Can 20- and 24-months-old Children Detect Subject-Verb Dependency?

by

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Abstract

This study examined English-acquiring 20- and 24-month-olds' ability to detect subject-verb dependency. Twenty-four-month-olds showed a significant preference for grammatical sentences over ungrammatical sentences in which ungrammaticality was cued by a pairing of a singular subject with the verb "are" but not when it was cued by a pairing of a plural subject with the verb "is". However, 20-month-olds did not show a preference in either condition. Another group of 20-month-olds were examined on their ability to detect a non-adjacent dependency in which a prepositional phrase was inserted in between the dependent elements. They showed no preference for either the grammatical sentences or the ungrammatical sentences. The result of this study revealed that it is not until about 24-months that children acquire an understanding of the structural properties of the relationship between the subject and the verb "to be" and this knowledge at first is limited to a singular subject. This suggests that not all dependencies are acquired by 24-months and the acquisition of a dependency is also contingent on the particular form of the dependent elements involved. Children's ability to detect different dependencies emerges at different ages of development.

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Acquiring a language is one of the first challenges children encounter when they come into this world. In order to learn a language, a child must be able to segment the different sounds they hear into words, figure out what the words mean, and learn how the different words relate to one another. When we think about the complexity of the language system, this should not be an easy task, yet children seem to accomplish this feat with relative ease. By the age of 2, they are typically able to string two to three words together to form simple utterances.

One of the main components of learning a language is to discover the structure of the language. To form a sentence, words are put together and these strings of words in a sentence are not completely independent to one another. The particular form that a word takes may depend on the other words in the sentence. Also, only certain word orders are permissible, and the meaning of the sentence depends on the word order. Word order and inflection are two ways in which dependency is reflected. One crucial step for acquiring the structure or syntax of a language is to be able to track these dependencies between the elements in a sentence. The focus of this paper is on the dependency component of grammar. The purpose of the present study is to examine whether infants are able to detect the subject-verb dependency. Will children show any difference in listening time between grammatical sentences such as *The dog **is** good/The dog**s** **are** good* and ungrammatical sentences like *The dog **are** good* (singular subject with a verb in the plural form)/*The dog**s** **is** good* (plural subject with a verb in the singular form)? In English and in many other languages, the particular form that a verb takes must be in agreement with the subject in number (i.e. singular or plural).

In Experiment 1, 20-months-old children were tested on their ability to detect the dependency when the subject and verb were adjacent to one another. In Experiment 2, a prepositional phrase was inserted in between the subject and the verb and 20-months-old

children were tested on their ability to detect this type of non-adjacent dependency. To test whether an older age group can detect the subject-verb dependency, a third experiment was performed. In Experiment 3, 24-months-old children were examined on their ability to detect the adjacent subject-verb dependency.

Language production vs. Language comprehension

Children's early acquisition of grammar begins long before they are able to display it productively. There is a great deal of evidence that children's syntactic comprehension exceeds their production. Shipley, Smith and Gleitman (1969) first provided evidence of this in their study looking at children at the telegraphic stage, who had just begun putting two or three words together. They gave 18-33 months old children verbal instructions that varied in syntax and content. Children showed a difference in response to different syntactic structures varying in syntactic complexity even when the semantic content was the same. In this study, syntactic structures were either well-formed commands such as *Throw me the ball* or telegraphic commands, where the function words were eliminated, such as *Throw ball*. The children who are still at the telegraphic stage obeyed more frequently the well-formed commands than commands consisting of one or two words. They demonstrated that they were able to distinguish between different speech forms and they followed the well-formed commands, which they have yet to use in their own speech, better than commands that they actually use in their own speech. This study revealed that young children at the telegraphic stage are showing sensitivity to more complex syntactic structure than what they are capable of producing. Since then multiple studies (e.g. Kemler Nelson, Jusczyk, Mandel, Myers, Turk & Gerke, 1995; Santelman & Jusczyk, 1998) have supported that children's early comprehension precedes production.

Most of the research in language development has been dedicated to children's language production. This greater concentration on children's productive language development has led to a relatively limited knowledge about preverbal children. Thus, less is known about children's early understanding of structural properties that are necessary to form grammatical sentences. In order to gain a coherent picture of the language acquisition process, it is essential to look at children's early understanding of the structure of their language. A child's language production may be limited by a number of factors such as their inability to articulate certain sounds, limitations in processing and lack of motivation to speak.

The Headturn Preference Procedure

One reason for the lack of research in children's early comprehension is due to the difficulty in experimentally testing what young children understand, since they are not yet capable of expressing what they know and do not know. In recent years, a new method known as the Headturn Preference Procedure (HPP) has emerged (Kemler Nelson et al., 1995) that allows researchers to examine children's early perceptual knowledge. In the HPP, the auditory stimulus is contingent to a visual stimulus such that the child's attention to the auditory stimulus (listening time) is measured by the length of time their head is turned toward that visual stimulus (looking time). Santelmann and Jusczyk (1998) adopted the HPP in their study and were the first to examine children's early detection of dependency. To test the infants' detection of the dependency, they compared their listening preference for the grammatical passages and the ungrammatical passages. The rationale is that if infants are able to detect the dependency they would listen longer to the more familiar grammatical sentence structure over the ungrammatical sentence structure. They found that 18-month-olds but not 15- month-olds were able to detect the dependency between the auxiliary *is* and the suffix ending *-ing*. This study provided support

that children begin acquiring the structure of their language long before they start producing sentences that contain dependencies. In the present study, a different dependent relationship, the dependency between the subject noun and the verb "to be", was investigated using the HPP.

The HPP used to study children's preference in natural languages suggests that children should prefer the stimuli that are more familiar to them and therefore, they should prefer the grammatical sentences over the ungrammatical sentences. Children's preference for familiar over novel stimuli is influenced by a combination of factors including the age of the child, the amount of exposure to the stimuli and the complexity of the stimuli. Young children begin by preferring familiar stimuli, but if they are exposed to a stimulus long enough, they will habituate to it, leading to a preference for the novel stimulus as demonstrated by many habituation studies with children. Hunter, Ames and Koopman (1983) suggest that the complexity of the stimuli must also be taken into account on the examination of children's stimuli preference. They propose that a complex stimulus due to having more information takes longer to process, therefore, when a child is exposed to a familiar stimulus without being habituated to it they should still maintain a strong interest in it and thus would continue preferring the familiar stimulus. This suggestion that complexity plays an important role in children's interest is supported by evidence from habituation studies on visual attention which show that children take longer to habituate to a more complex pattern compared than to a simpler pattern (Cohen, DeLoache & Rissman, 1975, Martin, 1975). Natural languages are considered to have a high degree of complexity compared to stimuli of other types (e.g. artificial languages and visual stimuli) and from previous HPP studies using natural languages (e.g. Hohle, Schmitz, Santelmann & Weissenborn, 2006; Santelmann & Jusczyk, 1998) children have shown a preference for the familiar stimuli. Thus, if

children can detect a dependency in a natural language, it should be expected that they would prefer the grammatical sentences over the unfamiliar, ungrammatical sentences.

The Relationship between Functional Markers and Structure

Languages can express syntactic structures, or in other words, provide information about how the different components in a sentence relate to one another, in a number of ways. For example, languages can use word order, inflectional morphology (e.g. suffix ending *-ing*) or prosody (intonation and rhythm) or a combination of any of these. Many of the languages in the world use word order to mark syntactic structures (e.g. English, Japanese, Turkish, Korean, Hindi). English is a language that depends heavily on word orders. For example, the sentence *The dog chases the cat* follows the usual subject-verb-object relations order. Switching the order of the words would yield an entirely different meaning for the sentence (e.g. *The cat chases the dog*). English sometimes also uses prosody to mark the syntactic structure of a sentence. Prosody is defined as the rhythm, stress and intonation of speech. For example, changing the intonation of a declarative sentence without changing the words in English can result in a sentence being interpreted as a question. In a sentence such as *He gave her the ball* when express in a neutral tone is a declarative sentence. However, if the sentence is express with a rising intonation on the end, the sentence would then be perceived as a question (*He gave her the ball?*)

By contrast, English lacks prosody and the complex morphology which characterizes many other languages in the world. English rarely use prosodic features to distinguish meanings. Other languages such as Mandarin and some African languages are tonal languages in which different tones (changing the pitch of a sound) are used to discriminate different words. In English, however, when a word is produced in a different tone, a majority of the time the meaning of the word stays the same. The sentences in English also tend to be constructed from

words composed of single morphemes unlike languages with a more complex morphological system. A morpheme is characterized as the smallest meaningful unit of a language. English contains very few inflectional affixes to provide information about the relations of the different words in the sentences. In the example given above, *The dog chases the cat*, there are no inflections attached to either of the nouns to provide information about which noun is the subject or object in the sentence. However, this is not to say that inflections do not play any role in English. For example, the inflection -s inserted after the stem of a noun indicates a plural and the absence of an -s inflection in most cases indicates that the noun is singular. German, on the other hand, is a language rich in morphology. For example in German, there are three grammatical genders (masculine, feminine, and neutral), two numbers (singular and plural) and four cases (nominative, accusative, genitive, and dative).

Although inflections in English are less common than in other languages, they play a rather important role in signaling some dependency relationships. Inflections are grouped under the category of functional morphemes which differ from content words. Content words have lexical meaning (e.g. nouns, verbs, adjectives and adverbs) whereas the purpose of functional morphemes (e.g. prepositions: *in, at*; conjunctions: *and, but*; determiners: *the, a*; auxiliaries: *have*, *could*; and inflectional morphemes: *-ing, -s*) is to express the relations among words in a sentence. Functional morphemes, by serving to express the relations among words, provide the structure for sentences and may play a significant role in the early stages of language acquisition.

The acquisition of grammar is heavily dependent on functional morphemes as shown in studies involving adults learning an artificial language (Morgan & Newport, 1981; Valian & Coulson, 1988). Recent evidence suggests that infants at a relatively young age are sensitive to

functional morphemes which may imply that functional morphemes serve an important role in early syntax acquisition (Shady, 1996; Shi, Werker & Cutler, 2006 Soderstrom, White, Conwell and Morgan, 2007).

Functional morphemes may also be important in aiding children to identify content words categories. Mintz (2003) suggests that *frequent frames*, two jointly occurring words separated by exactly one word, are used as a basis for the acquisition of grammatical categories. Some examples of frequent word frames would be *you_ it*, *the_ one*, and *the_ is.* Mintz examined how informative frequent frames are in categorizing words through a distributional analysis of six corpora from the CHILDES database of the adult utterances, and he found that frequent frames were extremely effective at categorizing words. Infants and adults are sensitive to frame-like units. Mintz's study (2002) showed that adults used distributional properties in an artificial language to form categories of words. The pair of function words, "the_is", used in the proposed study is one of the most frequent word frames in English. Shi and Lepage (2008) found that 8-month-olds acquiring the French language use frequent functional morphemes to segment potential word forms but not infrequent functional morphemes. This is similar to English-learning 13 month-olds using the frequent functor *the* to segment adjacent nouns (Shi, Cutler, Werker & Cruickshank, 2006).

Theories of grammar acquisition

There are two opposing views of on how children acquire grammar. On one side, there are the nativists, who believe that children are born with an innate knowledge of abstract syntactic structures, suggesting that children also possess adult-like linguistic competence. This continuity assumption of grammar acquisition was first introduced by Chomsky (1965) and later developed further by other nativist theorists such as Pinker. Pinker and Prince (1988) propose

that children's grammar is largely rule-based, drawing from the same basic unit types and abstract symbols as those of adults. More extreme theorists even go as far as suggesting that children possess full linguistic competence with a complete system of syntactic representation (Atkinson, 1982). The belief that language skills are largely innate is driven by children's early linguistic abilities and their creativity in producing sentences that they have never been exposed to.

An alternative view that challenges the nativist theory was one that was led by the empiricists, who believe that children acquire language through learning from the environment. B.F. Skinner was one of the most influential empiricist theorists. Language acquisition, according to Skinner (1957), like all other aspects of psychology, is a behavior learned via reinforcement and conditioning. Throughout the years, the attention to both theories has swung back and forth. In the 1990's, the empiricists' view was championed by Rumelhart and McClelland (1986). They suggest that grammar is learned from emergent properties of the input rather than based on abstract structural representation. Recent data supports this alternative view as it provides evidence that children's early language is more item-based and that it is not solely based on abstract representation.

Tomasello (2000), an empiricist, argues that children's lack of productivity and creativity weakens the continuity assumption. From Lieven, Pine and Baldwin's observational study (1997), it has been shown that children's production of verbs often comes from their first 25 lexically based patterns. Lexically based patterns are positional patterns in which a constant item occurs in a constant position relative to variable items it is combined with (e.g. I want X, It's a Y). However, this point by Tomasello has been contradicted by recent studies. Conwell and Demuth (2007) demonstrated that three-year-olds know that a sentence like "I pilked the cup to

Petey" has the same meaning as the sentence "I pilked Petey the cup". Children displayed a productive knowledge of the English dative alternation in the study even though they have not heard the novel verb being used in that form previously.

Tomasello also noted that morphological markings such as past tense were found to be very uneven across verbs, supporting an item-based nature that characterizes children's early language. Cross-linguistic studies have also provided support for this view. In a study of Italian-learning, Pizzuto and Cazelli (1992) found that 47 percent of all the verbs used by the children were of one form only although there are six possible verb forms in Italian (first person singular, first person plural, etc.). Other studies in other languages such as German and Spanish (Behrens, 1998; Gathecole et al, 1999) have also found similar results. This suggests that children may learn some verbs and their forms individually rather than abstracting other forms when they learn a verb in one form. This supports the view that children's early acquisition of syntax is built around particular items and utterances rather than on the basis of general underlying rules and abstract categories.

Arguing against the continuity assumption, Tomasello (2000) instead proposed that a usage-based model is better at accounting for children's early acquisition of syntax. This model suggests that children's language is derived early on from specific linguistic expressions that they are exposed to, and it is not until later on that they begin using their general cognitive and socio-cognitive skills to form categories and schemas and creative utterances by combining the acquired expressions and structures.

In a response to Tomasello's paper, Fisher (2002) suggests that Tomasello's interpretation of the data requires some assumptions: 1). When infants form a verb category, they should be willing to use any new verb in any sentence form 2). Infants are not using the word

due only to the lack of understanding of the syntax 3). Infants interpret any new verbs as transitive verbs. Although Tomasello's data may support item-based learning, it requires multiple assumptions. Fisher believes that although children do not yet have adult syntactic competence, abstract knowledge of sentence structure does play an important role in early language acquisition along with item-based learning.

In the present study, children were exposed to sentences that they would not have heard before in the same sentence context. Therefore, children in the study are expected to have some abstract knowledge. They have to apply their knowledge about syntactic properties of subjects and verbs in order to detect the dependency. There has been some evidence from studies that young preverbal children do have abstract syntactic knowledge. For example, Gertner, Fisher and Eisengart (2006) showed that children at as young as 21-months were able to use word order to interpret transitive sentences containing novel verbs.

Evidence from artificial grammar

One recent approach that has been adopted in studying infants' learning mechanism is to use artificial grammars. An advantage of testing infant's learning mechanism with an artificial grammar is that it allows for more control of the learning environment and less influence of prior knowledge. Infants are not tested on their memories of grammatical strings from their native language. Instead they have to be able to generalize the strings they hear to the structure that they just learned. Due to the complexity of the natural language environment, investigators testing on natural languages cannot control the infant's prior knowledge or know what the prior knowledge is completely. Therefore, unlike natural languages, artificial grammar can more easily identify the factors involved in language learning because it can eliminate the influence of prior knowledge.

One study using artificial grammar to explore infants' learning mechanism was done by Gomez and Gerken (1999). They used a finite state grammar to create a set of grammar syllable sequences, for example, *VOT PEL PEL PEL JIC*. They then compared chldren's listening preferences to these strings with strings in which the first and the last syllable had switched places creating the illegal endpoints, for example, *JIC PEL PEL PEL VOT* (which did not exist in the grammar). Children were exposed to the artificial grammar for only 2 minutes before the testing began. They preferred listening to the grammatical strings that followed the structure of the artificial grammar over the ungrammatical strings that violated it. For example, infants in the study preferred listening to the grammatical string *VOT PEL PEL PEL JIC* over the ungrammatical string *JIC PEL PEL PEL VOT* where *JIC* and *VOT* have switched positions. Gomez and Gerken's study showed that infants as young as 12-months were able to generalize the structure they learned from the artificial grammar to new syllables. They argue that infants use statistical learning mechanism to processing first-order dependencies and long distance dependency. However this learning mechanism cannot be bound to specific word pairs; rather it must extend to some degree of abstraction of the structure as well. Since infants were exposed to strings consisting of different items than the ones they heard during familiarization, they must have gained an abstract knowledge about the structure of the grammar to be able to apply what they learn as grammatical to these new strings consisting of different items.

Gomez (2002) examined 18-month-olds' ability to detect nonadjacent dependencies using artificial grammar. She created sentences that followed the patterns *aXc* or *bXd* in one version of the grammar and sentences that followed the patterns *aXd* or *bXc* in a counterbalanced version. X was the set of intervening variables between the two dependent elements ($a \mid b$ *and* $c \mid d$) thus, creating non-adjacent dependencies. Gomez also manipulated the size of the set of the

intervening variables of which she drew those variables from. She found that infants were better at detecting the nonadjacent dependency when there is a higher variability for the intervening variables. Gomez attributed this interesting finding to the possibility that the high variability in the larger set set-size increase the salience of the dependent elements which assisted the infants in the detection of the dependent relation.

In another study involving artificial grammar by Gomez and Lakusta (2004), 12-months-old infants were exposed to an artificial language consisting of grammatical categories: *a, b, X,* and *Y* (*X* being bisyllabic and *Y* being monosyllabic words) with *aX* and *bY* patterns. They were later able to generalized these patterns to novel strings of *X* (bisyllabic) following *a* and *Y* (monosyllabic) following *b*. For example during familiarization, they would hear the *a* items *alt* and *ush* paired with two-syllable words (e.g. *alt coomo*, *ush loga*) and the *b* items *ong* and *erd* paired with one syllable words (e.g. *erd deech*, *ong jic*). Then, during the test trials, they would hear the same *a*- and *b*-words (*alt, ush, ong* and *erd*,) which were now paired with novel *X* and *Y* words. An *a* item such as *alt* followed by an *X* item (bisyllabic) such as *fengle* would be grammatically correct according to the artificial grammar and similarly, a *b* item such as *ong* followed by a *Y* item (monosyllabic) such as *ghope,* would also be grammatical according to the artificial grammar. This study suggests that infants first learn by recognizing the co-occurrence relationships between functional elements and categories characterized by abstract features. After that, learners can form categories of functional elements based on the co-occurrence relationships to lexical ones. Infant's ability to generate form-based categories in artificial grammar may suggest that infants used a similar mechanism for grouping grammatical categories in natural languages in the early stages of language acquisition.

Content vs. Functional Morphemes

As mentioned previously, children's early understanding of syntax is not accurately reflected in their language production. A number of studies (e.g. Kemler Nelson et al., 1995; Santelmann & Jusczyk, 1998; Shipley et al., 1969) have shown us that their understanding of syntax exceeds what they are able to string together and say.

The order of acquisition of different aspects of the grammar in the domains of child production and perception also varies. For example, children seem to be sensitive to function words at a much earlier age than production would show. Earlier studies have shown that the first word-combinations produced by young English speaking children (two- to three-years-old) do not include systematic marking of subject-verb agreement (Brown, 1973; de Villiers & de Villiers, 1973) but perceptual studies have revealed that children are sensitive to the *–s* inflection on the verb in relation to a third person singular noun at a much earlier age (Soderstrom et. al, 2007). Infants preferred grammatical sentence such as *The boy reads every night from a new book* over the ungrammatical equivalent *The boy read every night from a new books*.

Shady (1996, as cited in Soderstrom et al., 2007) provided evidence that 16-month-olds can detect the order and distributional properties of function words that are often involved in dependency relationships. The positions of the function words were interchanged and infants preferred sentences where the functional words morphemes are in the appropriate locations. For example, infants listened longer to sentences such as "*the* large cake *is* baking" than to ungrammatical sentences where there functional morphemes are not in their proper locations such "*is* large cake *the* baking".

These perceptual studies provide evidence that infants are quite sensitive to the grammatical proprieties of function words in comparison to their knowledge about the properties of content words. Since research shows that infants' understanding of function words generally

precede that of content words, this may suggest that function words aid in the acquisition of the syntactic properties of content words, even though in children's language production, we see the opposite pattern where content words are produced first and children often omit functional morphemes in their utterances.

Early precursors to syntax acquisition

Past studies (Santelmann and Jusczyk, 1998; Sodestrom et al., 2007) have shown that children at a very young age have already begun the process of acquiring syntactic knowledge. In order to acquire syntax though, children must possess some necessary perceptual skills that assist them through the process.

Newborn born infants tested at 3-days old were able to distinguish function words from content words (Shi, Werker & Morgan, 1999). In this habituation study, the difference between lists of lexical and grammatical words was more perceptually salient to the infants compared to two different lists of words from the same category. So for example, infants would be more sensitive to the difference between the lexical word *taste* and the grammatical word *in* than the difference between the lexical word *taste* and another lexical word such as *play.* This suggests that infants at a very young age have already begun to attend to the acoustic and phonological cues to perceptually differentiate two fundamental grammatical categories. Children's ability to form categories across lexical items would be important part of learning the dependencies themselves.

Similarly, children would also need to be able to parse out the dependent elements in the sentence to detect the dependency. It has been shown that at the age of 7.5-months, English-learning children can segment word forms from sentences (Jusczyk and Aslin, 1995). In the study, half the infants were exposed to passages containing the target words *cup* and *dog* in the

familiarization phase and the other half were exposed to passages containing the target words *bike* and *feet.* In the testing trials of the experiment infants showed a familiarity preference. Infants that were preexposed to target words *cup* and *dog* listened significantly longer to the passages containing those words and similarly, infants that were preexposed to target words *bike* and *feet* listened significantly longer to the passages containing those words.

Subject-verb Dependency

The present study focuses on the subject-verb dependency, or the agreement relationship between a subject and its verb. This dependency relationship is common across many of the world's languages. About three-quarters of the world's languages have some sort of subject-verb agreement (Mallinson & Blake, 1981). Furthermore, the subject-verb relationship is a key component of the basic syntactic structure of sentences in most linguistic theories.

To encode a subject-verb agreement according to Generative Grammar, a child has to relate the subject and its verb, identify the features of the subject such as person and number, and mark the features onto the verb. The noun in the subject position of a sentence typically has the semantic role of an agent, which is the person/thing performing the action. In English, in most cases, the subject immediately precedes the verb and it also controls the subject-verb agreement. For non-pronoun, regular nouns, the absence and presence of the inflection *–s* indicates if the subject is singular or plural. Although the actual process of acquiring a subject-verb agreement may not be exactly identical to the view of the linguistic theory described above, in order to show sensitivity to the grammatical relationship, children must be performing this analysis at some level.

The subject-verb agreement used in our study involves the verb "to be" which can either be an auxiliary verb or a main verb (as a copula) of a sentence. Based on the Oxford English

Corpus (Fellbaum, 1990), this verb is one of the most frequent words found in writing. In our study, the present tense of *to be* was used as the copula of a sentence. An example would be, "The cow is cute". Unlike most other verbs, where the number agreement with the subject is simply marked by the presence or absence of an inflection *–s* at the end of the word, the verb "to be" requires additional changes to the stem of the word. In singular form "to be" transforms to "is" and in plural form, "to be" transforms to "are". Therefore, it might be expected that this dependency relationship would be especially salient for infants.

Singular vs. Plural Distinction

The present study examining children's detection of subject-verb dependency involves a singular vs. plural distinction. Most languages make a distinction between one entity and multiple entities in the singular and plural morphology of nouns (Chierchia, 1998) and they do so in a variety of ways. In English and many other languages, verbs must agree in number with their subjects. For example, in English the number marking can be encoded onto the determiner of a noun phrase (NP): *This moose* vs. *These moose* or on a pronoun: *I* vs. *We*. However, in this case we explore a third, more common, option, the regular plural marking on the noun itself (e.g. dog vs. dog**s**). Note that the marking on the noun is in a dependent relationship with the verb that follows it: *The dog* **is** *barking* vs. *The dog**s** **are** barking*.

In the present investigation of children's ability to detect the subject-verb dependency, one question that may follow is: if infants can dissociate between singular sentences and plural sentences does it also mean they can understand the singular-plural distinction conceptually? For example, can they understand that dog means there is only one dog present, whereas dogs means that there are more than one dog present? According to Soderstrom (2007), there is a necessary distinction between early perceptual grammatical knowledge (i.e. being able to

differentiate perceptually between “dog” and “dogs”) in a grammatical context and later semantic comprehension. It is important to keep in mind that the present study only examines children’s perception of the subject-verb dependency and does not speak to children’s comprehension of what they are hearing.

Studies of children’s productive use of plural find significant errors as late as 6 years old (Berko, 1958; Anisfeld & Tucker, 1968). In terms of children’s understanding of the plural marking, there is conflicting evidence. Some studies fail to find any support of the notion that children have a semantic understanding of the plural marker –s by the end of the second year (e.g. Feigenson & Carey, 2005), while others (Brown, 1973; Mervis & Johnson, 1991) have found evidence that children have some sort of knowledge of plurals around age two. Zapf and Smith (2009) found that children, long before they start producing plurals regularly, already possess the knowledge that English has singular and plural forms and that they are related. In the study, they presented two–year-olds with one kind and its label and then were either presented with two of the same kind (A⟶AA) or the initial kind and a different thing (A⟶AB). The children were then asked “What do you see?’. The children who were presented with AB as the following presentation gave the singular form of A but children who were presented with AA rarely gave the singular form of A. They either gave the correct plural response, no comment or some other comment. Although, this does not necessarily mean they understand semantically what singular and plural forms means, it does show infants know the distinction exists.

At the present, while there is still some controversy about whether infants younger than 5 years old can understand the semantics of the sentences they are exposed to, there is good reason to think that 20 month-olds’ understanding of structural properties are emerging.

Infants’ Detection of Dependent Relations

In recent years, a number of perceptual studies have shown that children can detect different dependencies at a relatively young age. These studies have also identified some factors that can affect infants' detection of dependency.

Factor 1: Distance

The first studies done to explore infants' knowledge about dependency and in particular, non-adjacent dependency is by Santelmann and Jusczyk (1998). They examined 15 and 18 months old infants' ability to detect to the dependent relationship between the auxiliary verb *is* and the verb ending *–ing*. An example of a test sentence would be *Everybody is baking bread*. For this study, they adopted the Headturn Preference Procedure (HPP) which I will be describing in more details in the method section. They created grammatical passages using the morphemes *is* and *–ing* and ungrammatical passages using the modal *can* and the verb ending *–ing*. The result of the study showed that 18-month olds but not 15-month-olds were able to detect the dependency between the auxiliary verb *is* and the verb ending *–ing*.

The other part of the study examined the effect of distance between dependent elements on infants' ability to detect the dependency. Adverbials of different lengths were inserted between the dependent morphemes increasing the distance between the morphemes. For example, the sentence in the first part of the study *Everybody is baking bread* (one syllable between dependent morphemes) would become *Everybody is often baking bread* (two syllables) and *Everybody is cheerfully baking bread* (four syllables). Eighteen-months-old infants showed preference for the grammatical sentences but only over a limited domain of one to three syllables. Santelmann and Jusczyk suggest that the results provide evidence that 18-month olds are working with a limited processing window.

Factor 2: The particular lexical items involved in the dependency relationship

In addition to the distance between morphemes, infants' sensitivity to dependent relationships is also affected by the particular lexical items involved in the relationship. Tincoff, Santelmann and Jusczyk (2000) examined the dependency between the verb ending –ing and alternative auxiliary forms: *is, was, are,* and *were (is and –ing vs. can and –ing; are and –ing vs. will and –ing; was and –ing vs. could and –ing; were and –ing vs. would and –ing).* They found that 18-month olds showed sensitivity only to the dependencies with *is* and *was* but showed no sensitivity to the dependencies with *are* and *were*. Tincoff et al. suggest frequency as a potential factor that may partially explain the results. The analysis showed that *is* was the most frequent form of *be* followed by *are* while *was* and *were* forms were far less frequent in comparison. The two most common occurrences of the *be* form with the verb ending *–ing* were also *is* and *are*. Given this analysis, frequency alone cannot fully explain the results of the study. However, Tincoff et al. suggest that the combination of the frequency of the grammatical and ungrammatical form is important. The modal verbs used for comparison (as the ungrammatical sentences) may have contributed to the pattern of the results. For example, perhaps the *are/will* comparison led to a decreased in preference for the *are* and *–ing* dependency.

Van Heugten and Johnson (2010) using the Headturn Preference Procedure found that Dutch-learning 24-month-olds but not 17-month-olds were able to detect the dependency between the definite article *het* and the diminutive suffix *–je*. However, the 24-month-olds were unable to detect the dependency between the definite article *de* and the plural suffix *-en*. Van Heugten et al. attribute their results to the distributional statistics in children's input with support from a corpus analysis. From their analysis, they found that the distributional properties of diminutive and plural dependencies differed substantially. The relative frequency of grammatical versus ungrammatical dependencies was found to be higher for diminutives than for plurals.

Factor 3: The intervening materials

Hohle et al. (2006) tested German 19-20 months old infants' ability to recognize the dependency between the auxiliary *haben 'have'* and the past participle form of the main verb over an intervening material. They found that infants acquiring German were not able to track dependencies when an adverb of 2 syllables is inserted. However, the infants were able to track the dependency when the inserted intervening material was a bisyllabic noun phrases, containing a definite article and a noun, for example, 'the ball'.

Hohle et al. argue that adverbs block the recognition of the verbal dependency in the German-learning infants but not English-learning infants in the study by Santelmann and Jusczyk (1998). One reason could be that in English most adverbs are formed with the suffix *–ly* and this suffix may have assisted the infants in recognizing the adverb and thus, helped them to track the dependency. In contrast, German has no marking on adverbs. Results from this study, therefore, suggest the analyzability of the intervening elements may contribute to the infants' ability to establish a relation between the dependent elements. The presence of a determiner in the sentence helps the child to assign a structure to this string of words, which in turn might support the recognition of dependent relationships within this string.

Dependency at 16-months-old: -s Inflection and other factors

A study by Soderstrom et al. (2007) provided evidence for the recognition of dependency at a younger age than studies previously have found. In their study, they examined different factors as possible cues to infants' detection of grammaticality including content word order and inflectional properties. They found that content word order did not play a role in 16-month-old infants' detection of grammatical sentence. On the other hand, 16-month-old infants showed sensitivity to inflectional properties. They preferred sentences such as *They used to sing in these*

chairs on the porch over ungrammatical sentences where the inflection was misplaced **They used to sings in these chair on the porch.* Soderstrom et al. suggest that the findings showing infants sensitivity to functional morphemes (-*s* inflection) emerging before their sensitivity to content word order implies that infants when they first begin to acquire grammar rely on functional morphemes to help build the grammatical structure. They also found that 16-month-old infants were sensitive to appropriate placement of –*s* inflection on highly familiar nouns and verbs when adjacent to function words (e.g. determiners), but not when the target content words were not adjacent to function words. The results of this study show that functional morpheme plays an important role in infants' early acquisition of structural properties.

Soderstrom et al. also demonstrated that the familiarity of the stem word in which the dependent morpheme is attached to plays a role in children's detection of dependency. Sixteen-month-olds were not able to detect the –*s* inflection violation when nonce stem words were used but they were able to when the –*s* inflection was placed instead on highly familiar nouns and verbs.

Cross-linguistic Comparisons and Different Dependencies

Aside from English, dependency detection in young children has also been studied in several other languages, including German, French and Dutch. Comparisons in the acquisition of dependency between different languages can reveal possible universal features in language acquisition as well as cross-linguistic differences.

As previously mentioned, Hohle et al.'s study (2006) examined the ability of infants to detect dependency in German-acquiring infants. Subject-verb agreement in English is very similar to subject-verb agreement in German. The German language, though, is very rich in morphology which allows greater flexibility in word order. Words in different order can have

the same meaning since the inflections alone can provide the information about the participants and their respective roles in a given event. On the other hand, the meaning of the sentences in the English language is quite dependent on the word order. Due to the freer word order, German allows a greater distance between discontinuous dependent morphemes.

A study mentioned earlier by van Heugten and Johnson (2010) on dependency was done on the acquisition of the Dutch language. They found that 24-month-olds were able to detect the definite article *het* and the diminutive suffix *–je.* This provides evidence that children acquiring a language aside from German and English by 24-months-old are also able to detect dependencies.

Infants' detection of dependency has also been explored in French-acquiring infants. Legendre, Goyet, Barriere, Kresh and Nazzi (2010) examined French infants' (14 months-old, 18-months-old, 24-months-old) ability to detect subject-verb non-adjacent dependency. They were interested in particular to the relationship between the singular/plural marking on the determiner and the verb ending. An example of a singular subject-verb and plural subject-verb agreement from the study would be ***le*** *garçon* ***fait*** *le vippe* and ***les*** *garçons* ***font*** *le vippe*. They found that 18-month-olds and 24-month-olds but not 14-month-olds preferred the grammatical passages over the ungrammatical passages. Their study expands on the findings of the previous studies in two ways. First, it is looking a language for which there are no prior studies of infant knowledge of dependencies. Notably, the infants acquiring the English, German and French are able to detect syntactic dependencies at around a fairly similar age (18-19 months). Second, Legendre et al. explores a different dependency than the previously mentioned studies. The dependency between the subject and the verb ending in French is more complex compared to the one found in English. This study is of particular interest since it was examining the same kind of dependency (subject-verb) as the one the present study is looking at. However, French has a

highly irregular verb morphology system. These differences must be taken into account when comparing between languages. Having a more complex verb morphology system might require more processing to detect a subject-verb dependency than a language with a simpler verb morphology system.

Legendre et al. suggest that their results supports that infants form abstract categories. According to them, infants form two abstract categories in their study. For example, category A (le + noun ; met) and category B (les + noun ; mettent). They also suggest that those infants must also possess the knowledge that the NP must match in category with the verb. Therefore, they conclude that infants rather than learning grammar on an item-based fashion, infants proceed by forming abstract categories early on. They then detect the dependencies not by examining the frequencies of the co-occurrence of the dependent elements but by matching the categories. This view is consistent with that of the Generative theorists in which grammar acquisition is based on forming symbolic and abstract representation. However, Legendre et al. notes that the abstract categories infants form at this stage lack semantic content. Children at as old as 24-months do not yet have an understanding of number (singular vs. plural). French acquiring infants are not able to comprehend the semantic content of singular vs. plural until 30-months-old (Legendre, Barriere, Goyet & Nazzi, 2010).

The Present Study

To sum up, previous studies have shown that English-acquiring infants by the age of 18 months are able to detect certain dependencies. At 16 months, infants can detect the verbal inflection *–s* in the relationship between the subject and the verb when preceding adjacent function words (Soderstrom et al, 2007). At 18 months, they can detect the dependency between the auxiliary verb is and the verb ending –ing up to a limited distance of three syllables in

between (Santelmann & Jusczyk, 1998). Infants can also detect the relationship between the auxiliary verb *was* and the verb ending *–ing* (Tincoff et al, 2000). Children's dependency detection has been found in a number of different languages. However, these studies do not provide much information about how they acquire these dependencies. Specifically, we do not know whether the ability to acquire such dependencies is part of a more general learning mechanism of syntactic structure. One way to know more about the learning mechanism involved is to explore different dependencies.

This study expands on the previous research. First, it examines a dependency relationship that has not previously been studied in English-learning infants – the subject-copula (the verb "to be") dependency. Second, this particular dependency also involves the distinction between singular and plural. Previous studies in English have not examined this type of subject-verb agreement. Children's semantic distinction of singular-plural is achieved relatively late and they do not always produce the plural form in all required contexts. Therefore, it is interesting to see if children's perception of the singular-plural subject-noun dependency also emerges late in language acquisition. In total, three experiments were run. Experiment 1 explores children's ability to detect the subject-verb dependency. Experiment 2 is motivated by Santelmann and Jusczyk's study exploring the effect of distance on children's detection of a dependency. Experiment 3 examines whether 24-month-olds can detect the dependency.

Experiment 1

Experiment 1 examined 20-months-old infants' ability to detect the subject-verb dependency in which the subject and verb was adjacent to each other. If 20-month-olds are able to detect the subject-verb dependency, they should show a preference for the grammatical

sentences over the ungrammatical sentences. Their preference was measured by their looking time towards the monitor playing the sentences.

Method

Participants: There were 3 main exclusion criteria: 1). Exposure to English less than 90% of their language input experience 2). Significant cognitive deficits or physical deficits that would impair their ability to participate in the study 3). Prematurity: children who were born earlier than 37 weeks gestation.

In addition, children were excluded if they were overly fussy or squirmy. Extreme fussiness and squirminess were defined as when a baby cries, fusses and/or moves around excessively and therefore, they were either not on task or difficult to code making the data unreliable. The decision to include or exclude a child's data in borderline cases were made on the judgment of the experimenter who was coding a child's head turn prior to examining the data for that child to avoid biasing the results. In the case of extreme fussiness or crying, the procedure was terminated as a reflection of the child's dissent from participation. The partial data were not included in these cases.

The infants were recruited primarily through a letter sent out with the help of Manitoba Health. Infants were randomly selected to receive the mailing from an electronic list created from provincial health records, based on age of child and location. Our laboratory did not directly access these records, and the mailing was sent out via a third party. Parents interested in participating or more information were requested to contact the laboratory directly. In addition, posters were put up in various community centers, libraries and medical offices in Winnipeg, again requesting the parents to contact the lab. Contact information and child information (the date of birth, any known cognitive deficits, prematurity, exposure to any other languages and

siblings) would then be collected to evaluate if they are eligible for the study and set up the appointment if so. For every 400 letters sent out, approximately, 20-30 parents would contact the lab.

A total of 32 infants participated in Experiment 1. In the singular noun condition, there were nine boys and seven girls with an approximate age of 20 months +/- 15 days (*M*age = 607 days, *SD*age = 10 days, age range; 592 – 625 days. In the plural noun condition, there were eight boys and eight girls with an approximate age of 20 months +/- 15 days (*M*age = 610 days, *SD*age = 11 days, age range; 595 – 625 days). Each child received a toy or book for their participation chosen by their parent.

The data for an additional 10 infants were excluded from the analysis. Six of them were excluded due to fussiness or squirminess, two of them were excluded due to technical problems, one due to prematurity and another one due to having greater than 10 percent of another language in his language input experience.

Stimuli

A 25-year-old female graduate student at the University of Manitoba who was unaware of the purpose of the study was asked to do the recording. She was born and raised in Winnipeg. Her first language is Canadian English.

The recording was done using an Audio-technica AT2020 USB microphone and the free software program Audacity (Version 1.2.6). The recording was done in the lab. The only instruction the speaker was given was to read the singular version of the sentences four times and the plural version of the sentences four times with an infant-directed speech. The first recording session of the stimuli had to be discarded due to the fast tempo in which the sentences were

produced. We asked her to come in again to redo them in a slower tempo. All the sentences were recorded with the prepositional phrase included.

There were four versions of each sentence: singular grammatical, plural grammatical, singular ungrammatical (singular noun phrase with a plural auxiliary) and plural grammatical (plural noun phrase with a singular auxiliary). The same sentences (concerning the same lexical items) were used for all four versions of the passages. In order to create the four matched versions of the sentences, the singular noun phrase, the plural noun phrase, the predicate containing *is,* the predicate containing *are* and the prepositional phrase were cross-spliced with each other as described below. Cross-splicing was done to equate the grammatical and ungrammatical versions as closely as possible on length and prosody.

There were 48 sentences containing different nouns and adjectives. These sentences were chosen to be consistent with stimuli being used in a parallel study being conducted by Barbara Hohle at the University of Potsdam, using the same sentence forms in both English and German. The 48 sentences were then ordered into eight passages consisting of six sentences each (see Appendix A). The test sentences did not include the prepositional phrase. These different phrases were all taken from different recording tokens for each sentence. This was done to avoid creating any artifacts that may result due to having the speaker produce ungrammatical sentences. Each sentence consisted of a subject noun phrase (two syllables) and a predicate (two syllables) allowing the dependent morphemes (the plural noun and the auxiliary “is” or “are”) to be adjacent to each other.

Four orders of the passages were created (see Appendix B) in order to counterbalance the presentation of grammatical and ungrammatical passages. The same four sets of ordering were used for the singular version and the plural version of the passages. Each child had 16 test trials

(two matched versions of the eight grammatical and ungrammatical passages). There were two practice trials prior to the test trials for the child to learn the association between looking and the sound being played. The music in the practice trials was a clip of classical music by Mozart.

For example:

Singular-grammatical: [The cow]1 [is cute]2

Singular-plural : [The cow]1 [are cute]3

Plural-grammatical: [The cows]4 [are cute]3

Plural-singular: [The cows]4 [is cute]2

Each number indicates a particular token (so token "1" is taken from a different recording of the singular grammatical sentence than token "2"). Each sentence was therefore created from two different tokens. The particular tokens were chosen to match the prosody and length of the grammatical and ungrammatical sentences as closely as possible. Silence was also added to some of the tokens to make the two types of sentences more similar.

The average length for the singular grammatical (Singular NP + *is* predicate) and ungrammatical sentences (Singular NP + *are* predicate) were 2.48 s (range = 2.04 s – 3.15 s) and 2.48 s (range = 2.04 s – 3.02 s) respectively. The average length for the plural grammatical (Plural NP + *are* predicate) and ungrammatical sentences (Plural NP + *is* predicate) were 2.52 s (range = 1.97 s – 3.02 s) and 2.52 s (range = 2.11 s – 3.06 s) respectively.

In between each sentence of a passage a 900 ms pause was inserted. The average passage lengths for the singular grammatical and ungrammatical were 19.36 s (range = 18.83 s – 19.85 s) and 19.36 (range = 18.50 s – 19.89 s) respectively. The average lengths for the plural

grammatical and ungrammatical version without the prepositional phrase were 19.62 s (range = 18.88 s – 20.18 s) and 19.62 s (range = 18.97 s – 20.13 s) respectively.

Apparatus

This study employed a version of the Head Turn Preference procedure to measure the child's interest (Kemler Nelson et al., 1995).The experiment was run on a Windows XP computer using the Multiscreen Headturn Preference Procedure software (Version 1.1.0.31) created by Dr. James Morgan of Brown University which was designed for infant audiovisual perceptual studies.

The parent and the child were in a testing room separate from the control room that the experimenter was in. In the testing room, the only visible objects were a chair where the parent was seated with the child on his/her lap and three monitors. One monitor was approximately 2 ft directly in front of the child and the other two monitors were on the right and left side at 90 degrees angle and approximately 1.5 ft away from the child. Below each monitor there was a camera mounted on the wall to capture the child's head movements. On each monitor there was a speaker where the sound was outputted. The lighting in the room was set to the low light level to eliminate any potential distraction.

In the control room, there was one computer that ran the software program. Another monitor was connected to the camera in the centre in the testing room to display the child's behavior so that the experimenter can code the child's head turn preference (the side cameras were not used for this procedure). A separate computer was also used to play the masking music that the parents were listening to in the testing room.

Procedure

Each child came into the lab once and participated in one session. There were two groups of infants. One group listened to singular subject nouns paired with singular (grammatical) and plural (ungrammatical) verb phrases. The other group listened to plural subjects paired with singular (ungrammatical) and plural (grammatical) verb phrases. They were presented with one of the four orders of presentation. The same set of passages was used for each child.

When they parents arrived at the lab, they were greeted in the waiting room and a consent form was given to them. The experimenter then explained the procedure of the experiment and answered any questions that the parents may have. The parents were told not to interact with their child during the study and to try to avoid adjusting or moving their child when the sound is being played. The experimenter told them that they will be wearing aviator headphone and listening to masking music so that they do not accidentally influence their child during the study. They were also informed that they had the option to terminate the experiment at any time. Once the parents agreed to participate, they were asked to sign the consent form. The child and one of the parents were then taken to the testing room and the parent was instructed to sit on the chair with the child on his/her lap and to put on the headphone.

The experimenter then returned to the control room to start the experiment. In order to avoid observer bias, the experimenter could not hear the sentences being played in the testing room

Before each trial, a yellow circle would flash on the front screen to attract the attention of the child and to have the child orient to the front. Once the child looked at it, the experiment would indicate this via a click on the mouse to the computer and the front screen would go blank. Next, the yellow circle would then appear on one of the side monitors (chosen at random by the computer). When the child made a 90 degree turn toward the monitor with the yellow circle, the

experimenter would indicate this via a click on the mouse to the computer and the screen would then display a colourful checkerboard and the sound would begin to play. The experimenter would continue to press on to the mouse button for as long as the child was looking at the monitor with the checkerboard and would release the mouse key immediately whenever the child looked away from the screen. If the child looked away for less than two seconds and looked back the trial continued, but the portion of time the infant was not looking was not counted in the measure. If the child looked for less than two seconds total on a trial, the trial was repeated. This ensured that the child was able to listen to at least one entire sentence. The dependent measures were the average number of seconds the infant looked toward the screen for each of the grammatical and ungrammatical trials.

After the completion of the study, the parent and the child were guided back to the greeting room and the experimenter would asked if they have any questions about the study. The parent was then given an information form on the child`s family environment to fill out. The information form contained questions such as the age of the parents, the parent`s experience with children, the age of siblings and the grandparents` involvement. It also asked the parents the same questions as when the research assistants first contacted them regarding the exclusion criteria.

Parents were then given a MacArthur-Bates Communicative Development Inventories Words and Sentences form (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993) to take home with them and were asked to mail the completed questionnaire back within the next couple of weeks. The questionnaire provides information on the child`s level of language development. Before they left the lab, the parents chose a toy or a book to take home with them for their child.

Looking times between the grammatical sentences and the ungrammatical sentences were compared. If children can detect the dependency, then they should show a preference for the grammatical sentences over the ungrammatical sentences.

Results

Table 1

Twenty-month-olds' Mean Looking Times for Grammatical and Ungrammatical Sentences in Adjacent Dependency

	Singular (n = 15)			Plural (n =15)		
Grammaticality	M (s)	SD (s)	range (s)	M (s)	SD (s)	range (s)
Grammatical	9.54	3.88	5.18 – 18.25	9.23	3.63	4.42 – 16.45
Ungrammatical	8.95	3.05	4.33 – 14.57	9.00	3.56	4.31 – 16.80
	p = 0.59			p = 0.69		

A 2 x 2 mixed analysis of variance (ANOVA) across the two conditions with one within-subject factor (grammaticality) and one between-subject factor (singular subject group vs. plural subject group) was conducted. There was no main effect of grammaticality, $F(1, 30) = 0.47$, $p = 0.50$ and there was no interaction between grammaticality and plurality condition, $F(1, 30) = 0.09$, $p = 0.76$. To examine the singular group and plural group individually, two planned t-tests were performed. The 2-tailed t-tests revealed that 20-month-olds did not show any listening preference for either the grammatical passages (M = 9.54 s , SD = 3.88 s) or the ungrammatical passages (M = 8.95 s , SD = 3.05 s) in the singular group, $t(15) = 0.56$, $p = 0.59$ and they did not show any preference for either the grammatical passages (M = 9.23 s , SD = 3.63 s) or the ungrammatical passages (M = 9.00 s , SD = 3.56 s) in the plural group, $t(15) = 0.41$, $p = 0.69$.

At 20-months-old, children have not yet acquired the subject-verb dependency, as they showed no preference for either grammatical or ungrammatical passages.

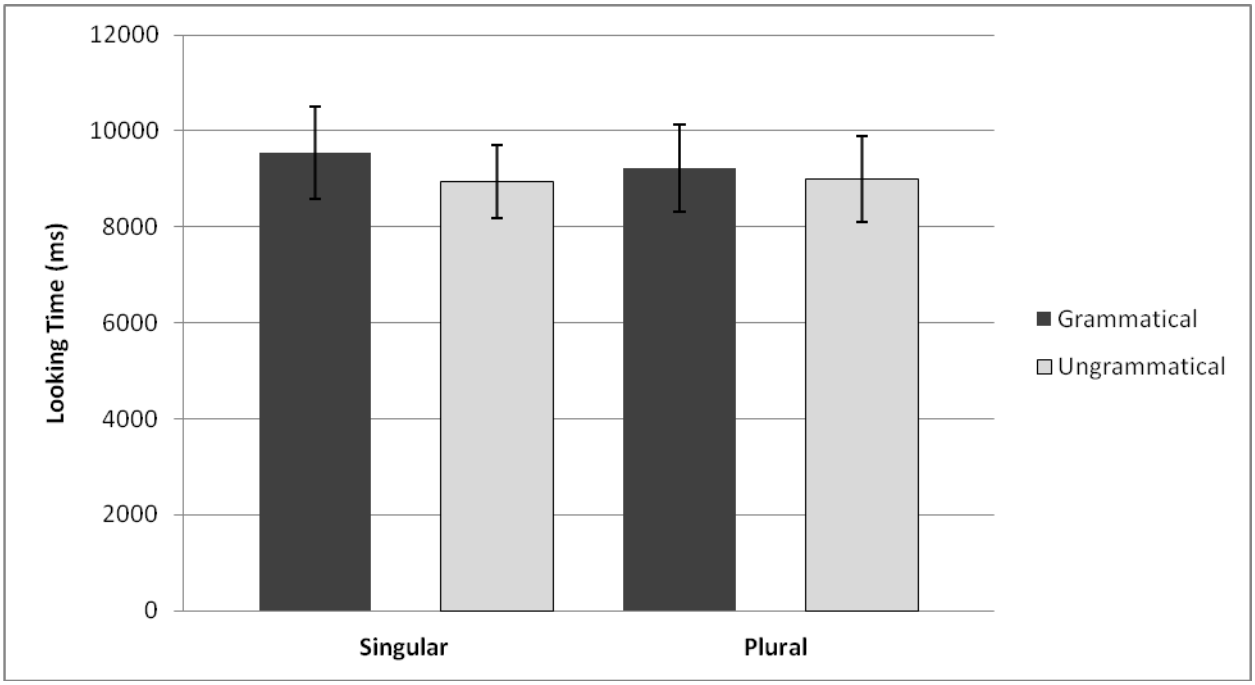

Figure 1: Mean looking time to grammatical and ungrammatical passages in singular and plural noun conditions in Experiment 1. Error bars are the standard errors of the mean.

In order to explore if language production affected the children's detection of the dependency in the study, children's MCDI vocabulary percentile scores were analyzed. A median split was done to divide half the children into a high language production group and the other half into a low language production group. However, parents whose children participated in the study did not all send back the MCDI's. Therefore, this part of the analysis was only done for those whose MCDI's were received. Of the 32 children who participated in Experiment 1, 22 of them sent back their MCDI's. Eleven of them (three boys and eight girls) were placed in the high production group and the remaining 11 were placed in the low production group (six boys and five girls). A 2 x 2 mixed ANOVA with one within-subject factor (grammaticality) and one between-subject factor (high vs. low language production score) revealed there was no

interaction between grammaticality and language production, $F(1, 20) = 0.34$, $p = 0.57$. An additional analysis was performed to explore the relationship between MCDI vocabulary percentile scores and grammaticality preference, with MCDI percentile scores and the difference score between grammatical and ungrammatical looking times as the bivariate variables. The analysis revealed a non-significant Pearson Correlation score of 0.18 ($p = .43$). Children who had a high language score did not differ in listening preference from children who had a low language score.

Discussion

There are a few possible reasons for infant's failed detection of the subject-verb dependency. First, we are looking at a dependency that has not been examined in English-speaking infants. Despite Soderstrom et al. (2007) finding evidence of dependency detection at the age as young as 16-months-old, the particular dependency examined may have a posed some difficulty for the child. It could be that the previous dependencies examined were more salient to the child. While the auxiliary "is" vs. "are" should be relatively salient, the absence and presence of the *–s* on the noun might haven difficult to detect.

Second, Hohle et al. (2006) found that the intervening materials can play a role in child's detection of a dependency; perhaps for this dependency children may need intervening materials to be able to detect the dependency. The addition of a prepositional phrase may assist the children in detecting the dependency since Soderstrom et al.'s study (2007) demonstrated that familiar content words play a role in children's ability to detect a dependency. It is possible that the appearance of a familiar content word in between the dependent elements allows the child to focus on the dependent elements by giving the child enough time to process the first dependent element before hearing the second dependent element thereby assisting the child to detect the

dependency. In Santelmann and Jusczyk's study, infants were able to detect the dependency despite having an intervening variable in between. However, in Hohle et al.'s study, German-speaking infants were not able to detect when an adverb of two syllables is inserted but they were able to track dependencies when the inserted intervening material was a bisyllabic noun phrases, containing a definite article and a noun. Hohle et al. suggested that in English the intervening adverb variable containing the structural marker *–ly* supported its processing and which helped the child recognized the dependent relationship and in German the article assisted the German-speaking children in recognizing the incoming noun and thereby, supporting the detection of the dependency.

Experiment 2

In Experiment 2, a prepositional phrase was inserted in between the dependent elements in which the subject and verb was now separated by four syllables. The prepositional phrase could possibly facilitate children's detection of the subject-verb dependency. First, the preposition is a familiar function word. Second, with four syllables in between the dependent elements, this may give the children enough time to process the first dependent element before the second dependent element is introduced.

Method

Participants: A total of 24 infants participated in Experiment 2. In the singular noun condition, there were five boys and seven girls with an approximate age of 20 months +/- 15 days (*M*age = 608 days, *SD*age = 11 days, age range; 596 – 626 days. In the plural noun condition, there were nine boys and three girls with an approximate age of 20 months +/- 15 days (*M*age = 608 days, *SD*age = 10 days, age range; 595 – 628 days. Each child received a toy or book for their participation chosen by their parent.

The data for an additional three infants were excluded from the analysis. Two of them were excluded due to fussiness or squirminess. One of them was excluded due to prematurity.

Stimuli

The only difference from Experiment 1 was that Experiment 2 contained test sentences which included the prepositional phrase. These different phrases were all taken from different recording tokens for each sentence. Each sentence was then consisted of a subject noun phrase (two syllables), a prepositional phrase (four syllables) and a predicate (two syllables) creating a nonadjacent dependency between the subject and the verb.

Singular-grammatical: [The cow]1 [in the meadow]5 [is cute]2
Singular-plural: [The cow]1 [in the meadow]5 [are cute]3
Plural-grammatical: [The cows]4 [in the meadow]5 [are cute]3
Plural-singular: [The cows]4 [in the meadow]5 [is cute]2

The average length for the singular grammatical and ungrammatical sentences with were 3.92 s (range = 3.18 s – 4.82 s) and 3.92 s (range = 3.23 s – 4.57 s) respectively. The average length for the plural grammatical and ungrammatical sentences 3.97 s (range = 3.28 s – 4.46 s) and 3.97 s (range = 3.23 s – 4.73 s) respectively.

In between each sentence of a passage a 900 ms pause was inserted. The average passage lengths for the singular grammatical and ungrammatical version with the prepositional phrase inserted were 28.04 s (range = 27.13 s – 29.13 s) and 28.03 s (range = 27.18 s – 29.18 s). The average passage lengths for the plural grammatical and ungrammatical version with the prepositional phrase inserted were 28.29 s (range = 27.5 s – 28.95 s) and 28.3 s (range = 27.33 s – 28.88 s) respectively.

The ordering of the 48 sentences into eight passages and the four orders of the eight passages was the same as Experiment 1. The same practice trials were also used.

Results

Table 2

Twenty-month-olds' Mean Looking Times for Grammatical and Ungrammatical Sentences in Non-Adjacent Dependency

	Singular (n = 12)			Plural (n =12)		
Grammaticality	M (s)	SD (s)	range (s)	M (s)	SD (s)	range (s)
Grammatical	8.12	3.76	4.35 – 16.45	10.20	6.62	3.79 – 22.00
Ungrammatical	8.81	2.54	5.81 – 13.62	9.11	4.48	4.33 – 16.82
	p = 0.43			p = 0.22		

A 2 x 2 mixed analysis of variance (ANOVA) across the two conditions with one within-subject factor (grammaticality) and one between-subject factor (singular subject group vs. plural subject group) was conducted. There was no main effect of grammaticality, $F(1, 22) = 0.12$, $p = 0.74$ and no effect of interaction between grammaticality and plurality condition, $F(1, 22) = 2.24$, $p = 0.15$. To examine the singular group and plural group individually, two planned t-tests were performed. The 2-tailed t-tests revealed that 20-month-olds in this non-adjacent dependency set up did not show any listening preference for either the grammatical passages (M = 8.12 s, SD = 3.76 s) or the ungrammatical passages (M = 8.81 s, SD = 2.54 s) in the singular group, $t(11) = 0.82$, $p = 0.43$ and they did not show any listening preference for either the grammatical passages (M = 10.20 s , SD = 6.62 s) or ungrammatical passages (M = 9.11 s, SD = 4.48 s) in the plural group $t(11) = 1.30$, $p = 0.22$. At 20-months-old, children have not yet

acquired the subject-verb non-adjacent dependency as they showed no preference for either grammatical or ungrammatical passages.

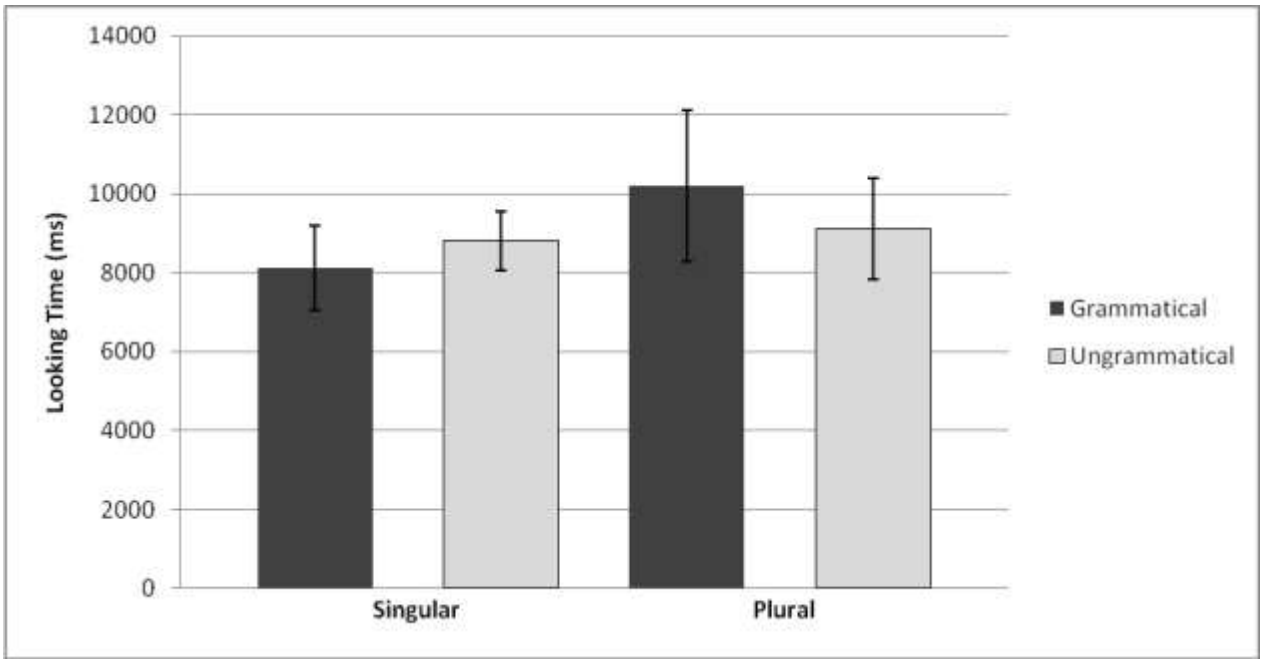

Figure 2: Mean looking time to grammatical and ungrammatical passages in singular and plural noun conditions in Experiment 2. Error bars are the standard errors of the mean.

Of the 24 children who participated in Experiment 2, 17 of them sent back their MCDI's. A median split was done to split in exactly the same way as Experiment 1. Nine children (four boys and five girls) were placed in the high production group and eight children were placed in the low production group (six boys and two girls). A 2 x 2 mixed ANOVA with one within-subject factor (grammaticality) and one between-subject factor (high vs. low language production score) revealed there was no interaction between grammaticality and language production, $F(1,15) = 3.53$, $p = 0.08$. An additional analysis was performed to explore the relationship between MCDI vocabulary percentile scores and grammaticality preference, with MCDI percentile scores and the difference score between grammatical and ungrammatical looking times as the bivariate variables. The analysis revealed a non-significant Pearson

Correlation score of 0.12 (p = .64). Children who had a high language score did not differ in listening preference from children who had a low language score.

Discussion

Experiment 1 and Experiment 2 suggest that at 20-months, children have not yet acquired the subject and the verb "to be" dependency with or without a prepositional phrase. Children's failure to detect a dependency in the first two experiments could be attributed to the children's young age. Perhaps, children have not developed the necessary cognitive capacities to process the subject-verb dependency. Their working memory may be too limited to process this particular dependency. Another possible factor is that at 20-months, children may not have enough language input and therefore, would hinder their ability to learn the dependency.

Experiment 3

In Experiment 3, an older age group, 24-month-olds, were tested in their ability to detect the subject and the verb "to be" dependency where the subject and the verb was adjacent to each other. The only difference between Experiment 1 and Experiment 3 was the age group tested. At 24-months, children will have more exposure to subject-verb dependency. Children are learning language at a rapid pace in the first couple of years so it would not be surprising that with a difference of only four months, children would be able to detect the dependency.

Method

Participants: A total of 32 infants participated in Experiment 3. In the singular noun condition, there were eight boys and eight girls with an approximate age of 24 months +/- 15 days (*M*age = 727 days, *SD*age = 11 days, age range; 712 – 744 days). Five of these children participated in Experiment 1 and three of them participated in Experiment 2. In the plural noun condition, there were eight boys and eight girls with an approximate age of 24 months +/- 15

days (*M*age = 729 days, *SD*age = 10 days, age range; 704 – 745 days). Six of these children participated in Experiment 1. Each child received a toy or book for their participation chosen by their parent.

The data for an additional seven infants were excluded from the study. Four of them were excluded due to fussiness or squirminess. One of them was excluded due to experimental error. Two of them were excluded due to prematurity.

Stimuli

The stimuli used were the same as Experiment 1.

Results

Table 3

Twenty-four-month-olds' Mean Looking Times for Grammatical and Ungrammatical Sentences in Adjacent Dependency

	Singular (n = 15)			Plural (n =15)		
Grammaticality	*M* (s)	*SD* (s)	range (s)	*M* (s)	*SD* (s)	range (s)
Grammatical	9.33	3.00	3.91 – 14.06	9.44	2.60	5.20 – 15.54
Ungrammatical	7.88	2.60	4.78 – 12.83	10.48	3.93	4.73 – 16.51
	p = 0.045			p = 0.26		

A 2 x 2 mixed analysis of variance (ANOVA) across the two conditions with one within-subject factor (grammaticality) and one between-subject factor (singular subject group vs. plural subject group) was conducted. There was no main effect of grammaticality, $F(1, 30) = 0.15$, $p = 0.70$ but there was a significant interaction, $F(1, 30) = 5.12$, $p = 0.03$. To examine the singular group and plural group individually, two planned t-tests were performed. The 2-tailed t-tests revealed that 24-month-olds listened longer to the grammatical passages (M = 9.33 s, SD = 3.0 s)

over ungrammatical passages (M = 7.88 s, SD = 2.60 s) in the singular group, $t(15) = 2.19$, $p = 0.045$, $d = 0.55$ but they did not show any listening preference for either the grammatical passages (M = 9.44 s, SD = 2.60 s) or the ungrammatical passages (M = 10.48 s, SD = 3.93 s) in the plural group $t(15) = 1.18$, $p = 0.26$. Twelve of the 16 children in the singular condition listened longer to the grammatical passages over the ungrammatical passages. At 24-months-old, children are beginning to acquire the subject-verb dependency as they were able to detect the dependency in the singular condition with an absence of *–s* inflection and the verb "is".

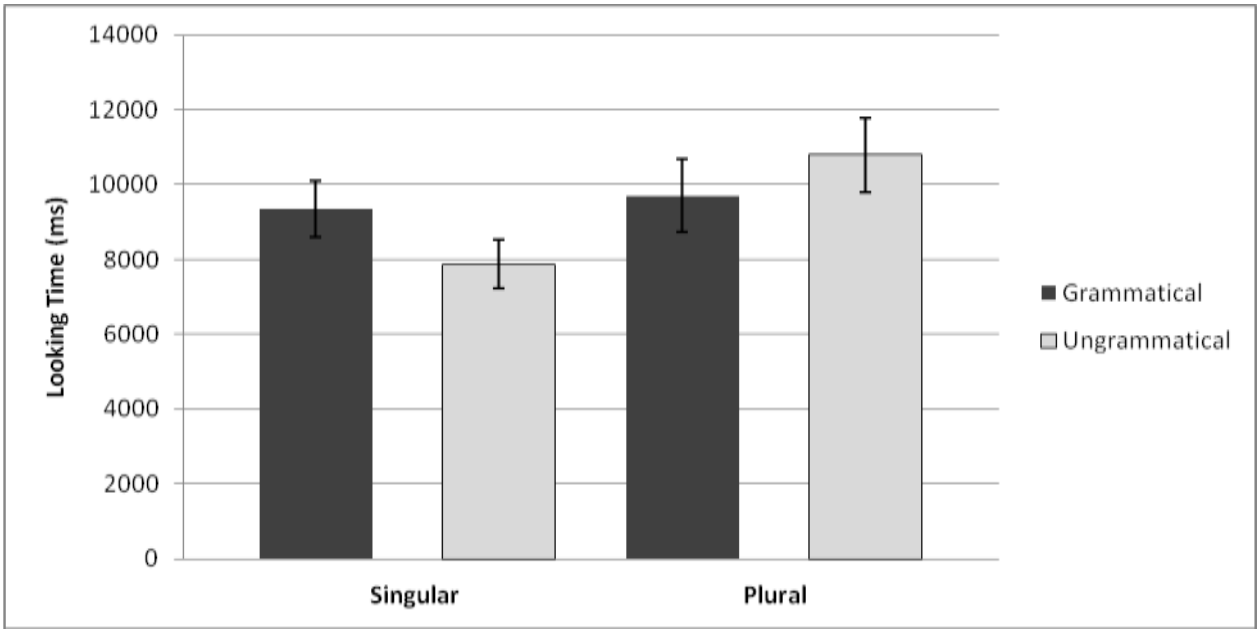

Figure 3: Mean looking time to grammatical and ungrammatical passages in singular and plural noun conditions in Experiment 3. Error bars are the standard errors of the mean.

Analysis for the singular and plural condition was done separately. For the singular condition, 10 children's MCDIs were received. Five children (three boys and two girls) were placed in the high language production group and five children (three boys and two girls) were placed in the low production group. A 2 x 2 mixed ANOVA with one within-subject factor (grammaticality) and one between-subject factor (high vs. low language production score) for the singular condition revealed there was no significant interaction between grammaticality and

language production, $F(1, 8) = 2.64$, $p = 0.14$. An additional analysis was performed to explore the relationship between MCDI vocabulary percentile scores and grammaticality preference with MCDI percentile scores and the difference score between grammatical and ungrammatical looking times as the bivariate variables. The analysis revealed a non-significant Pearson Correlation score of -0.48 ($p = .16$). For the plural condition, nine children's MCDIs were received. Five children (two boys and three girls) were placed in the high language production group and four children (two boys and two girls) were placed in the low production group. The 2 x 2 mixed ANOVA showed no significant interaction between grammaticality and language production for the plural condition, $F(1, 7) = 3.15$, $p = 0.12$. An additional analysis was performed to explore the relationship between MCDI vocabulary percentile scores and grammaticality preference with MCDI percentile scores and the difference score between grammatical and ungrammatical looking times as the bivariate variables. The analysis revealed a non-significant Pearson Correlation score of -0.53 ($p = .14$).

There were 14 children in Experiment 3 who had previously participated in either Experiment 1 or 2. Six of those children were in the plural condition and eight of the remaining children were in the singular condition In order to ensure previous participation did not interfere with the results of the data, a three-way ANOVA was conducted between grammaticality, plurality condition and if they had participated in other studies. The analysis revealed no significant interaction between all three factors, $F = 0.034$, $p = 0.86$. There was also no significant interaction between grammaticality and participation in other studies, $F = 0.01$, $p = 0.93$. Children in Experiment 3 who had previously participated in Experiment 1 or 2 did not show any difference in grammaticality preference compared to children who had not previously participated in those studies.

Discussion

The findings of Experiment 3 revealed that children can recognize the subject and the verb "to be" dependency but only for a certain form, the singular form "is" involving a singular subject and not the plural form "are" involving a plural subject. The results of this experiment with 24-month-olds being able to detect the singular "is" form and not the plural "are" form is to some degree similar to the findings of Tincoff et al. (2000). One potential factor could be the frequency of input of the forms. Tincoff et al. performed an analysis with mother to children (13-19 months) speech sample from the CHILDES database (MacWhinney, 1995), Bernstein-Ratner corpus (Bernstein-Ratner, 1984) and New England corpus (Ninio, Snow, Pan, & Rollins, 1994) and compared the frequency input of "is", "was', "are" and "were". They found that "is" was the most common in the analyzed speech. Children at this age may not have enough input of the plural form to learn the relationship concerning the verb "are".

On the other hand, Tincoff et al.'s analysis found that "are" was more frequent than "was", eighteen- month-olds in their study failed to detect the "are" and "-ing" dependency but were able to detect the "was" and "ing" dependency. Therefore, frequency input cannot be the only factor affecting children's detection of the dependency. They suggest that the ungrammatical pairing used in the study may have affected children's detection as well. Tincoff et al. used the ungrammatical *can* and *–ing* to pair with the grammatical *is* and *–ing* and they used the ungrammatical *will* and *–ing* to pair with the grammatical *are* and -ing. Children may have been more sensitive to the ungrammaticality of the *can* and *–ing* than *will* and *–ing* and if that is the case then that would have influenced the result of the data. Note though that unlike Tincoff's study, children heard both "is" and "are" in the experiments in the present study but it is still possible that the familiarity with "is" makes it more likely that children acquire the

singular noun form – verb agreement first. Some factor related to singular forms may make it easier to detect and it is possible that plural form requires a different level of processing that children at this age are not yet capable of doing. Perhaps the presence of an inflection on the plural noun form requires additional processing. Children might need more time to process the inflection but they are working with a limited processing capacity compared adults and therefore, failed to detect the dependency. Both of these factors (input frequency and limitations in cognitive processing) may play a role in detection of dependency although input frequency is the more likely factor affecting children's failure to detect the dependency involving the plural noun and the verb "are" in the present study.

The finding of the present study is also similar to some degree to the finding of Van Heugten and Johnson (2010). In their study, 24-month-old Dutch-acquiring children failed to detect the plural dependency between the definite article *het* and the plural word final *–en* but they were able to detect the dependency between the definite article *het* and the diminutive *-je.* This supports the view that the acquisition of a dependency is contingent to the particular form of the involved elements.

An interesting finding of this experiment is that it suggests that 24-month-olds may be able to detect an abstract dependency. For the twenty-four-month-olds to detect the singular noun "is" dependency, they had to be able to do this in the absence of an *–s* inflection. The singular noun does not have an explicit inflection (unlike the plural noun *–s*), so infants could not have been using such an explicit marker to detect the dependency relationship. Although the study by Soderstrom et al. (2007) show that inflections can assist children in the detection of a dependency, the result of the present study revealed that inflections do not necessarily have to be present. The ability to detect an abstract dependency may require a higher level of cognitive

processing than a dependency involving more concrete elements. This shows that children are capable of having abstract structural representations. Note that if the results of the study instead had shown that children were able to detect the dependency involving the plural noun and "are" but not the singular noun and "is", then it would have been possible that children were sensitive to the misplacements of inflections at a surface level, rather than showing sensitivity to the dependency itself.

Experiment 3 showed that the ability to detect the subject-verb dependency involving the "is" form of the verb "to be" emerges somewhere between the age of 20 and 24 months. Before that, children may not have enough experience with the particular dependency and therefore, failed to detect it at 20-months.

General Discussion

The present study showed that children at 20-months old were not able to detect the dependency between the subject and the verb "to be". At 24-months though, children were able to detect the dependency but limited to the singular form "is". At a similar age, in the Dutch study, Heugten and Johnson found that 24-month-olds but not 17-month-olds were able to detect the dependency between the definite article *het* and the diminutive suffix *–je*. The findings of the present study and the Dutch study with children's inability to detect the dependency at an early age deviates from the results some of the previous studies looking at children's early detection of dependencies. Previous studies show that young children are sensitive to dependent relationships long before they become advanced speakers of their language. For example, Soderstrom et al (2007) found that infants at 16 months were able to detect dependent relationships involving *-s* inflection. One possible explanation for this discrepant finding is that dependencies involving

different dependent elements do not all develop at the same time. Perhaps some aspects of subject-verb agreement make it more difficult to learn than others.

One possible reason might be that the violation of this dependency is not as salient as other dependencies. The *–s* inflection is subtle and listeners have a higher chance of not hearing it at all compared to other more salient dependent elements. Although Soderstrom et al.'s (2007) found that children were able to detect a dependency involving a *–s* inflection, half of their *–s* inflection was on the verb and half of their *–s* inflection was on the noun. Perhaps, having both made it easier to detect in some way. The familiarity and complexity of the sentence may possibly play a role as well. Soderstrom et al. also found that familiar content words play an important role in the detection of a dependency. Children failed to detect the *–s* inflection violation when it was placed on an unfamiliar noun or verb. The content words in the Soderstrom et al.'s study were chosen to be highly familiar to children; however, the content words employed in the present study were not chosen as such and were likely to be more unfamiliar to children. They can either have difficulty parsing unfamiliar nouns or it might be that they cannot detect dependencies involving unfamiliar words. If children do not recognize the unfamiliar noun as belonging to the category noun, then it would make parsing the *–s* on the noun more difficult. Another possibility is that they might have to allocate more resources to process the unfamiliar words which then might result in less attention and memory dedicated to detecting the dependency.

Another factor may be the frequency of the grammatical violation itself. It seems that adults rarely make the violations of dependencies such as the one that Santelmann and Jusczyk examined ("is" and "*–ing*" versus an ungrammatical pairing of "can" and "*-ing*"), therefore, if children hear that they will be more surprised. Violations of subject-verb agreement in number

agreement seem to be more common both orally and in writing. Often, the sentence structure can make the distance between the subject and the verb quite large which results in a more complex sentence. This could lead to cognitive overload and makes it more likely that adults makes the subject-verb number marking agreement error.

It has been documented that adults often make the subject-verb error when a noun phrase (local noun) separates the subject (head noun) and the verb (Bock & Miller, 1991; Vigliocco & Nicol, 1998). The error occurs when the head noun and the local noun does not agree in number with each other and adults make the error agreeing the verb with the noun that is closes to the verb rather than the head noun. An example of a subject-verb agreement error that Bock and Miller reported in their study is a sentence such as *The time for fun and games are over*. In the example, the verb *are* is incorrectly agreeing with the local noun *games* instead of the head noun *time.*

Franck, Vigliocco and Nicol (2002) showed that adults speaking English made this error more frequently when the syntactic distance is increased between the head noun and the local noun. This error has also been frequently found in other languages. Vigliocco and Hartsuiker (2002) found that working memory plays a role in the error of subject-verb agreement in the speech of Dutch speaking adults. Fayol, Largy and Lemaire (1994) found that working memory also affected adult's subject-verb agreement errors in writing. Both in Dutch and French, like in English, the verb must agree with the head noun rather than the local noun.

English speakers rely primarily on word order for information on sentence relation and therefore may have less attention dedicated to sentence agreement (Keeney & Wolfe, 1972; MacWhinney, Elizabeth Bates & Reinhold Kliegl, 1984). This may be a possible reason why English speakers make the common subject-verb agreement error.

While this study examined only the structural dependency aspect of the singular-plural distinction, it may be that the singular-plural distinction may generally be in language acquisition more difficult to acquire. In a study examining children's ability to map singular and plural markers in English onto the semantic distinction between singular and plural, Kouider, Halbreda, Wood and Carey (2006), found that 24-month-olds were able to look at the correct screen that is presenting the semantic singular-plural distinction only when number was marked on the verb, noun and the quantifier (e.g. "Look, there are some blickets"/ Look there is a blicket") and not when it is on the noun alone (e.g. "Look at the blicket"/ Look at the blickets"). This shows that children at this age require multiple cues in the syntax of a sentence to be able to make the distinction semantically between "is" and "are". Another study by Wood, Kouider and Carey (2009) also demonstrated children's awareness of a singular and plural form. Using a manual search paradigm, they found that 24 month-olds but not 20-month-old were able to show knowledge of the plurality when number marking was on the verb, quantifier and noun but not when the marking was on noun morphology alone. For example, they understand the semantic distinction between "There are some cars in the box" and "There is a car in the box" but not *cars vs car*. In another study, Keeney and Wolfe (1972) gave three to five-year-olds a pictorial test and they were presented with sentences such as 1). *The bird is singing* 2). *The birds are singing*. Keeney and Wolfe found that children in that age group could not tell the number of a sentence from the information (i.e. the meaning of singular and plural) contained in the verb inflection alone.

Since children have trouble conceptually identifying the singular-plural distinction without redundant markings in the syntactic structure of a sentence, this difficulty in singular-plural distinction may also be reflected in perceptually detecting it in syntax as well. A study by

Bernal, Lidz, Millotte and Christophe (2007) on 23-months-old French-learning children shows that syntax and semantic acquisition is closely linked. They presented children a moving object on a screen and they also taught them novel verbs within sentences that contained only functions words. They found that children were able to infer meaning (an action) to the verb by using the syntactic context of an unknown word.

Children also have difficulty producing the plural as late as four to seven-years-old. Berko (1958) presented children with a single novel object and labeled it "This is a wug" and then afterwards presented two of those novel objects and asked the children to provide the form. She found that even early school-age children failed to produce the plural form "wugs" in all the required contexts.

It may not be surprising then that 20-month-olds in the present study were not able to detect the dependency involving singular-plural marking. In Wood et al.'s study (2009), it was not until 36 months those children were able to successfully accomplish the task without the multiple cues marking number. Drawing from the results of the study, it can be concluded that language acquisition involving singular-plural seems to happen relatively late compared to other types of agreements in language.

The present study revealed that children at 20-months do not have the ability to detect the subject-verb dependency. However at 24-months, children were able to detect the dependency but only for the singular form. This suggests then that the acquisition of dependencies is acquired one at a time with subject-verb agreement evolving relatively late compared to other dependencies. Also, young children's knowledge of the relationships between morphemes is learned on a form-by-form basis. Early acquisition of dependencies is affected by frequency input and cognitive space. With the finding that 24-month-olds can only detect a subject-verb

dependency involving only the singular subject, the present study seems to support the empiricist view that language is acquired early on from the input of the environment. However, the findings can also be interpreted as due to brain maturation. More specifically, children at 20-months of age were not able to detect the dependency, possibly due to having a limited processing capacity. Twenty-four-month-olds' failure to detect the dependency involving the plural subject may also be attributed to having a limited processing capacity. Perhaps, plural subjects required additional processing compared to singular subjects. It seems more likely though that the frequency of *is* in children's language input had a greater impact on the results of the findings. It would be interesting to see when the detection of the plural form emerges. Future studies can examine other types of dependencies in English and in other languages.

Appendix A

A List of the Sentence Ordering

Passage 1

The egg inside the cup is cooked

The sword from the blacksmith is sharp

The wheel on the wagon is flat

The ship in the harbour is big

The worm under the ground is long

The bear inside the cage is strong

Passage 2

The leg in the picture is thin

The cow on the meadow is cute

The sock in the drawer is old

The dot on the eyebrow is blue

The star under the cloud is bright

The door in the kitchen is white

Passage 3

The hat on the table is black

The game for the woman is new

The toe with the bandage is plump

The chair with the backrest is soft

The room with the window is small

The shirt on the clothesline is wet

Passage 4

The shark in the water is sick

The train on the railway is cleared

The book with the cover is good

The way to the circus is short

The stone in the garden is grey

The pig in the sunlight is fat

Passage 5

The horn on the forehead is sharp

The dog behind the fence is good

The hand in the pocket is cold

The ball with the marking is round

The stick beside the witch is blunt

The desk in the parlour is high

Passage 6

The nut inside the shell is brown

The light from the lamppost is weak

The ear with the earring is red

The lake near the mountain is deep

The stream beside the bridge is foul

The hen beside the horse is smart

Passage 7

The board on the bookshelf is bent

The cord on the jacket is great

The clock near the picture is loud

The tent behind the house is green

The sign along the road is skewed

The shawl with the pattern is warm

Passage 8

The bed in the chamber is big

The boat with the engine is fast

The skirt from the boutique is nice

The knee with the swelling is sore

The shoe with the platform is tight

The stain on the sweater is pink

Appendix B

A List of the Passage Ordering

GR=grammatical UG=ungrammatical

Order 1: 7UG 3GR 4GR 8UG 1GR 5UG 2GR 6UG 5GR 1UG 2UG 6GR 3UG 7GR 4UG 8GR

Order 2: 1GR 5UG 2GR 6UG 3UG 7GR 4UG 8GR 5GR 1UG 2UG 6GR 7UG 3GR 4GR 8UG

Order 3: 5GR 1UG 2UG 6GR 3UG 7GR 4UG 8GR 1GR 5UG 2GR 6UG 7UG 3GR 4GR 8UG

Order 4: 7UG 3GR 4GR 8UG 5GR 1UG 2UG 6GR 3UG 7GR 4UG 8GR 1GR 5UG 2GR 6UG

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