this analysis was to determine if there was any added benefit to the addition of verb and noun cues compared to the ambiguous condition where no verb or noun cues were available. Here "added benefit" is defined as longer search times on plural trials. Therefore, for this analysis, only the mean search time on the Ambiguous condition (M = 1964.42 ms, SD = 2504.67) and the plural trials for the other three conditions were analyzed. Note that the ambiguous condition in this study ("I put the fish/sheep in the box") could be

interpreted as singular since the vast majority of the time unmarked nouns in English are singular nouns; therefore, if search times on the ambiguous condition are equivalent to search times on plural trials in any of the other conditions, this would provide strong evidence that the child did not realize any benefit from additional cues provided.

For this analysis, mean search time on the Ambiguous condition, as well as mean search time on the plural trials of the other three conditions of the manual search task, were compared in a mixed model with follow-up pairwise comparisons. The mixed model yielded a significant effect of condition $F(3, 81.49) = 15.78$, $p < .001$, indicating that there were significant differences between search times across conditions. Follow-up pairwise comparisons revealed that the Noun-only and Noun+Verb conditions differed significantly from the Ambiguous condition ($p < .001$ for both comparisons). Search times on plural Noun-only and plural Noun+Verb conditions were significantly longer than search times on Ambiguous trials, indicating that the plural information provided in the Noun-only and Noun+Verb condition was correctly interpreted by the children. The Verb-only condition did not differ significantly from the Ambiguous condition, although this difference approached significance ($p = .07$). See Figure 2. This suggests children did not interpret the addition of "are" in the Verb-only plural trials as indicating that there was more than one object in the box.

Figure 2

Difference in milliseconds between plural trials and ambiguous trials



* $p < .01$; Error bars represent standard error

It is also of interest to compare the non-ambiguous conditions to each other. If search times on plural trials are longer in one condition than in another, this would indicate that one condition provided more benefit to the child in terms of useful information for discerning the number of objects in the box. Pairwise comparisons showed that children searched significantly longer on plural Noun-only trials compared to plural Verb-only trials ($p = .002$). Additionally, children searched significantly longer on plural Noun+Verb trials compared to plural Verb-only trials ($p = .001$). However, search times on the plural Noun-only trials were roughly equivalent to search times on the plural Noun+Verb trials ($p = .95$). These differences are presented in Figure 3. This suggests that the noun information alone was sufficient, and the verb information provided no added benefit to the child for the purpose of determining the number of objects in

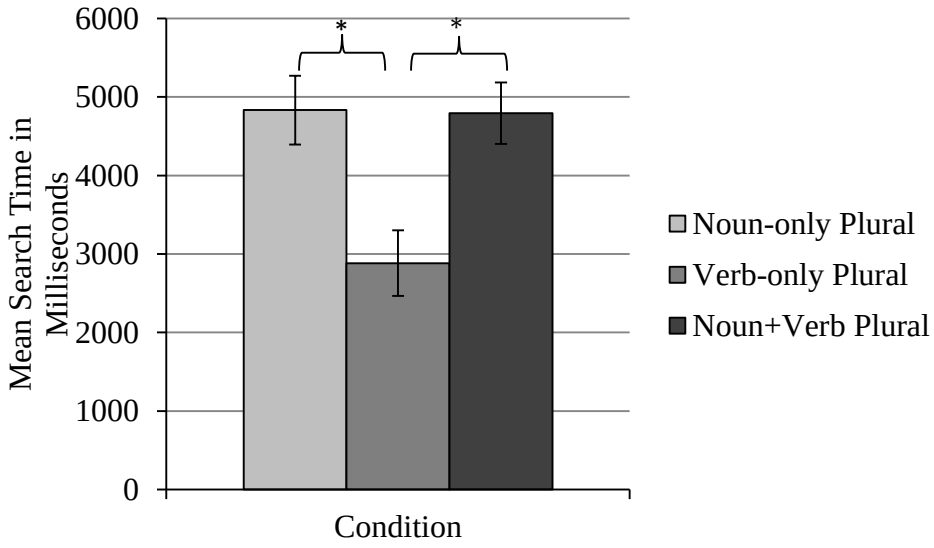
the box. The overall pattern of findings from these pairwise comparisons of search time across conditions can be summarized as follows:

Ambiguous = Plural Verb-only < Plural N-only = Plural Noun+Verb

Generally, this pattern of findings suggests that children treated the plural Verb-only trials as singular trials. To further confirm this, mean search times on plural Verb-only trials were compared to mean search times on singular Noun-only trials and singular Noun+Verb trials using a mixed model analysis with follow-up pairwise comparisons. Mean search times on plural Verb-only trials did not differ significantly from Noun-only singular trials ($p = .78$) or Noun+Verb singular trials ($p = .77$).

Figure 3

Mean search times on plural trials



* $p < .01$; Error bars represent standard error

Analysis 3. *What is the relationship between children's performance on a receptive task of their knowledge of subject-verb agreement and general measures of the language ability and non-verbal mental ability? What is the relationship between children's performance on a receptive task of their knowledge of "is" and "are" and measures of their production of "is" and "are"?*

The purpose of the final analysis is to determine whether performance on the manual search task, a task that taps receptive knowledge of morphology, is related to children's general non-verbal capabilities and their language production abilities. Multiple tasks were administered as part of this study in order to assess children's production of "is" and "are," their general language ability as measured by vocabulary use, and their non-verbal mental abilities. A series of correlations were computed to evaluate any possible relationships between search times on the manual search task and these other variables of children's abilities. Before presenting the outcomes of the correlation analysis, general outcomes of the production tasks are presented below.

Outcomes of production measures. Children in this age range are thought to be in the Optional Infinitive stage of development (Wexler, 1998). Three measures administered in this study were intended to capture whether children were optionally producing the forms "is" and "are", which are two words that always occupy the finiteness slot in a clause when they are present. The imitation task, the semi-structured language sample, and the parent questionnaire on language use probed children's use of "is" and "are." Results from each of these will be presented in turn.

The imitation task consisted of 16 items, eight with "is" and eight with "are" as the target verb. Four items were discarded due to difficulty in determining whether children were

accurately pronouncing the target verb. Two of these were sentences where the "is" was immediately followed by a word beginning with –s ("Kitty is small" and "Mary is sad"). For many of the children it was difficult to determine if the child produced a contracted form of the sentence (e.g. "Mary's sad") or if they had omitted the copula "is" (e.g. "Mary's sad" vs. "Mary sad"). Two sentences where "are" was the target were also excluded from analyses for a similar reason. In these sentences, the "are" was immediately followed by a word beginning with a schwa ("These kids are asleep" and "These kids are awake"). Children often produced sentences such as "These kids uh wake," and it was difficult to tell if the child had omitted the "are" or if they had produced the "are" and incorrectly produced the following word. This left 12 items for analysis.

Overall accuracy in imitation, measured as the proportion of items that were imitated verbatim, as well as proportion correct "is" in obligatory context and proportion correct "are" in obligatory context are reported in Table 8. Children performed at fairly high levels of accuracy for "is" and "are," although some children had no accurate imitations of "is" and "are" in obligatory contexts, suggesting that they were in the very earliest stages of production with these forms. Children's overall imitation scores were less accurate overall than their use of "is" and "are"; this is due to the fact that many children made errors such as omitting determiners, or changing words in the imitated sentence (such as "he" for "the boy"). The majority of errors of "is" and "are" in the imitation task were omissions. Of the 491 scorable obligatory contexts for "is" and "are" in the imitation task, 54 were omissions and 17 were errors of commission.

The semi-structured language sample was specifically designed to elicit spontaneous use of copula and auxiliary BE, in particular, the forms "is" and "are." Child utterances were transcribed and coded so that the total number of correct uses, errors, and omissions of "is" and

"are" could be extracted, in addition to measures of MLU in words and morphemes. Because of the challenge in interpreting proportion correct use of a given form when children produce very few obligatory contexts for that form, only language samples where children had at least five obligatory contexts for "is" and five obligatory contexts for "are" contributed data analyzing usage of these forms. Examining percent correct usage of a morpheme in a sample that has fewer than five obligatory contexts for that sample could lead to under- or over-estimating a child's ability to use that morpheme accurately. Thirteen children had fewer than five obligatory contexts for both "is" and "are," and one child did not complete the language sample; therefore this analysis was performed on a subset of 31 participants. Mean uses of "is" and "are" (see Table 8) suggest that these children were in the Optional Infinitive stage of development, although there was considerable variation across subjects. As expected, the overwhelming majority of incorrect uses of "is" and "are" were omissions. There were 1380 total obligatory contexts for "is" or "are" across all the language samples; of those, there were only 7 instances of errors of commission. This is in contrast with the rate of errors found in the imitation task, 17 out of 491 obligatory contexts were errors. This pattern is consistent with the theory of Grammatical Conservatism (Synder, 2008) which predicts that children will make unusual errors in elicited tasks that they would not make during spontaneous language production.

The parent questionnaire on is/are use was included in the study as a back-up measure of children's use of "is" and "are" to be considered in the event that a child refused to participate in the production tasks. Scores ranged from 0, indicating that the child never produced "is" or "are," to 6, indicating that the child often or always produced "is" or "are," according to the parent completing the form. Once again, the mean for this measure (see Table 8) suggests that

these children are in the Optional Infinitive stage of development, although there was considerable variation across the full range of scores.

In addition to measures of is/are use, two standardized measures were administered as well: the MacArthur-Bates CDI-III, as a standardized measure of language development, and the Visual Reception subscale of the Mullen, as a measure of non-linguistic mental ability. Mean raw scores and mean percentile rankings for each of these are presented in Table 8. The MB-CDI III contains both a vocabulary checklist as well a series of questions about language use. The variable of interest here is vocabulary, as vocabulary is typically the measure used to classify two-year-old children as at risk for language impairment or delay. Percentile rankings for the MB-CDI III can either be sex-specific or based on the full distribution with both sexes combined. The percentile ranking reported in Table 8 is the mean general (i.e. not sex-specific) percentile ranking.

Table 8

Means, Standard Deviations, and Ranges for Performance Measures

	N	Mean	SD	Range
Imitation Accuracy	45	.64	0.29	0-1
Imitation proportion correct "is"	45	.84	0.29	0-1
Imitation proportion correct "are"	43	.87	0.24	0-1
Language Sample Total Utterances	43	12.37	45.24	27-215
Language Sample Complete & Intelligible Utterances	43	2.14	31.38	15-149
MLU in morphemes	43	3.3	1.05	1.28-7.61
Language Sample % correct "is"	31	0.76	0.32	0-1.0
Language Sample % correct "are"	31	0.75	0.32	0-1.0
Parent Questionnaire Score	42	4.02	2.52	0-6
Visual Reception Raw Score	45	40	6.55	28-67
Visual Reception Percentile	45	65.56	12.28	3-99
Vocabulary Raw Score	42	58.19	21.68	1-100
Vocabulary Percentile	42	36.4	25.65	1-99

Relationships between search time and other variables. The overall group performance on the Verb-only condition indicated that (as a group) children at this age did not comprehend the verb information available to them. One purpose of this analysis was to determine if individual differences in performance on the comprehension measure was in any way related to individual children's performance on general measures on language ability (MLU and Vocabulary scores) and/or non-verbal mental ability (Visual Reception subscale of the Mullen). Another purpose of this analysis was to probe whether proficiency in production of "is"/"are" was related on the Verb-only and Noun+Verb conditions of the manual search task (where "is" and "are" were presented). These relationships were addressed with a series of bivariate correlations.

The manual search data could be correlated with other measures in several different ways. First, individual difference scores could be computed by subtracting each subject's mean search time on singular trials from their mean search time on plural trials. While this approach may seem intuitive, issues in the statistical reliability of difference scores can make interpretation difficult. Difference scores may be particularly difficult to interpret for the Verb-only and Noun+Verb conditions because of the possibility that knowledge of "is" and "are" are dissociated; that is, a child might know that "are" signifies plural, but might not know that "is" signifies singular (or vice versa). If knowledge of these forms is dissociated, difference scores would not be appropriate, as they would obscure this possible pattern. Therefore, for the

correlations with other measures of performance, mean search times on plural trials and mean search times on singular trials were correlated with the other variables separately[2].

Prior to running these correlations, all of the variables were checked for outliers and variables were transformed as appropriate. Any outliers were identified by examining box and whiskers plots for each variable with follow-up examination of the standardized residuals. Search time values were square-root transformed, as these variables were positively skewed, which is typical of response time measures. Proportion data, such as proportion correct "is" and "are" in obligatory contexts were arcsine transformed, due the binomial distribution of these variables[3].

Correlations between search times and general measures: MLU, Vocabulary, and Visual Reception subscale of the Mullen. Bivariate correlation analyses were conducted between the search times for each condition and the general measures of performance: Visual Reception subscale of the Mullen, Vocabulary, as measured by the raw score of the MB-CDI, and MLUm from the language sample. Significant correlations emerged between the Visual Reception scores and search time on singular Noun-only trials (r = .48, p = .002), singular Verb-only trials (r = .35, p = .02), and plural Noun+Verb trials (r = .35, p = .02). Visual Reception

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[2] The null findings described here do not appear to be an artifact of the type or nature of the analysis reported. Regardless of whether correlations were run on difference scores, or on plural trial search times with singular trial search times partialled out, there were no significant correlations between search time and any of the production measures.

[3] Correlations were also run on non-transformed data, and the overall pattern of results was exactly the same.

scores were positively correlated with the other search time conditions as well, but not statistically significantly so. Thus, children who had higher raw scores on the Visual Reception subscale of the Mullen, also had longer search times on Noun-only and Verb-only singular trials, and on plural trials in the Noun+Verb condition. This was unexpected and there is no obvious explanation for it. However, children vary somewhat in whether they tend to search for a long time on trials, or if they are "quick searchers"; it is possible that children who searched for longer times are generally more thorough and deliberate, and thus would also score higher on a test of non-verbal mental ability. One purpose of including the Visual Reception subscale of the Mullen was to determine if better comprehension was simply due to higher non-verbal mental ability. These correlations do not suggest that children who had higher scores on the Visual Reception subscale were also demonstrating better comprehension of the morphemes targeted in the manual search task, with the possible exception of the Noun+Verb plural condition. With regards to the general language measures, the lack of correlation between vocabulary scores and search times and MLU in morphemes with search times suggests that performance on the manual search task is not clearly related to general language abilities as measured by vocabulary and MLU.

Correlation of search times on Verb-only and Noun+Verb trials with production of "is" and "are." Next, relationships between search time on conditions where verb information was presented and children's productions of "is" and "are" were probed with correlations. There were no significant correlations between any of the production measures of "is" and "are" and search times on Verb-only and Noun+Verb trials.

There are two possible explanations for the lack correlation between search times on the conditions where verb information was provided and children's level of proficiency with the verbs assessed. One is that the comprehension task did not tap knowledge of "is" / "are" and

therefore, there was no relationship between performance on the comprehension task and proficiency in production of these forms. Given the null findings in the comparison of singular vs. plural trials in the Verb-only condition, this possibility must be considered. Analysis 2 suggested that children's performance in the Noun+Verb condition was driven by their sensitivity to noun information, so it is also possible that the Noun+Verb condition did not tap knowledge of "is" and "are." Follow-up work to clarify whether the manual search task tapped knowledge of verb information in the Verb-only condition is discussed in the final chapter.

It is also possible that bivariate correlations were not the appropriate method of probing possible relationships production of "is" and "are" and comprehension of "is" and "are." To explore this possibility, Verb-only search times were binned in a variety of ways, and differences on production measures between the members of each bin were compared using one-way ANOVAs or *t*-tests. Multiple options for binning were evaluated including creating four bins from the search time variables with cut points at the mean and one standard deviation above and below the mean, as well as dichotomizing the search times into two bins based on standard error above the mean. The prediction is that for plural trials, children in bins with longer search times would have better proficiency in production, particularly for "are" while for singular trials, children in bins with the lowest search times would have better proficiency in production, particularly for "is." This prediction was not supported by the data, as there were no significant differences in production measures between any of the bins that were tested. These leaves open the possibility that the Verb-only condition did not tap comprehension of "is" and "are," but also leaves open the possibility that comprehension of "is" and "are" and production of "is" and "are" develop separately in children. Each of these possibilities is considered in the next chapter.

Chapter V: Discussion

Overall, 30- to 36-month-old children showed comprehension of the noun cues to number, but failed to show comprehension of the verb cues to number. Additionally, the presence of the verb provided no added benefit to children over hearing only the noun cue. Finally, attempts to find a relationship between children's comprehension of "is" and "are" as measured in the manual search task with their production of these forms were unsuccessful. In this section, I will discuss each of these general findings with a particular focus on the contribution of these findings to our current understanding of early knowledge of number agreement morphology. I will also consider two explanations for the null findings in the Verb-only condition as well as the lack of relationship between performance on the measure of comprehension of "is" and "are" with children's production of these forms.

Methodological contribution

Before launching a discussion of the explanations and implications of these findings, it is important to note the methodological contribution of this work. As discussed in the introduction, two- to three-year-old children pose a challenge to researchers as they are generally too old for the looking preference methods used to test infants, but too young for the psycholinguistic methods used for older children and adults. The present study provides support for the use of a manual search task to test questions of comprehension of number agreement morphology in young children. This method has been used successfully with two-year-olds and younger children by Carey and colleagues to test acquisition of number concepts, but has not been adopted by others to test questions regarding acquisition of number morphology. Recent work in the area of sensitivity number agreement morphology using the more traditional measures of looking preference and pointing tasks have yielded mixed results. Recall that Legendere et al. (in

press) found that 28- to 46-month-olds did not show differentiation of singular and plural trials in a looking preference study when both noun and verb information was provided (e.g. “the boy/boys kisses/kiss the /naj/”). This is in contrast to the findings of the present study, where children reliably searched longer on plural trials compared to singular trials in both the Noun-only condition and the Noun+Verb condition, suggesting that noun morphology alone was sufficient for children 30- to 36-months-old to differentiate between singular and plural trials. This is evidence that the manual search task employed here may be more appropriate than passive looking preference methods for detecting comprehension of these forms in this age range.

Researchers have also used picture selection and pointing tasks to ask similar questions to the ones addressed in the present study. However, these more explicit tasks have been problematic as well. The findings of Brandt-Kobele and Höhle (2010) highlight potential issues with pointing tasks. Recall that Brandt-Kobele and Höhle (2010) found that although eye gaze data suggested that children were sensitive to morphological information, their pointing behavior was at chance in differentiating between singular and plural trials. Given the challenge of assessing comprehension in this age range, null findings are especially difficult to interpret. The manual search task may represent a middle ground between a completely passive looking preference study and the explicit forced choice pointing tasks. The results from the Noun-only and Noun+Verb conditions confirmed that this task worked: when children were presented with cues they could interpret, their search behavior reflected their knowledge via significantly longer search times on plural trials compared to singular trials. It must be noted however, that this method was successful only after extensive piloting. Having established the sensitivity of the method for addressing the research questions posed here, let us now consider the pattern of

findings in light of recent work in this area as well as implications for theories of language acquisition.

Two-year-olds' Comprehension of Number Agreement Morphology on Nouns

The results from the Noun-only and Noun+Verb condition strongly suggest that 30- to 36- month-olds are sensitive to number morphology on nouns and are able to access this knowledge in sentence comprehension. In order to show differentiation of singular and plural trials in the manual search task, children must access the meaning of the morphemes under investigation. Therefore, the findings from these conditions demonstrate that these children possess knowledge of those meanings and are able to access that knowledge. Previous work examining children's sensitivity to number morphology using both the manual search task (Wood et al., 2009) as well as looking time studies (Kouider et al., 2006) found that 24-month-old children did not differentiate between singular and plural trials when only noun information was available, although they were able to do so when verb and quantifier information was provided in the verbal prompts. Combined with those findings, the current study suggests that sensitivity to and comprehension of noun morphology develops during the third year of life. This finding is significant in light of the fact that recent work by Legendere et al. (in press) suggests that English-speaking children in this age range are not sensitive to noun morphology.

Analysis of Added Benefit of Multiple Cues

The results from comparisons between the plural trials of each condition suggest that in the Noun+Verb condition, children's longer search times on plural trials were driven by their comprehension of the noun; the presence of the verb provided no added benefit. Kouider et al (2006) found that 24-month-olds shifted their gaze to the target prior to hearing the noun when presented with sentences that contained quantifier, verb, and noun information (e.g. "here is/are/

a /some blicket/blickets"). They speculated that it is possible children were responding to the verb information. The findings presented here suggest that it was more likely to be the quantifier that children were sensitive to. Recall that Wood et al. (2009), Kouider et al. (2006) as well as the pilot work reported here, found that when the quantifier was included, children showed differentiation between singular and plural trials at 24- to 36-months. Taken in combination with the findings from the Noun+Verb condition of the current study, this suggests that it was the presence of the quantifier that was most informative/interpretable for children in previous work. However, it remains a possibility that in online sentence processing, as measured in eye-tracking studies, children are sensitive to verb information.

Two-year-olds' Comprehension of Number Agreement Morphology on Verbs

The interpretations from the Noun-only and Noun+Verb conditions are fairly straightforward. Less straightforward, however is the null finding from the Verb-only condition as well as the lack of correlation between search times and measures of language production. One possibility is that the null finding in the Verb-only condition is an artifact of the methodology used here. A second possibility is that the null finding in the Verb-only condition reflects that 30- to 36-month-old children do not comprehend "is" and "are." If this is a true effect, this may indicate an asymmetry between production abilities and comprehension abilities with respect to "is" and "are." Each of these possibilities will be considered in turn.

Possibility 1: Null findings due to methodological issues. First, consider the possibility that the Verb-only null finding is an artifact of the methods used here. Given the results from the Noun-only and Noun+Verb conditions, it is unlikely that a general procedural flaw is to blame for the null findings in the Verb-only condition. It is possible, however, that the verbal prompt used in the Verb-only condition was problematic. One criticism of previous work examining

comprehension of number agreement morphology on verbs was that in the verbal prompts used in previous work the verb was always preceded by a noun which was ambiguous to subject number. Given that in English, most of the time, number information is conveyed using noun morphology, it is possible that these studies may have been ineffective in assessing sensitivity to verb morphology because children were unable to revise an initial interpretation of the sentence based on the noun information. To address this, the current study moved the ambiguous noun to the end of the sentence, so that interpreting the verb information would not require the child to revise their initial interpretation of a more valid cue. It is possible that simply moving the ambiguous noun to the end of the sentence did not prevent children from relying on it for interpretation. Although "sheep" and "fish" are technically ambiguous with regards to number, it is possible the children interpreted them as singular. If this is the case, the plural Verb-only trials would have been interpreted as having conflicting information with regards to number. Given that the noun is the more reliable cue, it is possible that children ignored the conflicting verb morphology.

Note that the possible failure of the Verb-only condition of the manual search task to tap knowledge of "is" and "are" could partly explain the complete lack of relationship between comprehension and production reported in Analysis 3. If children were relying solely on the noun in the Verb-only condition, they would have been treating every trial as singular. In that case, any variation in search times would be due to children's general tendencies toward being "long searchers" or "quick searchers," which may be related to their non-verbal mental ability as measured by the Visual Reception subscale of the Mullen. There is no reason to think that general searching tendencies would in any way be related to language production measures, however.

As discussed in Chapter II, a version of this study was piloted where there was no noun in the Verb-only prompt. Instead an elliptical utterance was used ("Anything in my box? There is/are!"). This prompt was abandoned for the final study because "there is!" does not unambiguously indicate that there is only a single object in the box. Additionally, "there is" is used in conversational English with plural objects, particularly with "is" in the contracted form (e.g. "there's a lot of books on the shelf." "there's ants everywhere!" etc.). It is difficult (if not impossible) to generate a sentence in English that unambiguously indicates there is only a single object in the box and also contains no noun. A looking time study, such as the one carried out by Lukyanenko (2011) could examine sensitivity to "is" and "are," but given the mixed results using looking preference studies elsewhere, a null finding using looking time would be difficult to interpret.

While designing a study to test comprehension of "is" using the manual search task may be a challenge, it would be possible to follow-up with a study examining comprehension of "are" using an elliptical phrase as the verbal prompt. If it turns out that children this age understand "are," this would be important evidence of comprehension of number information on the verb which has so far been difficult to find using a variety of methods. Search times on plural elliptical trials (e.g. "Anything in my box? There are!") could be compared to search times on unambiguous singular trials where the children are provided multiple cues to singularity (e.g. "here is a car in my box"). While this approach would not allow for testing sensitivity to "is," it would allow for assessing knowledge of "are" without the potentially problematic noun in the verbal prompt. Coupled with measures of production of "are," such a study could also shed some light on the possible relationship between proficiency with "are" and performance on the manual search task.

Even if children were relying on the ambiguous noun in the Verb-only condition, we can at least say that in a task that effectively taps knowledge of number agreement morphology on nouns in 30- to 36-month-olds, children ignored number information available on verbs ("is" and "are"). This was true both when it was the only accurate cue to subject number, or when it could have been interpreted as conflicting with noun information (Verb-only condition) as well as when it was an additional cue to subject number (Noun+Verb condition). These findings alone suggest a relative lack of sensitivity to verb agreement morphology with regards to "is" and "are" compared to noun agreement morphology in 30- to 36-month-olds.

Possibility 2: Null findings reflect lack of comprehension. It is also possible that children's lack of differentiation between singular and plural trials on the Verb-only condition reflects a true lack of comprehension of these forms. Given the complete lack of correlation between search times and production measures of "is" and "are," this also would suggest that comprehension and production of these forms develop on separate trajectories.

If the null findings in the Verb-only condition and the lack of correlation between comprehension of "is" and "are" were not due to methodological problems, but rather reflect children's lack of comprehension of number morphology on verbs, then this study joins several that support a lack of comprehension of number morphology on verbs and an asymmetry between comprehension and production of these forms. In fact every study conducted to date that tested *comprehension* of number morphology on verbs in English, whether the target morphemes are "is" and "are" or third person singular –s, reports that this knowledge is not available for sentence interpretation until very late in development. The studies that show evidence for receptive knowledge of number morphology on verbs in children under four used looking time. These studies were likely tapping the *sensitivity* to number morphology on verbs that contributes

to online sentence processing. It is possible that measures of online sentence processing tap the knowledge of language form, i.e. syntactic dependencies between subject and verb, while tasks such as picture selection and manual search tap comprehension of meaning. In this case, this study would support the theory that syntactic knowledge precedes knowledge of meaning, at least for verb agreement morphology, and that only syntactic knowledge is required for children to begin using these forms in their spontaneous speech. In support of this possibility, recent work suggests that three-year-old children rely on grammatical number rather than notional number in sentence processing (Lukyanenko & Fisher, 2012).

Legendere et al. (in press) suggest that given the cross-linguistic patterns of data regarding early comprehension of verb agreement morphology, a cue salience/validity argument best explains the data. The findings presented here do not directly support this possibility. Legendere et al. (in press) base their argument on studies of English-speaking children's sensitivity to third person singular –s, which is clearly less salient and less reliable or valid than the liason-based subject verb agreement evaluated in French-speaking children. However, "is" and "are" are arguably much more salient even than the liason-based agreement marking in French, and certainly more salient than third person singular -s, as they are suppletive forms. Therefore, surface salience cannot account for children's lack of comprehension of "is" and "are". It is possible that cue validity is part of the story, however. It may be that children learning English ignore all verb information about number because verbs in English very rarely provide meaningful information about number. If cue validity plays a role in how children acquire knowledge of these morphemes, one would expect that for English, children would demonstrate knowledge of the verb morphemes marking tense before morphemes marking agreement, as tense information is more reliably conveyed on verbs than agreement. Of course, it is difficult to

tease these apart in English, because for so much of the tense/agreement system, morphemes carry *both* tense and agreement, and the system is sparse to begin with. However, some studies have examined children's sensitivity to verb morphemes in tasks where temporality, rather than number, is contrasted in the stimuli. These studies have found that children demonstrate knowledge of the meaning of –ed as a marker of past tense as well as "is V-ing" as marker of present tense (Wagner, Swensen, & Naigles, 2009; Beyer & Hudson Kam, 2009). Clearly more work is needed both in English, as well as cross-linguistically to evaluate the role of cue validity in acquisition of verb morphology. The findings of the current study may be consistent with a view point that cue validity in the abstract (i.e. the validity of verbs generally), rather than with regards to a particular surface form, plays a role in the acquisition of knowledge about these forms.

Conclusions and Future Directions

To summarize, this study provides evidence that two-year-old children comprehend number morphology on nouns and use this information in sentence interpretation. However, two-year-old children did not show comprehension of verb morphology, specifically "is" and "are," nor did the presence of verb morphology provide any added benefit in sentence interpretation. The data reported here may support the possibility that young children acquire syntactic knowledge before acquiring form-to-meaning mappings, although future work is needed to confirm that the null findings reported here were not due to a methodological flaw in the verbal prompts. The data reported here do not directly support the possibility that surface salience of cues predicts whether young children will comprehend a given cue. It remains possible however, that abstract cue validity (i.e. validity of verb information compared to noun information

generally) may play a role in when children are able to use particular morphemes for sentence interpretation.

With regard to the relationships between production abilities and comprehension abilities, no clear patterns emerged other than a complete lack of relationship. These data leave open the possibility that production proficiency develops on a separate trajectory from comprehension of form-to-meaning mapping. This could be consistent with the perspective that production proficiency is related to syntactic knowledge and not semantic knowledge, at least for the morphemes involved in number agreement in English. This possibility requires further study.

Two avenues for future work have already been proposed: a follow-up study to test knowledge of "are" using the manual search task, as well as work examining the role of cue validity in acquisition of verb morphology. Another direction for future work lies in examining knowledge of third person singular –s using the manual search task. Given that much of the recent work on knowledge of subject verb agreement in young children has focused on the third person singular –s morpheme, such a study has the potential to contribute important information about knowledge of that form. Early pilot work suggested that manipulating third person singular –s was too subtle for two-year-old children. However, many of the children tested during the pilot phase were between 24-30 months. It is possible that with a slightly older age group testing this morpheme would be more feasible. Considering the findings of Legendere et al. (in press), and the possibility that the looking time method was not ideal for tapping this knowledge, it seems important that a follow-up study on knowledge of third person singular –s is conducted using a different methodology. Given the success of the manual search task in tapping knowledge of number morphology on nouns, it is a natural next step to assess knowledge of third person singular –s using the manual search task.

In conclusion, this study contributes new information not only to the ongoing debate about the nature of very young children's knowledge of agreement morphology on verbs, but also to our understanding of children's comprehension of noun agreement morphology. The findings presented here motivate several follow-up investigations that have the potential to further clarify our understanding of how this component of the grammar develops during the third year of life.

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Appendix A

Manual Search Task Experimental Scripts

GROUPS 1 & 3- AMBIGUOUS

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1- Ambiguous Fish

I am going to put the fish in my box! I am going to put the fish in my box. Here I go! [1 fish in]

[With box at eye level] ***Wow! I put the fish in my box! I put the fish in my box!*** [Move box toward child]

Can you reach?

Once child retrieves the fish immediately have the child put in into the bowl.

10 second search period

Experimenter shrugs shoulders.

Trial 2-Ambiguous Sheep

I am going to put the sheep in my box! I am going to put the sheep in my box. Here I go! [1 sheep in]

[With box at eye level] ***Wow! I put the sheep in my box! I put the sheep in my box!*** [Move box toward child]

Can you reach?

Once child retrieves the sheep immediately have the child put in into the bowl.

10 second search period

Experimenter shrugs shoulders.

GROUPS 1 & 3- VERB ONLY

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Singular Sheep

Hmmm… what will I hide? Oh! Here is the sheep! Here is the sheep! [1 sheep in]

[box at eye-level] ***Wow! Here is the sheep in my box! Here is the sheep in my box!*** [move box to child]

Can you reach? [place sheep in bowl]

10 second search period

Trial 2-Plural Fish

Hmmm… what will I hide? Oh! Here are the fish! Here are the fish! [1 fish in]

[box at eye-level] ***Wow! Here are the fish in my box! Here are the fish in my box!*** [move box to child]

Can you reach? [place fish in bowl]

10 second search period. [Silently retrieve 2nd fish]

Trial 3-Plural Sheep

Hmmm… what will I hide? Oh! Here are the sheep! Here are the sheep! [1 sheep in]

[box at eye-level] ***Wow! Here are the sheep in my box! Here are the sheep in my box!*** box to child]

Can you reach? [place sheep in bowl]

10 second search period. [Silently retrieve 2nd sheep]

Trial 4-Singular Fish

Hmmm… what will I hide? Oh! Here is the fish! Here is the fish! [1 fish in]

[box at eye-level] ***Wow! Here is the fish in my box! Here is the fish in my box!*** [move box to child]

Can you reach? [place fish in bowl]

10 second search period

GROUPS 1 & 3-NOUN ONLY

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Plural Spoon

I am going to put the spoons in my box! I am going to put the spoons in my box! Here I go! [1 spoon in] [box at eye-level] ***Wow! I put the spoons in my box! I put the spoons in my box!*** [move box to child]

Can you reach? [place spoon in bowl]

10 second search period. [Silently retrieve 2nd spoon]

Trial 2-Singular Duck

I am going to put the duck in my box! I am going to put the duck in my box! Here I go! [1 duck in] [box at eye-level] ***Wow! I put the duck in my box! I put the duck in my box!*** [move box to child]

Can you reach? [place duck in bowl]

10 second search period.

Trial 2-Singular Spoon

I am going to put the spoon in my box! I am going to put the spoon in my box! Here I go! [1 spoon in] [box at eye-level] ***Wow! I put the spoon in my box! I put the spoon in my box!*** [move box to child]

Can you reach? [place spoon in bowl]

10 second search period.

Trial 1-Plural Ducks

I am going to put the ducks in my box! I am going to put the ducks in my box! Here I go! [1 duck in] [box at eye-level] ***Wow! I put the ducks in my box! I put the ducks in my box!*** [move box to child]

Can you reach? [place duck in bowl]

10 second search period. [Silently retrieve 2nd duck]

GROUPS 1 & 3- NOUN & VERB

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Singular Frog

Hmmm... what will I hide in the box? [1 frog in]

[box at eye-level] ***Wow! Here is the frog in my box! Here is the frog in my box!*** [move box to child]

Can you reach? [place frog in bowl]

10 second search period.

Trial 2-Plural Shoes

Hmmm… what will I hide in the box? [1 shoe in]

[box at eye-level] ***Wow! Here are the shoes in my box! Here are the shoes in my box!*** [box to child]

Can you reach? [place shoe in bowl]

10 second search period. [Silently retrieve 2nd shoe]

Trial 3-Plural Frogs

Hmmm… what will I hide in the box? [1 frog in]

[box at eye-level] ***Wow! Here are the frogs in my box! Here are the frogs in my box!*** [box to child]

Can you reach? [place frog in bowl]

10 second search period. [Silently retrieve 2nd frog]

Trial 1-Singular Shoe

Hmmm… what will I hide in the box? [1 shoe in]

[box at eye-level] ***Wow! Here is the shoe in my box! Here is the shoe in my box!*** [move box to child]

Can you reach? [place shoe in bowl]

10 second search period

GROUPS 2 & 4- AMBIGUOUS

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Ambiguous Sheep

I am going to put the sheep in my box! I am going to put the sheep in my box. Here I go! [1 sheep in] [With box at eye level] ***Wow! I put the sheep in my box! I put the sheep in my box!*** [Move box toward child]

Can you reach?

Once child retrieves the sheep immediately have the child put in into the bowl.

10 second search period

Experimenter shrugs shoulders.

Trial 2- Ambiguous Fish

I am going to put the fish in my box! I am going to put the fish in my box. Here I go! [1 fish in] [With box at eye level] ***Wow! I put the fish in my box! I put the fish in my box!*** [Move box toward child]

Can you reach?

Once child retrieves the fish immediately have the child put in into the bowl.

10 second search period

Experimenter shrugs shoulders.

GROUPS 2 & 4- VERB ONLY

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Plural Sheep

Hmmm… what will I hide? Oh! Here are the sheep! Here are the sheep! [1 sheep in]

[box at eye-level] ***Wow! Here are the sheep in my box! Here are the sheep in my box!*** box to child]

Can you reach? [place sheep in bowl]

10 second search period. [Silently retrieve 2nd sheep]

Trial 2-Singular Fish

Hmmm… what will I hide? Oh! Here is the fish! Here is the fish! [1 fish in]

[box at eye-level] ***Wow! Here is the fish in my box! Here is the fish in my box!*** [move box to child]

Can you reach? [place fish in bowl]

10 second search period

Trial 3-Singular Sheep

Hmmm… what will I hide? Oh! Here is the sheep! Here is the sheep! [1 sheep in]

[box at eye-level] ***Wow! Here is the sheep in my box! Here is the sheep in my box!*** [move box to child]

Can you reach? [place sheep in bowl]

10 second search period

Trial 4-Plural Fish

Hmmm… what will I hide? Oh! Here are the fish! Here are the fish! [1 fish in]

[box at eye-level] ***Wow! Here are the fish in my box! Here are the fish in my box!*** [move box to child]

Can you reach? [place fish in bowl]

10 second search period. [Silently retrieve 2nd fish]

GROUPS 2 & 4-NOUN ONLY

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Singular Spoon

I am going to put the spoon in my box! I am going to put the spoon in my box! Here I go! [1 spoon in] [box at eye-level] ***Wow! I put the spoon in my box! I put the spoon in my box!*** [move box to child]

Can you reach? [place spoon in bowl]

10 second search period.

Trial 2-Plural Ducks

I am going to put the ducks in my box! I am going to put the ducks in my box! Here I go! [1 duck in] [box at eye-level] ***Wow! I put the ducks in my box! I put the ducks in my box!*** [move box to child]

Can you reach? [place duck in bowl]

10 second search period. [Silently retrieve 2nd duck]

Trial 3-Plural Spoon

I am going to put the spoons in my box! I am going to put the spoons in my box! Here I go! [1 spoon in] [box at eye-level] ***Wow! I put the spoons in my box! I put the spoons in my box!*** [move box to child]

Can you reach? [place spoon in bowl]

10 second search period. [Silently retrieve 2nd spoon]

Trial 4-Singular Duck

I am going to put the duck in my box! I am going to put the duck in my box! Here I go! [1 duck in] [box at eye-level] ***Wow! I put the duck in my box! I put the duck in my box!*** [move box to child]

Can you reach? [place duck in bowl]

10 second search period.

GROUPS 2 & 4- NOUN & VERB

Familiarization 1 (same for all conditions)

What's in my box? Can you reach?

When child retrieves ball, move bowl toward child and have him/her drop it in. If child does not immediately drop it in, take toy from child and place in bowl.

10 second search period

That time I only put one toy into the box. No more toys in there!

Familiarization 2 (same for all conditions)

Now I am going to hide two toys in my box. [Out of view, place two blocks in box]

Can you get the toys for me?

10 second search period

If child does not continue to search after retrieving the first object: ***That time I put two toys into the box! Keep looking for the other one!*** Continue until child retrieves both blocks.

Great you found both blocks! In our game, sometimes I will put one toy **[hold up one finger]** ***in the box and sometimes I will put two toys*** **[hold up two fingers]** ***in the box. Let's get started.***

Trial 1-Plural Frogs

Hmmm… what will I hide in the box? [1 frog in]

[box at eye-level] ***Wow! Here are the frogs in my box! Here are the frogs in my box!*** [box to child]

Can you reach? [place frog in bowl]

10 second search period. [Silently retrieve 2nd frog]

Trial 2-Singular Shoe

Hmmm… what will I hide in the box? [1 shoe in]

[box at eye-level] ***Wow! Here is the shoe in my box! Here is the shoe in my box!*** [move box to child]

Can you reach? [place shoe in bowl]

10 second search period

Trial 3-Singular Frog

Hmmm… what will I hide in the box? [1 frog in]

[box at eye-level] ***Wow! Here is the frog in my box! Here is the frog in my box!*** [move box to child]

Can you reach? [place frog in bowl]

10 second search period.

Trial 4-Plural Shoes

Hmmm… what will I hide in the box? [1 shoe in]

[box at eye-level] ***Wow! Here are the shoes in my box! Here are the shoes in my box!*** [box to child]

Can you reach? [place shoe in bowl]

10 second search period. [Silently retrieve 2nd shoe]

Appendix B

Semi-structured Picture Book Activity Prompts

1. Look! This cat's sleeping. Tell me about these cats.
2. These cats are black. Tell me about this cat.
3. This dog's black. Tell me about these.
4. The dogs are playing. What about this one?
5. These frogs are yellow. What about this one?
6. This one's swimming. What about these?
7. These goats are babies. What about this one?
8. This goat is walking. Tell me about these ones.
9. These cows are black and white. What about this one?
10. This cow is tired. Tell me about these cows.
11. This duck is in the water. What about these?
12. These ducks are babies. Tell me about this one.
13. These bugs are on the leaf. What about this one?
14. This bug is red. What about these?
15. This bird is flying. Tell me about these.
16. These birds are little. What about this one?
17. This horse is running. Tell me about these.
18. These horses are white. Tell me about this one.
19. These pigs are messy. Tell me about this one.
20. This pig is hungry. What about these?

Appendix C

Imitation Task Items

1. Kitty is small.
2. Bears are big.
3. Joe is happy.
4. Mary is sad.
5. Bird is here.
6. Bugs are there.
7. These are red.
8. Those are blue.
9. This frog is there.
10. These frogs are here.
11. These kids are asleep.
12. These kids are awake.
13. The girl is happy.
14. The boys are sad.
15. The cat is black.
16. The dog is brown.

Appendix D

Parent Questionnaire

Please circle the sentence in each pair that sounds the most like something your child would say:

1. Bear hungry Bear is hungry

2. Those cats eating Those cats are eating

3. Mommy happy Mommy is happy

4. The baby crying The baby is crying

5. My cars driving My cars are driving

6. These boots red These boots are red