Effect of Subject Types on the Production of Auxiliary Is in Young English-Speaking Children

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Purpose: In this study, the authors tested the unique checking constraint (UCC) hypothesis and the usage-based approach concerning why young children variably use tense and agreement morphemes in obligatory contexts by examining the effect of subject types on the production of auxiliary is.

Method: Twenty typically developing 3-year-olds were included in this study. The children’s production of auxiliary is was elicited in sentences with pronominal subjects, high-frequency lexical noun phrase (NP) subjects (e.g., the dog), and low-frequency lexical NP subjects (e.g., the deer).

Results: As a group, children did not use auxiliary is more accurately with pronominal subjects than with lexical NP subjects. Furthermore, individual data revealed that although some children used auxiliary is more accurately with pronominal subjects than with lexical NP subjects, the majority of children did not show this trend.

Conclusion: The symmetry observed between lexical and pronominal subjects supports the predictions of the UCC hypothesis, although additional mechanisms may be needed to account for the asymmetry between subject types in some individual children. Discrepant results between the present study and previous studies were attributed to differences in task formats and children’s developmental levels.

KEY WORDS: tense and agreement morphemes, usage-based approach, unique checking constraint hypothesis, morphosyntactic development, input frequency

It has been well documented that young children acquiring English produce tense and agreement morphemes inconsistently in obligatory contexts (Brown, 1973; Lahey, Liebergott, Chasnick, Menyuk, & Adams, 1992; Pine, Conti-Ramsden, Joseph, Liebergott, & Serratrice, 2008; Wilson, 2003). Tense and agreement morphemes refer to the function words and inflections that mark for tense and agreement, such as forms of auxiliary BE (e.g., am, is, are, was, were) and third person singular –s, as in He jumps. Although children start to use tense and agreement morphemes early, they pass through a period in which they produce these morphemes inconsistently. One common observation of this inconsistency is that children may frequently omit tense and agreement morphemes in obligatory contexts, but when they do use these morphemes, they tend to use them correctly. However, why children omit these morphemes is still open to debate (Pine et al., 2008; Schütze & Wexler, 1996; Wexler, 1998; Wilson, 2003).

Current theories that account for the inconsistent use of tense and agreement morphemes in typically developing children include generative accounts (e.g., Radford, 1990; Wexler, 1998) and constructivist accounts (e.g., Tomasello, 2003). The unique checking constraint (UCC) hypothesis
(Wexler, 1998, 2003), one of the generative accounts, assumes that children are born with an abstract representation of tense and agreement (or finiteness marking). The variable production of tense and agreement morphemes in early childhood is attributed to the presence of the UCC in their grammar. In contrast, the usage-based approach, one of the constructivist accounts, posits that children learn tense and agreement morphemes from the input. The variable production of tense and agreement morphemes is attributed to the presence of adultlike abstract representation and use of lexically specific constructions, which may or may not contain these morphemes. In this study, we tested the predictions derived from the UCC hypothesis and the usage-based approach by examining the effect of subject types (i.e., pronominal, high-frequency lexical noun phrase [NP], and low-frequency lexical NP subjects) on the production of auxiliary is in 3-year-olds through an elicited production task. In the text that follows, we briefly review the basic assumptions, predictions, and empirical evidence for each account. We then address the potential limitations of the existing evidence and lay out the scope of the present study.

The UCC Hypothesis

Basic assumptions of the UCC hypothesis. The UCC hypothesis, which was developed within the framework of minimalist syntax (see Radford, 2004), assumes that children are born with innate linguistic principles and parameters (Wexler, 1998). Children acquire extensive knowledge related to tense and agreement and their related morphemes as early as the two-word stage, which occurs around 18 months of age in typically developing children. For instance, once children at this age have produced auxiliary is, they know that it marks third person, singular, and present tense. When sentences are generated with this underlying knowledge, the indexing of tense and agreement morphemes would prevent substitution of one morpheme for the other. One demonstration of this very early knowledge of tense and agreement is that even though young children frequently omit tense and agreement morphemes, they rarely use these morphemes in the wrong contexts (e.g., *It are a dog and *Him is going to school [asterisks denote ungrammatical sentences]; Wexler, 1996). Omission occurs not because children have not learned the grammatical and phonological properties of these morphemes but, rather, because there is a strong maturational constraint in the child’s developing grammar—the unique checking constraint (UCC), which blocks the production of tense and agreement morphemes. The UCC becomes relaxed during development through maturational mechanisms that are under biological rather than experiential control.

However, the UCC limits this checking process in young children such that the sentence subject can check only one feature on the representation—that is, either the agreement feature (AGR in Depictions 1 and 2) or the tense feature (TNS in Depictions 1 and 2). Because a syntactic representation with unchecked features is ruled out as ungrammatical by the grammar, the child needs to modify the syntactic representation in order to derive a grammatical sentence, given the UCC. This modification will force the feature of either agreement or tense to be omitted from the representation. If the agreement feature is preserved and the tense feature is omitted from the representation, the child would produce a sentence such as *He running, as illustrated in Depiction 2a. In contrast, if the tense feature is preserved and the agreement feature is omitted, the child may produce sentences such as *Him running, as demonstrated in Depiction 2b.

The UCC hypothesis assumes that the syntactic representation of a sentence with tense marking (i.e., a finite sentence) has separate features of agreement and tense (Adger, 2003; Avram, 2002). To produce correct tense-marking for a sentence (e.g., He is running), the sentence subject (e.g., He) must check both the Agreement and Tense features on the representation, as Depiction 1 schematizes.

(1) Simplified syntactic representation of He is running (where AGRP = agreement phrase; TP = tense phrase; VP = verb phrase; DP = determiner phrase; t = trace)
However, it should be noted that finite sentences such as *He’s running are also observed in young children who omit tense and agreement morphemes. Finite sentences require both the agreement and tense features to be preserved on the representation. A question arises here: If the UCC is present in young children’s grammar, how could it be possible for them to preserve both the agreement and tense features on the representations?

To account for this issue, Wexler (1998) adopted the notion of minimize violations—which basically requires the computational system of syntax to choose the derivation that violates as few grammatical properties as possible. If more than one derivation minimally violates the properties, any of them may be chosen for the output sentence. The omission of the features of agreement or tense under the restriction of UCC involves one violation of a grammatical property of the syntactic representation. The preservation of both the agreement and tense features on the representation does not violate any grammatical properties, but it does violate the UCC in the child’s grammar. Because all three of the derivations involve only one violation, any of them may be chosen as the output sentence, which results in variable use of tense and agreement morphemes.

The UCC is eventually relaxed via developmental processes so that the child’s production can conform to the adult form. While the UCC is still present in the child’s grammar, it constrains the sentence subject to check only one of the two required features for the derivation of tense and agreement morphemes, leading to the omission of these morphemes. Although not explicitly addressed, one prediction that follows from the UCC hypothesis is that the production/omission rate of a given form of auxiliary BE (e.g., is) should be similar in sentences with pronominal subjects and in those with lexical NP subjects because both subject types are determiner phrases (Adger, 2003) and have the same structural properties, as Depiction 3 exemplifies.

Empirical evidence for the UCC hypothesis. To explore children’s knowledge of finiteness, Schütze and Wexler (1996) examined the use of tense and agreement morphemes and their relation to the use of nominative subject pronouns in a corpus of three young children ages 1;11–3;1 (years;months). These children used nominative (e.g., he) or non-nominative (e.g., him) subject pronouns in a sentence. When children used nominative subject pronouns, they sometimes omitted the tense and agreement morphemes (e.g., *He happy) and sometimes used them correctly (e.g., He’s happy). However, when children used non-nominative subject pronouns, they used tense and agreement morphemes only in about 5% of these sentences (e.g., *Him is happy). In addition, children seldom made agreement errors with nominative subject pronouns (e.g., *He are happy). Based on their findings, Schütze and Wexler (1996) made two claims. First, they claimed that the features of AGR and TNS are represented separately so that these features can be independently omitted from the child’s representation of finite sentences. Second, the authors suggested that young children have an intact abstract representation of finiteness, but they simply view finiteness marking of sentences as optional in their grammar. Schütze and Wexler further argued that this optionality in young children’s grammar leads to the variable use of tense and agreement morphemes in obligatory contexts.

Similar patterns of use of tense and agreement morphemes also were observed in experimental studies. Wexler, Schütze, and Rice (1998) examined the use of tense and agreement morphemes in children with specific language impairment (SLI; mean age = 5;0) and their younger typically developing peers (mean age = 3;0) matched on mean length of utterance (MLU) through spontaneous data and an experimental probe. In both the SLI and MLU-matched groups, nominative subject pronouns appeared together with inflected verbs, whereas non-nominative subject pronouns rarely appeared with
inflected verbs. Children in both groups often omitted the tense and agreement morphemes, but when they used these morphemes, they tended to use them in the correct context. These findings further supported the hypothesis that the features of AGR or TNS can be optionally omitted from the syntactic representation of sentences in young children.

In a longitudinal study, Rice, Wexler, and Hershberger (1998) investigated the growth trajectory of the use of tense and agreement morphemes in groups of children with SLI and their typically developing MLU-matched peers. Each child was tested at 6-month intervals over 3 years, for seven data points. The age range during the study was 2;6–6;8 for the MLU-matched group and 4;5–8;9 for the SLI group. In the MLU-matched group, the growth curves for each morpheme showed similar trajectories. All of the individual curves showed slow growth at the beginning, rapid growth in the middle, and an asymptote at ceiling level by the end of the study. Wexler (2003) argued that the slow growth of tense and agreement morphemes in the beginning signaled the presence of a maturational constraint in the grammar (i.e., the UCC), and the acceleration phase marked the relaxation of the constraint. This similarity of growth curves across tense and agreement morphemes reinforced the argument that these morphemes are controlled by a common underlying grammatical function.

In summary, the corpus and experimental studies reviewed in this article support the assumption of the UCC hypothesis that young children have an intact representation of tense and agreement in their grammar, as evidenced by the finding that children rarely make commission errors with these morphemes. The problem that young children have is that the features of AGR or TNS may be omitted due to the presence of the UCC in their grammar. This optional presence of AGR or TNS in the representation leads to the variable production of auxiliary BE and other tense and agreement morphemes.

However, other researchers have argued that these findings can actually be interpreted without assuming that young children have an abstract representation of tense and agreement. The scarcity of errors such as *He are happy in young children may be due to the low rate of such ungrammatical utterances in the input (Tomasello, 2003). In addition, both corpus and experimental studies have found that non-nominative subject pronouns occur in finite sentences (e.g., *Him is sick) at a rate much higher than noise in some children (Ambridge & Pine, 2006; Pine, Rowland, Lieven, & Theakston, 2005; Rispoli, 1999). Furthermore, if the UCC does cause the omission of tense and agreement morphemes in young children, it should affect sentences with different subject types equally. Studies from the usage-based approach reviewed in the next section (e.g., Pine et al., 2008; Wilson, 2003) have provided evidence against the UCC hypothesis, in that young children tended to produce tense and agreement morphemes more accurately with pronominal subjects than with lexical NP subjects.

### The Usage-Based Approach

**Basic assumptions of the usage-based approach.** The usage-based approach (Theakston & Lieven, 2005; Tomasello, 2003) holds that language is composed of constructions. Constructions are conventionalized symbolic units with form and meaning pairings, which may include morphemes, words, idioms, sentence frames, and so forth (Goldberg, 1995). This approach does not assume that the child has any innate abstract linguistic knowledge. Instead, it assumes that language acquisition involves learning linguistic constructions of different sizes and complexities from the input (Tomasello, 2000, 2003). The usage-based approach suggests that young children inconsistently use tense and agreement morphemes because they have not developed adult-like abstract representations and instead use lexically specific constructions that may or may not contain these morphemes (Pine et al., 2008; Theakston, Lieven, Pine, & Rowland, 2005; Wilson, 2003).

In this approach, the acquisition of tense and agreement morphemes begins with gestalt learning of independent word sequences with these morphemes (e.g., *you’re welcome, what’s that?). At some point, the child discovers the relation between these word sequences and develops a more abstract way to represent these constructions. For instance, initially the child may learn and produce phrases and sentences with forms of auxiliary BE in chunks without analyzing the elements inside, such as *He’s eating and It’s running. After hearing a large number of constructions with similar forms of auxiliary BE, the child might start to see regularities in the input and use some lexically specific constructions with auxiliary BE, such as *He’s verb-ing and It’s verb-ing. These constructions are lexically specific because the child only uses the auxiliary BE together with certain specific subjects, based on how he or she heard the auxiliary BE used previously. For instance, the child might say *He’s verb-ing but not *She’s verb-ing because he has not learned that he and she both work the same way within the sentence. That is, the child does not have abstract grammatical categories, such as “pronoun,” that would unify these. Later in development, the child figures out—from a variety of lexically specific constructions (e.g., *Mom’s verb-ing, The deer’s verb-ing)—that there are more abstract ways to represent the present progressive construction (i.e., *NPsubject-3SG’s + verb-ing [where 3SG refers to third person singular]) and may use auxiliary is with any subject type. Eventually, the child acquires the most abstract form—*NPsubject + auxiliary BE + verb-ing—and is
able to produce forms of auxiliary BE flexibly and accurately. The variable production of auxiliary BE decreases gradually as the child acquires the adultlike abstract constructions that contain auxiliary BE. It should be noted that even if children develop adultlike abstract constructions, the frequently used lexically specific constructions may remain in the representation and can still be adopted for language production (Bybee, 1995, 2002; Dąbrowska, 2000; Dąbrowska & Lieven, 2005). As long as children have not developed adultlike abstract constructions, they will variably produce auxiliary BE forms.

How would omission of tense and agreement morphemes occur in a child who has not developed abstract representations but only uses lexically specific constructions of these morphemes? There are at least two possibilities. First, the child may have no or weak representations of the particular lexically specific constructions that are required by specific discource contexts (Theakston & Lieven, 2008; Theakston et al., 2005; Wilson, 2003). For instance, the child may only have He’s verb-ing and The dog’s verb-ing constructions in the representations but not The sheep’s verb-ing. However, the discourse context may require the child to say a sentence such as The sheep is crying. Because there is no construction like The sheep’s verb-ing in the representation and the child has not yet acquired an abstract construction like NP_{subject}-3SG’s + verb-ing, he or she may just combine words based on their semantics and produce The sheep crying, leading to the omission of auxiliary BE.

The second possibility is children may learn the constructions without tense and agreement morphemes directly from the input (Lieven, 2008; Theakston & Lieven, 2008; Theakston et al., 2005). For instance, the child may have learned the constructions such as He verb-ing and The dog’s verb-ing due to partial processing of input utterances such as Is he doing, and I see the dog running (Freudenthal, Pine, Aguado-Orea, & Gobet, 2007; Newport, 1990; Slobin, 1985). These constructions without auxiliary BE may compete with and win out over those with auxiliary BE when the child attempts to express the meaning of present progressive. Thus, the child may produce auxiliary BE variably even in similar contexts (e.g., He’s running vs. He running) due to the competition between the correct and incorrect constructions.

Within the framework of the usage-based approach, input frequency plays a crucial role in the specific constructions that the child may use (Bybee, 1995; Tomasello, 2003). For instance, children hear specific pronoun + auxiliary BE combinations (e.g., He’s eating) more often than specific lexical NP + auxiliary BE combinations (e.g., The deer’s eating) in the input. Because more frequent constructions are more entrenched and easier to retrieve than less frequent constructions, children are more likely to use a particular auxiliary BE form correctly in sentences with pronoun subjects than in those with lexical NP subjects (Wilson, 2003). Therefore, frequency—rather than structural properties—is the driving force of acquisition of auxiliary BE as well as other tense and agreement morphemes within the usage-based approach.

Empirical evidence for the usage-based approach.
Wilson (2003) investigated the acquisition of copula BE, auxiliary BE, and third person singular –s (3SG-s) in longitudinal transcripts from five children ages 1;6–3;5. The children demonstrated different types of variability in using these tense and agreement morphemes. First, the overall production rates of copula BE, auxiliary BE, and 3SG-s differed significantly within each child (i.e., between-morpheme variability). Second, for the same morpheme (e.g., auxiliary is), the production rate varied as a function of subject types within a given child. The target morphemes were produced more accurately in sentences with closed-class subjects than in those with open-class subjects. Third, for a given BE form, the provision rates also varied in sentences with different closed-class subjects. For instance, the provision rate of auxiliary is tended to be higher in sentences with the subject he than in those with the subject she. These findings were replicated in a study by Pine and colleagues (2008), in which sentences with non-nominitive subject pronouns were included in analysis and the lexical knowledge of tense and agreement morphemes of children was controlled.

The studies of Wilson (2003) and Pine and colleagues (2008) both suggested that children acquire these morphemes by learning lexically specific constructions from the input. They argued that variable use of tense and agreement morphemes reflected inconsistent knowledge of the range of distinct constructions.

Joseph, Serratrice, and Conti-Ramsden (2002) examined the development of copula and auxiliary BE in children with SLI (ages 3;1–4;8) and in their peers matched on MLU in words (ages 1;8–2;4) via a corpus study. Both the SLI and MLU-matched groups showed variability in using copula and auxiliary BE. For both groups, copula BE was produced more often than auxiliary BE, and the form is was produced more often than the forms are or am. For the same BE form (e.g., copula is), the production rate was higher in sentences with personal pronoun subjects (e.g., he) than in those with other pronounal subjects (e.g., this), which was, in turn, higher than those with lexical NP subjects. Furthermore, the distribution of BE forms in the maternal input accounted for a significant proportion of the variance in the children’s use of BE forms. Therefore, Joseph and colleagues (2002) argued that the variable use of copula and auxiliary BE is not “a random, across-the-board” (p. 167) phenomenon.
The observed asymmetry between pronominal and lexical subjects is attributable to the input frequency: Children hear BE forms in the former more often than in the latter. Copula and auxiliary BE are, therefore, particularly entrenched in the sentence constructions with pronominal subjects and, thus, are more likely to be produced.

Theakston and colleagues (2005) investigated the use of auxiliaries BE and HAVE in a longitudinal data set from 11 typically developing children ages 2;0–3;0. Although the production rates of auxiliaries BE and HAVE were positively correlated, there were significant differences in the production rates of individual forms of BE and HAVE. For auxiliary BE, children provided the form *is*(61.9%) more frequently than the form *am*(32.7%) in obligatory contexts. For auxiliary HAVE, they produced the form *has*(62.4%) more often than the form *have*(25.5%) in obligatory contexts. Theakston and colleagues suggested that the variable use of auxiliaries BE and HAVE in early childhood cannot be explained by an underlying optionality, which would be expected to function equally on different forms of the same auxiliary. The variability was also not attributable to performance limitations in that there were no significant differences in MLU between utterances containing the target auxiliary and those in which the target auxiliary was omitted. In contrast, except for the pronominal subject *you*, the maternal input frequency was significantly correlated with the age at which a specific subject + auxiliary construction was acquired. Theakston and colleagues, therefore, argued that the input frequency and the acquisition of lexically specific constructions may provide an adequate account for the variable use of auxiliary BE and HAVE. This variability resulted from the child’s acquisition of specific subject + auxiliary constructions individually, depending on what he or she heard from the input.

In summary, both corpus and experimental studies reviewed here support the assumption of the usage-based approach that children acquire tense and agreement morphemes from lexically specific constructions that contain these morphemes in the environmental input. The production/omission of tense and agreement morphemes is not unified under a common underlying grammatical representation of tense marking. The assumption is supported by variation of production accuracy in different tense and agreement morphemes (e.g., auxiliaries BE and HAVE) and in different forms of the same morpheme (e.g., *is*, *am*, and *are* of auxiliary BE). It is further evidenced in different production accuracy of the same form of a given tense and agreement morpheme (e.g., auxiliary *is*) in sentences with different subject types (e.g., pronominal and lexical) within the same child. The variable use of tense and agreement morphemes is attributed to young children’s use of lexically specific constructions that may or may not contain these morphemes and lack of adultlike abstract representation of these morphemes. Tense and agreement morphemes tend to be used more correctly in more frequent constructions (e.g., *pronoun + auxiliary BE*) than in less frequent ones (e.g., *lexical NP + auxiliary BE*).

However, within- and between-morpheme variability are not necessarily evidence against the notion of unified underlying representations of tense marking. Recall that Rice and colleagues (1998) showed that the growth curves were quite similar across tense and agreement morphemes in English. The similarity of individual growth curves could indicate that these morphemes were unified under one grammatical function. They further argued that the variation of production rates between and within tense and agreement morphemes may result from input frequency, the phonological properties of the surface form (e.g., duration), and/or grammatical differences across these morphemes. For instance, auxiliary DO typically does not appear in positive declarative sentences, but auxiliary BE does not have this constraint. Although these factors may seem to “pull apart the [tense and agreement] morphemes over time” (Rice et al., 1998, p. 1427), they do not affect the similarity of growth curves between these morphemes. Variation with different subject types could also be attributed to performance factors, such as sentence length (Bloom, 1990). For instance, sentences with lexical NP subjects are potentially longer than those with pronominal subjects. Tense and agreement morphemes could, therefore, be at higher risk of omission with lexical NP subjects than with pronominal subjects in young children due to performance/length considerations.

**Limitations of the Existing Evidence**

Because empirical evidence supports both the UCC hypothesis and the usage-based approach, why children variably use tense and agreement morphemes remains unclear. However, although the UCC hypothesis can well explain the inconsistent use of tense morphemes through the presence of the UCC in the grammar, it does not provide specific predictions regarding how input frequency, phonological properties, and/or grammatical differences lead to between- and within-morpheme variability. In addition, the effect of the UCC should be equal for all forms of copula BE as well as auxiliaries BE and HAVE, regardless of subject types—a prediction challenged by evidence from the usage-based approach (Pine et al., 2008; Wilson, 2003). Although performance factors (e.g., sentence length) may be incorporated into the UCC hypothesis to explain this variation, Theakston and colleagues (2005) indicated that children tended to produce auxiliaries BE and HAVE more accurately with pronominal subjects than with lexical NP subjects even after sentence length was controlled.
Alternatively, although the evidence from the usage-based approach seemed to challenge the UCC hypothesis, it may not be straightforward. A strict test of the UCC hypothesis should examine the child’s production of tense and agreement morphemes at a given point of developmental time (Ambridge & Pine, 2006). However, the language samples used in the previous studies (e.g., Pine et al., 2008; Theakston et al., 2005) were collected over a period of five to 14 months. The production rate of tense and agreement morphemes by subject type was computed by collapsing the language samples. Had the previous studies examined the child’s production at a given point in time rather than over a period of time, the effect of subject types on the use of tense and agreement morphemes might have been different. For example, it is possible that the production rate of auxiliary is with lexical NP subjects might be equal to that with pronominal subjects during the later period of data collection due to the development of abstract constructions. However, collapsing the language samples may have obscured this developmental change if the child had produced auxiliary is with lexical NP subjects at a much lower rate than with pronominal subjects during the earlier period of data collection (Rispoli, Hadley, & Holt, 2009).

In addition, the determination of an obligatory context for copula and auxiliary BE in language samples may sometimes be ambiguous (Gerken, 2000). For example, the child’s utterance *it there may be coded as omission of copula is in this context; however, this utterance might actually mean Put it there or I want it there. These contexts would make it difficult to draw firm conclusions about the relationships between use of tense and agreement morphemes and specific constructions.

Furthermore, the variation in the accuracy of BE and HAVE with subject types can be attributed to the difference in the complexity of syntactic structure even if sentence length is controlled. Lexical NP subjects (e.g., [DP [D The] [NP cat]]) are more complex, structurally, than pronominal subjects (e.g., [DP [D She]]). The asymmetry between subject types may thus be attributed to performance factors in addition to frequency of subjects. One way to test this account is to examine the production accuracy of tense and agreement morphemes with high- and low-frequency lexical NP subjects—a test that has not been conducted in the previous corpus or in experimental studies.

The Scope of the Current Study

To reduce the ambiguity of obligatory contexts and explore the effect of lexical NP subjects with different frequencies on the production of tense and agreement morphemes, in this study, we adopted an elicited production task to investigate the child’s use of auxiliary is at a given time point of development in sentences with three different subject types: pronominal subjects, high-frequency lexical NP subjects, and low-frequency lexical NP subjects. Elicited production allows for greater control of the target utterances than spontaneous samples, including factors such as obligatory context, sentence length, verb type, and sentence structure. In addition, the usage-based approach stresses the role of input frequency in the acquisition of tense and agreement morphemes. Elicited production enables us to manipulate the frequency of subject types to examine this effect. In this way, we may offer more precise evidence with regard to the UCC hypothesis and the usage-based approach.

The specific question addressed is: Does production accuracy of auxiliary is in young children differ in sentences with pronominal, high-frequency lexical NP, and low-frequency lexical NP subjects? The UCC hypothesis would predict that production accuracy of auxiliary is in young children would be similar in sentences with different subject types, given that the UCC should affect sentences with pronominal and lexical NP subjects equally. In contrast, the usage-based approach would predict that production accuracy of auxiliary is in young children should be higher with pronominal subjects than with high-frequency lexical NP subjects, followed by low-frequency lexical NP subjects.

Method

Participants

Seventy-two typically developing children with an age range from 2;7 to 3;5 were recruited for participation in this study. They were all monolingual native speakers of English. Children at this age range were recruited because they were likely to be using auxiliary is variably (Rice, Wexler, & Cleave, 1995; Theakston et al., 2005; Wilson, 2003). Of these 72 children, 20 children (11 girls, 9 boys) with a mean age of 3;0 (range = 2;8–3;4) were included in the analysis reported here. Fifty-two of the 72 children recruited were excluded from analysis. Among these 52 excluded children, 19 children did not finish the study, and 24 children (mean age = 3;0, range = 2;7–3;4) had reached ceiling levels of performance. Children had to perform below the ceiling level (i.e., 90% correct; Brown, 1973) of auxiliary is so that sources of variability could be legitimately examined. A child was excluded if he or she produced at or above 90% correct of auxiliary is in all three conditions. Four children (mean age = 2;11, range = 2;8–3;1) were excluded because they did not produce at least three scorable items for each condition and, thus, their performance could not be reliably measured (Balason & Dollaghan, 2002). In addition, five children (mean age = 3;0, range = 2;11–3;1) were excluded because they did not produce at least one correct usage of auxiliary is in the task. This last requirement was because it has been
argued that testing the UCC hypothesis is valid only when the child has shown the target morpheme in his or her productive lexical inventory (Pine et al., 2008; Schütze, 2001).

All of the 20 participants were typically developing as documented by parent report, performance above the 10th percentile on one of two standardized language tests, hearing within normal limits per American Speech-Language-Hearing Association (ASHA) standards (1997), and no history of receiving intervention for cognitive, motor, or communication disorders. The standardized language tests were the Preschool Language Scale—Fourth Edition (PLS–4; Zimmerman, Steiner, & Pond, 2002) for children who were younger than 3;0 and the Structured Photographic Expressive Language Test—Preschool (SPELT–P; Werner & Kresheck, 1983) for those who were at or older than 3;0. We used the SPELT–P for those who were at or older than 3;0 because we only saw 3-year-olds at the beginning stage of this study. We adopted the PLS–4 when we extended the age range below 3;0. As a component of assessment, we collected a conversational language sample for each child. All children demonstrated an MLU within the typical range with reference to the norms in Miller (1981).

**Stimuli**

The target items consisted of simple declarative transitive sentences that required the use of auxiliary is and varied with regard to subject types (i.e., pronominal, high-frequency lexical NP, and low-frequency lexical NP subjects). Each condition had 10 target sentences. To ensure that the words used in the target sentences were likely to be familiar to typically developing children around 3 years of age, the selection of lexical items for the subjects and verbs in the target sentences was primarily based on Part 1 of the MacArthur–Bates Communicative Development Inventories: Words and Sentences (MCDI: WS; Fenson et al., 1993).

To select subject words with different frequencies, we used the frequency list of Moe, Hopkins, and Rush (1982) to determine the token frequency of 183 nouns from MB-CDI: WS and 16 additional nouns that were considered child friendly. Nouns with frequencies above the median (i.e., 29) for all 199 nouns were considered high frequency and were selected as subjects for the high-frequency lexical NP subject condition. Pronouns that were under consideration for the pronominal subject condition included he, she, it, this, and that. We did not choose this and that as the subjects because they did not sound felicitous in the transitive present progressive sentences (e.g., *This is/That’s eating a cake* [where “?” means “questionable”]). Because all the rest of the three pronouns had frequencies above 2,700, which was much higher than the frequency (i.e., 860) of the most frequent noun among the 199 nouns, we did not include a low-frequency pronominal subject condition in this study.

The frequency comparison was based on lexical frequency in first-graders’ spoken discourse (Moe et al., 1982). However, the prediction of the usage-based approach is actually based on the co-occurrence frequency of the lexical items and auxiliary is in the parental input. Although Goodman, Dale, and Li (2008) found that the acquisition order of lexical items of a given word class (e.g., nouns) in young children reflected the frequency of parental use, what remains unknown is whether the lexical frequency in children’s spoken discourse also reflects the co-occurrence frequency of the lexical items and auxiliary is in the parental input. To answer this question, we hand-coded the co-occurrence frequency of each lexical item chosen as a target subject and auxiliary is in the parental input of the American English corpora in the Child Language Data Exchange System (CHILDES; MacWhinney, 2000) and then computed the correlation of log frequency of each lexical item and the log frequency of co-occurrence. The log frequencies were significantly correlated, $r = .78, p < .01$. This high correlation validates the use of lexical frequency from child speech to choose the subject words for the target sentences in this study.

In total, there were three pronominal subjects (i.e., *he, she, it*), six high-frequency lexical NP subjects (i.e., *cat, dog, duck, goat, Mom, pig*), and 5 low-frequency lexical NP subjects (i.e., *ant, deer, frog, queen, sheep*) for the target sentences. Because each condition had 10 sentences, all these lexical items—except the exception of *duck* and *Mom*—were repeated as subjects across target sentences. Each pronominal subject appeared in no more than four target sentences, whereas each lexical NP subject appeared in no more than two sentences. We repeated the lexical NP subjects in target sentences for two reasons. First, there were not many choices of nouns available under the constraints mentioned previously, especially for low-frequency lexical NP subjects. Second, because repeating the pronominal subjects for target sentences was inevitable, repeating the lexical NP subjects would make the target sentences more similar across conditions.

The median and range of raw frequency and mean log frequency of lexical items selected for target subjects are tabulated by condition in Table 1.

A one-way analysis of variance (ANOVA) showed that the mean log frequency of lexical items chosen for target subjects differed significantly across sentences with different subject types, $F(2, 27) = 320.03, p < .001, \eta^2_p = .96$. A post hoc Tukey test at .05 level showed that the mean log frequency of the selected pronouns was higher than the high-frequency lexical NPs. In turn, the mean log frequency of high-frequency lexical NPs was higher than the selected low-frequency lexical NPs.
Table 1. Frequency distribution of lexical items chosen for target subjects, by condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mdn M</th>
<th>Range M</th>
<th>Log M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pronominal subject</td>
<td>5,408.0</td>
<td>2,753–7,583</td>
<td>3.69 (0.18)</td>
</tr>
<tr>
<td>High-frequency NP subject</td>
<td>448.0</td>
<td>167–606</td>
<td>2.54 (0.23)</td>
</tr>
<tr>
<td>Low-frequency NP subject</td>
<td>10.0</td>
<td>5–27</td>
<td>0.99 (0.29)</td>
</tr>
</tbody>
</table>

Note. Mdn = median; NP = noun phrase; Log = log frequency.

All of the subject words denoted an animal or person so that they could serve as the agent of the transitive verb selected for the target sentence. The lexical NP subject words were also required to be monosyllabic to control for sentence length and end with a vowel or non-sibilant consonant to create contexts that allow the contraction of auxiliary is. Contexts for contraction were important because the usage-based approach suggests that children may learn auxiliary is from the specific subject + contracted auxiliary is constructions (e.g., he’s, Mommy’s) in the input (Wilson, 2003). Thus, contexts for contracted auxiliary is allowed us to test more precisely the prediction of the usage-based approach on the effect of subject types.

We used a set of 10 transitive verbs from MCDI: WS repeated across three conditions in order to control for verb frequency. The length of each sentence was controlled at six syllables (e.g., He’s eating a cookie, The goat’s driving the car). The target sentences with auxiliary is are listed in Appendix A.

We used pictures to elicit the target sentences in this study. Because the target sentences/pictures involved fantasy events (e.g., The goat’s driving the car), we asked 21 adults to rate the degree of fantasy of the target sentences together with their corresponding pictures, although the effect of degree of fantasy on the production of tense and agreement morphemes remains unknown. The participants were instructed to judge whether the event that the picture depicted existed in the real world. Pictures that were judged as fantasy were assigned a score of 2. In contrast, those that were judged as real were assigned a score of 1. Higher scores meant higher degrees of fantasy. Kruskal–Wallis H tests showed that there was no significant difference in degrees of fantasy of target sentences/pictures across subject types, $\chi^2(2) = 2.806, p = .246$.

Procedures

Each child was tested individually by a trained examiner. The examiners were eight undergraduate students and two graduate students at the University of Iowa; all examiners were monolingual English speakers.

The task began with a warm-up comprehension activity in which children were asked to point to one of four pictures at each trial after hearing the instruction “Show me ______” (e.g., Show me the dog) from the examiner. All of the subject lexical NPs in the target sentences were presented in this activity. We did this in order to familiarize the child with these NPs; the child’s performance did not affect inclusion in or exclusion from analysis. If the child made errors, the examiner named all four pictures for the child and asked the child to point to the target picture again.

Next, the child was invited to play a game in which the child and the examiner needed to work together to help a teacher talk about pictures because a wizard had cast a spell on the teacher. We adopted a parallel structure method to elicit production of the target sentences. Target sentences were presented in drawings that depicted the event described by the target sentences (e.g., The deer’s eating a cake) together with a contrastive event (e.g., The horses are wiping the floor). The contrastive events always used plural-form subjects and auxiliary are. The contrastive sentences are listed in Appendix A. Sample pictures of target sentences are illustrated in Appendix B. To eliminate order effects, all of the target sentences were randomized into one list in the task. We used five practice items to familiarize the child with the experiment. All responses were audiotaped for further analysis.

Each trial began with the examiner pointing to the picture and prompting the child by describing the contrastive event. For all items, we included the verb phrase in the prompt (e.g., Eating a cake.) in order to reduce the task demands. To maximize the use of target subject words, we prompted the child slightly differently for sentences with pronominal subjects (see 4a) or lexical NP subjects (see 4b).

(4a) Target: He’s eating a cookie.
Prompt: Look! Making a cake. Eating a cookie. They are making a cake. What’s happening to him?

(4b) Target: The deer’s eating a cake.
Prompt: Look! Wiping the floor. Eating a cake. The horses are wiping the floor. What’s happening in this picture?

To elicit responses with pronominal subjects, we ensured that the subject words in the contrast events were always pronouns. We also prompted the target pronominal subject in the last sentence of the instruction. To elicit responses with lexical NP subjects, we ensured that the subject words in the contrast events were always lexical NPs. We did not prompt the lexical subject in the last sentence of the prompt because children were more likely to use lexical NP subjects in sentences if they
did not hear the NP in the previous discourse (Matthews, Lieven, Theakston, & Tomasello, 2006).

At the end of the prompt, the examiner pointed to the target picture and waited for the child’s response. When the child responded with a nontarget subject in the sentence, the examiner prompted by condition if the child substituted a pronoun with a noun or vice versa. Under these circumstances, or if the child produced by condition the verb phrase, the examiner prompted the child by saying “Can you start by saying target subject word?” (e.g., Can you start by saying he/the deer?). The examiner maximally used three additional prompts for each item. Examples of additional prompts are described in Appendix C.

**Transcription and Coding**

The children’s responses were transcribed by the examiner and coded as correct, incorrect, or unscorable. If there was more than one response for a given item, we typically treated the last response as the target response. The rules of coding correct, incorrect, and unscorable responses are described in the section that follows.

**Correct Productions**

Target productions (244 responses). All elements in the target sentences were present, with auxiliary is being contracted (e.g., The dog’s eating a cake) or uncontracted (e.g., The dog is eating a cake). Production with missing elements unrelated to tense marking or with nontarget verb or object NP were also scored as target productions (e.g., The dog’s chewing food).

Productions with an alternative subject (66 responses). The target subject was replaced by another subject. Although correct, the response was counted as a correct production of the alternative subject type. If the lexical NP subject used in the response changed frequency, it was reclassified as high/low frequency based on the median frequency of 29.

Productions with a non-nominative subject case (7 responses). The auxiliary and verb inflection were correctly used, but the case of the pronominal subject form was incorrect, such as Him is driving an airplane instead of He’s driving an airplane. In this case, the response was still counted as a correct production of pronominal subject type. It is worth noting that the use of non-nominative subject pronouns with a tense and agreement morpheme is not predicted by either the UCC hypothesis (Schütze & Wexler, 1996) or the usage-based approach (Tomasello, 2003), although Pine and colleagues (Ambridge & Pine, 2006; Pine et al., 2005) did find evidence for these errors. Nevertheless, because the study’s focus is on auxiliary production, we treated this response as correct to avoid underestimating the child’s ability to use auxiliary is.

**Incorrect Productions**

Omission of auxiliary (199 responses). Auxiliary is was omitted (e.g., *The dog eating a cake). Similar to the correct productions, we also recorded whether the child used target subjects, nontarget subjects, or non-nominative subjects in the omission errors. In total, there were 148 omission errors with target subjects, 36 omission errors with alternative subjects, and 15 omission errors with non-nominative subjects.

Agreement error (0 responses). A third person plural auxiliary are was used with a third person singular subject (e.g., *The dog are eating a cake).

**Unscorable Productions**

Use of an unrelated structure (16 responses). A grammatical sentence was produced but was unrelated to the target structure (e.g., The dog eats the cake, The dog’s eaten a cake, or The dog is naughty).

Omission of subject (61 responses). The subject was omitted (e.g., Eating a cake or Is eating a cake). Given that no subject was included, we were unable to code the subject type for this response.

No response (6 responses). The child did not respond to the stimuli or answered “I don’t know.”

Recall that in order to be included, each child had to produce at least three scorable sentences in each condition. Table 2 summarizes the total number of scorable sentences and the mean number, standard deviation, and range of scorable sentences across children by condition.

**Reliability of Task Transcription and Coding**

To check the transcription and coding reliability of the experimental task, we randomly sampled 20% of the subjects included in the analysis (n = 4). These four samples were retranscribed and recoded by the first author. The mean reliability was 0.92 (SD = 0.06) in identifying the target sentences, 0.96 (SD = 0.05) in transcribing
content words in the target sentences, 0.92 (SD = 0.07) in transcribing grammatical morphemes, and 0.91 (SD = 0.03) in coding the correctness of using auxiliary *is*.

**Statistical Analysis**

The dependent measure was the accuracy of auxiliary *is* of each scorable response for each child. Because of the dichotomous (i.e., correct or incorrect) nature of the dependent measure, we adopted a binomial logistic regression model to evaluate the effect of subject types on the production of auxiliary *is*. We chose this analysis over a repeated-measures ANOVA for four reasons: First, because correctness of responses is discrete and not continuous, using proportion in the ANOVA model may lead to distortions in statistics (Dixon, 2008; Jaeger, 2008). Second, proportions are not normally distributed, which violates one of the basic assumptions of ANOVA (Jaeger, 2008; Quené & van den Bergh, 2008). Third, in addition to the factors of interest, the binomial logistic regression can take more than one type of random effect (e.g., test items, individual children) into account in one model. This eliminates the potential drawbacks of considering the random effects in separate ANOVAs (e.g., by-subject and by-item analyses), which include limited statistical power and lack of flexibility in coping with missing data points (see Baayen, Davidson, & Bates, 2008). Finally, the inclusion of random factors within the model also weights the responses according to the number of data points within each condition/category. Thus, a response category, such as high-frequency lexical NPs, for which there were more scorable responses is treated as more reliable; thus, estimates of the beta coefficients are more likely to attain significance (Jaeger, 2008).

Like linear regression, the logistic model relates one or more predictor variables to the dependent variable. The predictor variables may be either categorical (e.g., subject types) or continuous. When a categorical variable has more than two levels, one of the levels is selected as a reference category/condition, as Equation 1 exemplifies (where SUBJPron refers to the pronoun subject condition and SUBJLow refers to the low-frequency lexical NP subject condition).

**Model A:**  
\[ \text{Logit} \left( Y_{i} \right) = \beta_0 + \beta_1 \text{SUBJPron} + \beta_2 \text{SUBJLow} \]  
(Equation 1)

In Equation 1, the model predicts the effect of subject types on the accuracy of auxiliary *is*, and the high-frequency lexical NP subject condition is selected as the reference category. Logistic regression generates a constant (intercept) and β-coefficients (slope). Unlike linear regression, these values are used for computing the logit rather than the scores, as Equation 1 shows. The logit is the natural logarithm of predicted odds for a given event, such as the log odds of producing auxiliary *is* accurately in the pronoun subject condition. The log odds can be transformed into odds and probabilities for the ease of interpretation.

The β-coefficients reflect the log odds ratios between the category/condition of interest and the reference category/condition. For instance, \( \beta_1 \) in Equation 1 reflects the log odds ratio of producing correct auxiliary *is* when the pronoun subject condition is compared with the high-frequency lexical NP subject condition. A positive β-coefficient indicates an increased likelihood to produce auxiliary *is* accurately in the condition of interest (e.g., the pronoun subject condition) as compared with the reference group (e.g., the high-frequency lexical NP subject condition). The p values of the β-coefficients reported in the model indicate whether the β-coefficient is significantly different than 0. For instance, if \( \beta_1 \) in Equation 1 is positive and reaches a significant level, this would suggest that children are more likely to produce auxiliary *is* correctly with pronoun subjects than with high-frequency lexical NP subjects. Log odds ratios can be transformed into odds ratios (ORs) to ease interpretation. ORs larger than 1 mean that children are more likely to produce auxiliary *is* in the condition of interest than in the reference condition.

**Results**

**Sentence Length of Target Responses**

Because children omitted and/or changed sentence elements, the sentence length of the target responses could have changed across subject conditions. The difference in sentence length could confound the effect of subject types on the production of auxiliary *is*. To examine this possibility, we computed the length of target responses (excluding auxiliary *is*) in syllables for each item produced by each child and compared sentence length across subject conditions (Theakston et al., 2005).

The mean sentence length of target responses excluding auxiliary *is* was 5.76 syllables (SD = 0.39) for the pronoun subject condition, 5.82 syllables (SD = 0.54) for the high-frequency lexical NP subject condition, and 5.77 syllables (SD = 0.33) for the low-frequency lexical NP subject condition. A one-way repeated-measures ANOVA showed that mean sentence length did not differ significantly across subject conditions, \( F(2, 38) = 0.153, p = .86 \). Thus, we see that the sentence length remained similar across different subject types—even if the child omitted and/or changed sentence elements in the target responses—and, thus, can be ignored in all future analyses. To be especially cautious, we also considered sentence length as a predictor of production accuracy in each of the mixed-model binomial logistic regressions reported in the text that follows. It was not a significant predictor (all ps > .14) and did not significantly improve
model fit. For these reasons, sentence length was dropped from all models, and coefficients are not reported.

**Effect of Subject Types on the Production of Auxiliary Is**

Table 3 presents the total number of correct items and the actual percent correct of auxiliary *is* across children by subject type. To examine the effect of subject types on the production of auxiliary *is*, we performed a mixed-model binomial logistic regression, with each child and item treated as random factors and with subject types (i.e., pronominal, high-frequency lexical NP, and low-frequency lexical NP subjects) treated as fixed factors, as Model A shows. Model A is repeated in Equation 2:

\[
\text{Model A: } \text{Logit} \left( Y_i \right) = \beta_0 + \beta_1 \text{SUBJPron} + \beta_2 \text{SUBJLow} \\
\]

(2)

Because we included random factors in the model, \( \beta_0 \) reflects the random factors plus the performance in the reference condition (i.e., high-frequency lexical NP subjects). Table 4 presents the results of Model A.

The results of Model A indicated that the likelihood of producing auxiliary *is* correctly in the high-frequency lexical NP subject condition did not differ significantly from the pronominal subject (Pronominal/HighNP OR = 1.35) or the low-frequency lexical NP subject (LowNP/HighNP OR = 1.60) conditions. However, this model did not reveal whether the pronominal and low-frequency lexical NP subject conditions differed from one another. We re-ran the model with the pronominal subject condition as the reference condition (Jaccard, 2001). The results make it clear that there was also no significant difference between the pronominal and low-frequency lexical NP subject conditions (LowNP/Pronominal OR = 1.19, \( p = .53 \)).

As can be seen in Tables 3 and 4, the likelihood of accurately producing auxiliary *is* did not differ across subject types in young children, a finding that is inconsistent with the previous corpus studies (e.g., Pine et al., 2008; Wilson, 2003). Because the previous studies did not divide lexical NP subjects by frequency, we combined sentences with high-frequency and low-frequency lexical NP subjects in a mixed-model logistic regression to allow a more direct comparison between our data and the results from these studies. Even with this modification to the analysis, the lexical NP subject condition was not significantly different from the pronominal subject condition (Pronominal/Lexical OR = 1.11, \( p = .65 \)).

It is possible that by analyzing data for the group, individual trends were obscured. Both theories under examination make predictions with regard to individual children rather than group trends. Although the regression technique that we used does account for this, to some extent, examination of individual data is important for confirmation of these findings. To that end, Figure 1 shows individual data by condition. Children were ranked by their overall percent correct of auxiliary *is* within the experiment. Five children (HP, AS, CD, CH, and KS; ages 2;8–3;3) produced auxiliary *is* more accurately with pronominal subjects than with other subject types. The rest of the 15 children (i.e., from ZE to EE; ages 2;10–3;4) did not show this trend. It should be noted that all five children who showed pronominal advantage in producing auxiliary *is* were ranked at the lower end of

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>M (%)</th>
<th>SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pronominal subject</td>
<td>111</td>
<td>62</td>
<td>22</td>
</tr>
<tr>
<td>High-frequency lexical NP subject</td>
<td>102</td>
<td>54</td>
<td>31</td>
</tr>
<tr>
<td>Low-frequency lexical NP subject</td>
<td>105</td>
<td>66</td>
<td>33</td>
</tr>
</tbody>
</table>

**Table 3.** Total number of correct sentences and mean percent correct of auxiliary *is* across children by subject type.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variance</th>
<th>SD</th>
<th>Coefficient</th>
<th>SE</th>
<th>OR</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>0.02</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child</td>
<td>1.30</td>
<td>1.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.32</td>
<td>0.31</td>
<td>1.38</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject type (reference condition = high-frequency lexical NP subjects)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronominal subjects</td>
<td>0.30</td>
<td>0.26</td>
<td>1.35</td>
<td>0.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-frequency lexical NP subjects</td>
<td>0.47</td>
<td>0.26</td>
<td>1.60</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.** Regression Model A, showing the likelihood of producing auxiliary *is* correctly by subject type.

Note. Odds ratio (OR) was computed by taking the exponential of the coefficient, such as exp (0.30) = 1.35. Blank cells indicate “not applicable.” SE = standard error.
overall percent correct of auxiliary *is* in the task, although they were not the youngest children in the sample.

To directly compare the present study with the previous corpus studies, we collapsed the two lexical NP conditions in Figure 2. The left panel presents the performance of individual children in sentences with pronominal or lexical NP subjects. For ease of comparison across studies, the right panel of Figure 2 also includes mean percent correct of auxiliary *BE* (*is* and *are*) with pronominal subjects and with lexical NP subjects reported by Wilson (2003) and Pine and colleagues (2008). Eight children (HP, AS, CD, CH, KS, ZE, LG, and TK; ages 2;8–3;3) produced auxiliary *is* more accurately with pronominal subjects than with lexical NP subjects. This is consistent with Wilson (2003) and Pine and colleagues (2008) using spontaneous language samples. However, seven children (SF, IR, AB, ET, AV, IV, and EE; ages 2;10–3;3) produced auxiliary *is* more accurately with lexical NP subjects than with pronominal subjects, and five children (AH, AV, AM, SC, and CK; ages 2;10–3;4) did not show differences between the pronominal and the lexical NP subjects. Thus, although individual children varied considerably in their performance, the majority of the children who were included in the analysis did not produce auxiliary *is* more accurately with pronominal subjects than with lexical NP subjects. In addition, the ages of children who showed pronominal advantage and those who did not show this advantage overlapped to a great extent. It seems that...
Discussion

The study tested the UCC hypothesis and the usage-based approach by examining the effect of subject types on the production of auxiliary *is*. When we considered the effect of subject types on a group basis, the production accuracy of auxiliary *is* did not vary in sentences with pronominal subjects or lexical NP subjects in 3-year-olds who still used auxiliary *is* variably. This finding was inconsistent with the predictions of the usage-based approach, in favor of the UCC hypothesis. When we inspected the effect of subject types on a child-by-child basis, some children produced auxiliary *is* more accurately with pronominal subjects than with lexical NP subjects, which supported the prediction of the usage-based approach. This was particularly the case in children whose overall percent correct of auxiliary *is* was relatively low in the task. However, the majority of the children did not show the facilitative effect of pronominal subjects on the use of auxiliary *is*, nor did the other 24 children who were originally tested and could not be used in this analysis because they used auxiliary *is* at ceiling levels. Taken together, these findings indicated that the facilitative effect of pronominal subjects occurs only in a very early period of grammatical development. Counter to some assertions in the literature (e.g., Tomasello, 2000), average 3-year-olds in the study seem to have acquired quite abstract grammatical representations and did not rely exclusively on highly frequent/lexically specific subject + auxiliary *is* constructions to support their production of auxiliary *is*.

Limitations of the Current Study

Before we discuss the results in detail, we should consider three limitations of this study. First, we excluded a large number of potential participants from the final data analysis. Fifty-two of 72 participants were excluded from analysis for a variety of reasons. At first glance, this could suggest that the experimental task may be too challenging for 3-year-olds. However, recall that 24 children—or approximately half of the excluded participants—were excluded because of ceiling-level performance, suggesting that the task was age appropriate.

A second concern is that the children changed the lexical item used in the subject for approximately 21% (124/600) of the items. Because of these changes, it is possible that we may not have had enough items to reliably measure some children’s performance for any given category, particularly if the majority of these changes occurred in one condition. We attempted to address this problem in three ways: (a) by excluding children from analysis who produced fewer than three items in any of the conditions, (b) by reclassifying the lexical items that the children actually produced into an appropriate category to maximize retention of data, and (c) by our choice of statistical approaches.

Third, it is possible that we too greatly restricted the frequency range within the lexical NP subjects, making it difficult to find differences between the high- and low-frequency lexical NP’s. In order to select age-appropriate nouns for the subjects in target sentences, we picked the nouns primarily based on the word list in MCDI: WS (Fenson et al., 1993) and used the median frequency to consider a selected noun as high or low frequency. Although the specific high-frequency lexical NP + auxiliary *is* constructions may be relatively more frequent than the specific low-frequency lexical NP + auxiliary *is* constructions, the difference in the strength of representations of these constructions may have not yet reached a level that would influence the children’s use of auxiliary *is* in an elicited production task. This methodological decision could have made it more difficult for us to find in favor of the usage-based account. However, differences that favor the usage-based account were not found even when we collapsed across high- and low-frequency targets and compared lexical NPs as a group to pronominal NPs (for further discussion, see section that follows). Future work with regard to how frequency influences the use of grammatical markers should attempt to balance practical factors related to getting children to produce scorable items within the task and theoretical issues surrounding an appropriate distance between high- and low-frequency items.

Testing the UCC Hypothesis

With regard to the two language-learning hypotheses we were testing, the results from the children as a group appear to be clear. The symmetry observed at the group level between lexical and pronominal subject types supports the predictions of the UCC hypothesis, which states that it is the failure of sentence subjects to check the features of Agreement or Tense that leads to the omission of tense and agreement morphemes (Wexler, 1998). Because both pronominal and lexical subjects are determiner phrases and have similar structural properties, they should be affected equally by the UCC. The likelihood of accurately producing auxiliary *is* should be similar across these two subject types, which was confirmed in the aggregate results of the present study.
Note that although we reported results only from those children who were variable, 24 of the 52 (46%) children who finished the task (ages 2;7–3;4) had reached a ceiling level of using auxiliary is. This finding suggests that the average 3-year-old has developed sufficient abstract knowledge to produce auxiliary BE—or, at least, auxiliary is—reliably. If we take a strong view of the UCC hypothesis, this would appear to be consistent with its predictions that maturation occurs early and rapidly.

Even though the group data supported the UCC hypothesis, the account actually makes predictions at the level of the individual child, and the individual data were not completely consistent with this account. For instance, the data from KS show a clear asymmetrical level of performance favoring the pronominal subject, whereas data from AV2 show the opposite pattern. A strong UCC account would actually predict that all children would more closely resemble the pattern shown by AH, for example. Furthermore, there are hints that developmental change may be influencing our results. Recall that children with lower overall percent correct in the task tended to produce auxiliary is more accurately with pronominal subjects than with lexical NP subjects (see Figure 2). This result indicates that some children did rely on highly frequent/lexically specific constructions (e.g., He’s verb-ing) to produce auxiliary is—at least, when their use of auxiliary is was still limited. It is possible that this trend toward more accurate productions with lexical NPs as children become more accurate overall is related to the increasingly abstract representations available to children. Although the UCC hypothesis predicts developmental change with regard to overall accuracy due to maturation of the constraint (Rice et al., 1998), it does not predict that individual children will perform better under one condition than under another. Future work will have to explore whether there are developmental effects that can explain these changing levels of variability within the scope of the UCC account.

**Testing the Usage-Based Approach**

Turning now to the usage-based approach, we see mixed results. Although the asymmetrical performance observed in the individual data initially appears to support this hypothesis (Tomasello, 2003; Pine et al., 2008), closer examination of the data shows that auxiliary is was not always used more accurately with more frequent (i.e., pronominal) subjects. A stronger facilitation effect should be observed for pronominal subjects because they are strengthened by the frequency with which they co-occur with the auxiliary form (Joseph et al., 2002; Theakston et al., 2005). Instead, we see comparable rates of use across subject types at the group level. The lack of asymmetry between the pronominal and lexical NP subjects in the group and individual data suggests that 3-year-olds have started to build up abstract constructions for auxiliary is and have surpassed lexically specific constructions, even though the representation of abstract constructions has not yet reached adultlike levels of strength and is still prone to errors (Theakston & Rowland, 2009). This finding seems to challenge the usage-based view that young children may have only lexically specific constructions in their representations (e.g., Theakston & Lieven, 2008; Tomasello, 2000). Nonetheless, the usage-based approach does assume that children will eventually develop abstract constructions to produce auxiliary is and other linguistic constructions, and it is possible that we observed that ability in the children here.

Alternatively, for the five children with less than 40% correct overall use of auxiliary is in the task (HP, AS, CD, CH, and KS; ages 2;8–3;3), we do observe the predicted asymmetry. These are not the youngest children in the sample—indeed, they seem to be spread across the entire age range. The fact that some children do show this pattern lends credence to the predictions of the usage-based approach. Had we included more children with lower overall accuracy of auxiliary is, the group data could have supported the predictions of the usage-based approach. It is possible that children begin by learning highly frequent/lexically specific constructions of auxiliary is (Lieven, 2008; Theakston et al., 2005; Wilson, 2003), which leads to the asymmetry between pronominal and lexical NP subjects. Once they have built up the abstract representations to a degree sufficient for supporting production, the advantage of pronominal subjects will gradually diminish, as was observed in children with relatively higher overall percent correct in the task.

This explanation, however, poses other challenges to the usage-based approach. This account remains unclear as to when and how the process of abstraction occurs, how the degree of abstractness can be measured, and how lexically specific and abstract constructions interact to support children’s production. For instance, when a child with variable production of auxiliary is shows symmetry between subject types (e.g., participant AH), we are not sure how this symmetry occurs from a usage-based point of view. One could argue that this is because the child uses the abstract constructions to support the production of auxiliary is for both subject types. But then, one is left wondering why auxiliary is is sometimes omitted. It is also possible that the child continues to use lexically specific constructions to produce sentences with pronominal subjects even when he or she has begun to use abstract constructions for sentences with lexical subjects and that the strength of abstract constructions (e.g., NP’s verb-ing) “catches up” with that of lexically specific constructions (e.g., He’s/She’s verb-ing)
sometime in development. More sensitive measures may be necessary in order to document the changes that occur over the course of development. Continuous measures of comprehension (e.g., Spivey, Tanenhaus, Eberhard, & Sedivy, 2002; Trueswell, Sekerina, Hill, & Logrip, 1999) and lexical production (Brooks & MacWhinney, 2000; Kohnert, Bates, & Hernandez, 1999) have fundamentally altered the way in which we view relative contributions of frequency and context. The development of similar measures of production that can be used with young children would significantly improve our ability to assess the veracity of the usage-based account. For example, studies such as those using eye tracking, reaction times (RTs), and utterance length with adults would need to be adapted for use with children (Ferriera & Swets, 2002; Gennari & MacDonald, 2009; Lee & Thompson, 2008).

**Comparison With Other Studies**

The finding that the accuracy of auxiliary *is* did not differ across subject types in 3-year-olds as a whole is inconsistent with the findings of previous corpus studies (e.g., Pine et al., 2008; Wilson, 2003). Discrepant findings between the present study and previous research could have resulted from the differences in the design. Although in previous studies, the authors collapsed language samples collected over a period of time to explore the child’s production of auxiliary *is* and other tense and agreement morphemes, in this study we adopted an experimental paradigm (i.e., an elicited production task) to examine children’s use of auxiliary *is* at a given point of developmental time. This has two implications with regard to understanding and interpreting our findings. First, elicited production tasks may encourage the children to use abstract constructions that they have already acquired but do not yet use fluently in spontaneous speech. Although elicited production does allow us to be more confident about the target production, it also means that we may be requiring children to produce responses that they would not typically produce in spontaneous discourse. Second, elicited production allowed us to examine children’s performance at a given developmental time point. The language sample analyses in other studies used larger windows of developmental time and collapsed analyses across these windows. Collapsing across time was necessary in order to obtain a sufficient number of utterances for evaluation in those studies. Nonetheless, it was possible that some children in the corpus studies may have produced auxiliary BE differently at some later points; however, by collapsing language samples over a period of several months, this pattern was not readily observable (Rispoli et al., 2009).

Our use of a cross-sectional design with elicited production introduces another concern into our analyses. We examined children who were potentially at different developmental stages, both in relation to one another and in relation to previous studies. The age range of children at the beginning of the study in Wilson (2003) was 1;8–2;8 and in Pine and colleagues (2008) was 1;8–2;0, both of which were younger than the ages of participants in the present study. The reason that the two previous studies showed a high-frequency advantage might have been because their participants were young and still relied heavily on highly frequent/lexically specific constructions to produce tense and agreement morphemes. The presence of older children (ages 2;8–3;4) in the present study—children who might have developed more abstract knowledge—may have obscured this trend in the group analysis. Furthermore, age has been shown to be a poor predictor of developmental level for language (Samuelson & Smith, 1999). By choosing children on the basis of age and performance in the experimental conditions (i.e., below 90% correct), we may have mixed children with various developmental levels or stages. As can be seen in the data presented individually, there do seem to be some children for whom a pronominal advantage is observed and other children for whom there is no such advantage, which might have led to the null results in the group analysis.

Although the finding that the facilitative effect of pronominal subjects on the use of auxiliary *is* shifted with the children’s accuracy level in the task was not predicted by the UCC hypothesis or the usage-based approach, it was consistent with the gradual morphosyntactic learning (GML) hypothesis (Rispoli et al., 2009). This generative account argues that combinations of pronominal subjects and contracted auxiliary *is* are more likely to be produced via direct activation because of their frequency, whereas combinations of lexical NP subjects and auxiliary *is* are more likely to be produced via grammatical encoding. This is particularly true for children at earlier stages of grammatical development. Before children’s grammatical encoding mechanisms reach adult-like levels of functioning, the production of auxiliary *is* with lexical NP subjects will be variable (Hadley, Rispoli, Fitzgerald, & Bahnsen, in press). Thus, the GML hypothesis predicts that the production accuracy of auxiliary *is* should be higher with pronominal subjects than with lexical NP subjects in children with lower developmental levels because the production of the former is more likely to be accomplished through direct activation. The difference in production accuracy of auxiliary *is* by subject type should decrease over time as children’s grammatical encoding mechanisms gradually develop. This difference occurs because there is a general shift in development from sentence production via direction activation to sentence production via grammatical encoding. The findings of the present study seem to support these predictions.

One way to further examine the predictions of the GML hypothesis is to collect longitudinal data within the
same children and observe their use of auxiliary is with different subject types over time (Theakston & Rowland, 2009). The other is to consider collecting cross-sectional data from different children who were selected based on a recognized measure of developmental change within language—rather than age—to determine if there are better ways of controlling children’s developmental profiles and whether such a control would allow us to better explain developmental change. Measures such as finite verb morphology composites (Goffman & J. Leonard, 2000) and tense productivity scores (Hadley & Short, 2005; Rispoli et al., 2009) have been used to document children’s developmental levels of tense and could potentially be incorporated into the analysis to account for the role of subject types in the production of auxiliary is.

Conclusion

This study tested the UCC hypothesis and the usage-based approach by examining the effect of subject types on the production of auxiliary is in 3-year-olds via an elicited production task. The group data showed that the production accuracy of auxiliary is did not differ with pronominal subjects or lexical NP subjects in 3-year-olds who used auxiliary is inconsistently. The individual data showed considerable individual variability with regard to the role of subject type on auxiliary is production. In contrast to the predictions of the usage-based approach, although some children used auxiliary is more accurately with pronominal subjects than with lexical NP subjects, the majority of children did not show this trend. Those children who did show an advantage with pronominal subjects appeared to be those children with lower levels of overall accuracy in the task, which pointed to changing developmental profiles over time. Taken together, these findings more closely align with the predictions of the UCC hypothesis than with the predictions of the usage-based approach. However, had we included more children in the early stages of grammatical development, we might have found the asymmetry between subject types as predicted by the usage-based approach by examining the effect of subject types over time. Taken together, these findings more closely align with the predictions of the UCC hypothesis than with the predictions of the usage-based approach. Thus, we do not rule out the possibility that frequency is an important factor in accounting for the variable production of auxiliary is and other tense and agreement morphemes in young children. Rather, we suggest that longitudinal studies and methodological advances allowing for the precise documentation of children’s developmental levels—in combination with stimuli that employ a greater range in lexical frequency and more precise measurement techniques—are necessary in order to better understand the role of frequency in the acquisition of tense and agreement morphemes and other aspects of language development.

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### Appendix A. Contrastive and target sentences of auxiliary is.

<table>
<thead>
<tr>
<th>Contrastive sentences</th>
<th>Target sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-frequency pronominal subjects</strong></td>
<td></td>
</tr>
<tr>
<td>1. They’re making a cake.</td>
<td>1. He’s eating a cookie.</td>
</tr>
<tr>
<td>2. They’re cleaning the table.</td>
<td>2. She’s drinking the water.</td>
</tr>
<tr>
<td>3. They’re walking the dog.</td>
<td>3. It’s licking the doctor.</td>
</tr>
<tr>
<td>4. They’re cooking the chicken.</td>
<td>4. He’s drawing a flower.</td>
</tr>
<tr>
<td>5. They’re painting the door.</td>
<td>5. She’s hitting the TV.</td>
</tr>
<tr>
<td>6. They’re wiping the window.</td>
<td>6. It’s chasing the bunny.</td>
</tr>
<tr>
<td>7. They’re touching the ball.</td>
<td>7. He’s driving the airplane.</td>
</tr>
<tr>
<td>8. They’re climbing the wall.</td>
<td>8. She’s feeding the rabbit.</td>
</tr>
<tr>
<td>9. They’re throwing the ball.</td>
<td>9. It’s kissing the princess.</td>
</tr>
<tr>
<td>10. They’re moving the orange.</td>
<td>10. He’s cutting the apple.</td>
</tr>
<tr>
<td><strong>High-frequency lexical NP subjects</strong></td>
<td></td>
</tr>
<tr>
<td>11. The foxes are moving the pumpkin.</td>
<td>11. The dog’s eating a cake.</td>
</tr>
<tr>
<td>12. The chickens are making a pie.</td>
<td>12. The goat’s drinking the juice.</td>
</tr>
<tr>
<td>13. The angels are cleaning the chair.</td>
<td>13. The dog’s licking the boy.</td>
</tr>
<tr>
<td>14. The boys are walking the cat.</td>
<td>14. The duck’s drawing a star.</td>
</tr>
<tr>
<td>15. The wolves are wiping the floor.</td>
<td>15. The pig’s hitting the tree.</td>
</tr>
<tr>
<td>16. The witches are painting the wall.</td>
<td>16. The cat’s chasing the mouse.</td>
</tr>
<tr>
<td>17. The mice are climbing the ladder.</td>
<td>17. The goat’s driving the car.</td>
</tr>
<tr>
<td>18. Tom and Jane are watering the flower.</td>
<td>18. Mom’s feeding the turtle.</td>
</tr>
<tr>
<td>19. The bunnies are throwing the apple.</td>
<td>19. The cat’s kissing the girl.</td>
</tr>
<tr>
<td>20. The penguins are touching the table.</td>
<td>20. The pig’s cutting the cake.</td>
</tr>
<tr>
<td><strong>Low-frequency lexical NP subjects</strong></td>
<td></td>
</tr>
<tr>
<td>21. The horses are wiping the floor.</td>
<td>21. The deer’s eating a cake.</td>
</tr>
<tr>
<td>22. The wolves are painting the chair.</td>
<td>22. The queen’s drinking the tea.</td>
</tr>
<tr>
<td>23. The foxes are climbing the ladder.</td>
<td>23. The sheep’s licking the boy.</td>
</tr>
<tr>
<td>24. The chickens are throwing the ball.</td>
<td>24. The ant’s drawing a tree.</td>
</tr>
<tr>
<td>25. The angels are walking the dog.</td>
<td>25. The frog’s hitting the boat.</td>
</tr>
<tr>
<td>26. The elephants are moving the TV.</td>
<td>26. The sheep’s chasing the duck.</td>
</tr>
<tr>
<td>27. The lions are watering the tree.</td>
<td>27. The frog’s riding a bike.</td>
</tr>
<tr>
<td>28. The witches are making the soup.</td>
<td>28. The queen’s feeding the bird.</td>
</tr>
<tr>
<td>29. The monkeys are cleaning the table.</td>
<td>29. The deer’s kissing the prince.</td>
</tr>
<tr>
<td>30. The mice are touching the cheese.</td>
<td>30. The ant’s cutting the bread.</td>
</tr>
</tbody>
</table>
Appendix B. Sample pictures.

1. He’s drawing a flower.

2. The goat’s driving the car.

3. The deer’s eating a cake.
Appendix C. Examples of additional prompts.

The use of additional prompts depended on the child’s response (Target: He’s eating a cookie). If the child did not respond or used an alternative subject type, the prompts could be one of the following three prompts:

1) Can you tell me what’s happening to him?
2) Can you start by saying “HE” if I’ll start. They’re moving the orange but . . .
3) They’re moving the orange but he . . .

If the child responded with an alternative sentence structure (e.g., He’s a bear), the prompt was to repeat the verb phrases and contrastive sentences, such as the following prompt:

4) Remember? Moving the orange. Cutting the apple. They’re moving the orange but . . .
Effect of Subject Types on the Production of Auxiliary Is in Young English-Speaking Children

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