LEARNING HOW TO LICENSE NULL NOUN-CLASS PREFIXES IN SESOTHO

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Noun-class prefixes are obligatory in most Bantu languages. However, the Sotho languages (Sesotho, Setswana, Sepedi) permit a subset of prefixes to be realized as null at the intersection of 'unmarked' phonological, syntactic, and discourse conditions. This raises the question of how and when the licensing of null prefixes is learned. Using longitudinal data from three Sesotho-speaking children, this article shows that the conditions needed to license null prefixes have been learned before the age of three, suggesting early abilities for grammatical generalization even at the intersection of different levels of linguistic structure. The implications for learnability theory and Bantu linguistic structure more generally are discussed.*

Keywords: Sesotho, Bantu languages, noun-class prefixes, nominal agreement, language acquisition, learnability

1. INTRODUCTION. Most of the approximately five hundred Bantu languages of sub-Saharan Africa have a series of singular/plural noun-class prefix pairs (see Nurse & Phillipson 2003). These are listed in 1 for the southern Bantu language Sesotho, spoken in Lesotho and adjacent parts of South Africa to the north (Doke & Mofokeng 1985).[1]

(1) Sesotho nouns and noun-class prefixes

CLASS	SINGULAR	CLASS	PLURAL	
1	mo-tho	2	ba-tho	'person'
1a	Ø-rakhadi	1b	bo-rakhadi	'aunt'
3	mo-se	4	me-se	'dress'
5	le-tsatsi	6	ma-tsatsi	'day/sun'
7	se-fate	8	di-fate	'tree'
9	Ø-ntja	10	di-ntja	'dog'
14	bo-phelo			'health'

These prefixes mark grammatical gender and participate in a rich system of agreement within the determiner phrase (DP), the inflectional phrase (IP), and the complementizer phrase (CP). This is shown in 2 and 3.[2]

[1] Bantu language names are alternatively written in the literature either with or without the noun-class prefix (e.g. Setswana vs. Tswana). In this article we include the prefix. Note also that Sesotho is alternatively referred to in the literature as Southern Sotho, and Sepedi as Northern Sotho.

[2] Unless otherwise indicated, all examples follow phonetically more transparent South African orthographic conventions. Glosses are as follows: numbers indicate noun class, CONJ: conjunction, COP: copula, DEM: demonstrative, FOC: focus, FV: final vowel, LOC: locative suffix, NEG: negation, OM: object marker, PASS: passive, PN: pronoun, PRF: perfect, REL: relative complementizer, RL: relative suffix, SM: subject-verb agreement, WH: WH-question.

(2) Se-tulo se-se-cha se-du-tse   pela ba-na   ba-ka.
    7-chair 7-7-new 7.SM-sit-PRF.FV beside 2-children 2-my
       'The new chair is sitting next to my children.'

(3) Se-tulo seo   ke-se-batl-a-ng   se   turu.
    7-chair 7.REL SM.1SG-7.OM-want-FV-RL 7.COP expensive
       'The chair that I like is expensive.'

It has long been known that children learning Bantu languages tend to omit noun-class prefixes at early stages of acquisition, exhibiting null forms, a 'filler syllable', and finally a full CV prefix by around the age of 3;0 (Siswati—Kunene 1979; IsiZulu—Suzman 1980, 1991; Sesotho—Connelly 1984, Demuth 1988, Ziesler & Demuth 1995; Setswana—Tsonope 1987; IsiXhosa—Gxilishe et al. 2007). Illustrative examples are provided in 4.

(4) The development of Sesotho noun-class prefixes between two to three years
    target le-phoqo 'green corn stalk'   class 5
    null   Ø-phoko
    filler a-phonko
    CV   le-phoqo

Some of this variability in early noun-class prefix production is due to prosodic constraints in children's early grammars. For example, children are more likely to preserve noun-class prefixes when these occur before a monosyllabic stem, as in 5a, than before a disyllabic stem, as in 5b, where they tend to be omitted (indicated in parentheses) (Connelly 1984). This lead Demuth (1992a, 1994) to propose a prosodic explanation for this phenomenon, suggesting that children would be more likely to preserve a noun-class prefix if it could be prosodified as part of a disyllabic foot.

(5) Prosodic licensing of noun-class prefixes in early speech
    a. [mo-tho]$_{FT}$ 'person'   class 1
    b. (mo)-[sadi]$_{FT}$ 'woman'   class 1

Recent quantitative analysis, however, has shown that these prosodic licensing effects disappear around the age of 2;3–2;6 (Demuth & Ellis 2009). Thus, some of the persisting variability in children's use of noun-class prefixes is due to other factors.

One might wonder if some of the variable production of noun-class prefixes could be due to problems with knowing which noun class a noun stem belongs to. Demuth (1988), however, showed that errors of commission are rare; most errors are due to omission. In addition, children typically produce postnominal modifiers with the appropriate form of agreement even when the noun-class prefix is realized as null (Demuth & Weschler 2009). This is illustrated in 6 (from Demuth 1994:129).

(6) Correct nominal agreement used even when the prefix is realized null
    (se)-kolo **sa**-ne
     7-school 7-DEM
       'that school'   (Hlobohang 2;1 yrs.)

Thus, Sesotho-speaking two-year-olds appear to know the noun class of the noun even when they produce it without a prefix. This again raises questions about the underlying reasons for children's variable production of noun-class prefixes, and if the nature of the language input they hear might play a role in explaining this persistent variability.

Tsonope (1987), in a study showing the variable production of noun-class prefixes by Setswana-speaking children, claimed that Setswana-speaking adults never omit

noun-class prefixes. Nor do grammars of these languages report the possibility of omitting noun-class prefixes (e.g. Doke & Mofokeng 1985, Cole 1955), though Grinevald and Seifart (2004:249) briefly mention this possibility in Setswana. Ziesler and Demuth (1995) did find that Sesotho-speaking adults omit prefixes in casual conversation with children and others, but did not realize that only some prefixes can be null, and only under certain conditions. Thus, unlike the Cameroon Bantoid language Aghem, where null prefixes are obligatory when all nouns are followed by agreement (Hyman 1980), this is not the case for Sesotho or for the other Sotho languages (Setswana, Sepedi). Rather, there are phonological, syntactic, and discourse conditions that together license null prefixes in the Sotho languages, raising interesting questions about how such a system of interacting constraints from different linguistic domains might be learned. The purpose of this article is therefore to clarify the conditions under which null prefixes are permitted in Sotho languages, and then to investigate how and when this system is acquired. We use examples from Sesotho to illustrate throughout.

2. LICENSING NULL NOUN-CLASS PREFIXES IN SOTHO. In this section we show that null noun-class prefixes in the Sotho languages are licensed when all three conditions in 7 are met. That is, when the noun and its prefix are phonologically and discourse 'unmarked', and phi-features can be satisfied by alternative means within the c-domain, the prefix can be realized as null.[3]

    (7) Licensing conditions for null noun-class prefixes in Sotho
- phonological: only with prefixes beginning with a coronal consonant
- syntactic: only when noun is within the same c-domain as agreement
- discourse: only with previously mentioned, noncontrastive, nonfocused referents

2.1. NULL PREFIXES ARE PHONOLOGICALLY LICENSED. As mentioned above, only some Sesotho prefixes can be realized as null. These are italicized in 8, where the phonetic quality of vowel has been used (as opposed to the orthography) (see discussion of segmental inventory in Doke & Mofokeng 1985 and Rose & Demuth 2006). All prefixes are low-toned except class 2a, which has high tone.

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[3] The definition of c-command (constituent command) (or c-domain, Manzini 1983) is based partly on the relationship of 'dominance' where one node dominates another node if it is above it in the tree (i.e. its parent or grandparent) (Chomsky 1981). Thus, X c-commands Y if and only if (a) neither X nor Y dominates the other, and (b) the Sentence node that most immediately dominates X also dominates Y. This is illustrated in the tree in (i).

(i)

              B
       /   \
    A   C
            / \
         D   E
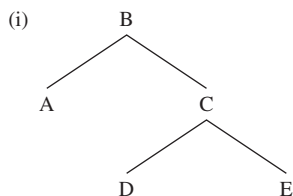
A c-commands C, D, and E.
B does not c-command any nodes.
C c-commands A.
D c-commands E.
E c-commands D.

Thus, DP (determiner phrase) is the c-domain for nominal + modifier agreement since it is the minimal maximal category dominating them both. IP (inflectional phrase) is the c-domain for the subject NP (noun phrase) and subject-verb agreement since it is the minimal maximal category dominating both.

(8) Sesotho noun-class prefixes (those italicized can be realized as null)

SINGULAR		PLURAL	
1	mʊ-	2	ba-
1a	Ø-	2a	bó-
3	mʊ-	4	mɪ-
5	*lɪ-*	6	ma-
7	*sɪ-*	8	*di-*
9	Ø-	10	*di-*
14	bʊ-		

Note that neither tone nor the quality of the vowel makes any difference in the ability of the noun class to be realized as null. However, the nature of the consonant does. All of the prefixes that can be realized as null contain a coronal consonant. This is of particular interest because the coronal place of articulation has been considered to be 'unmarked', often undergoing special phonological processes (e.g. Paradis & Prunet 1989). Thus, we suggest that those prefixes that contain an 'unmarked' consonant are those that can be realized as null. It is therefore of interest to note that, in addition to the prefixes outlined in 8 for Sesotho, closely related Setswana has a class 11 *lʊ-* prefix. We would therefore predict that this prefix would appear as null under appropriate licensing conditions, and this is the case. We also note that Sotho class 14 *bʊ-* can be realized as null, but not as freely as those with prefixes beginning with a coronal consonant. This is discussed further in §2.3.

2.2. Null prefixes are syntactically licensed. We have identified above the noun classes that permit a null prefix when certain syntactic conditions are met. One of these conditions is that the noun must cooccur with some form of agreement, within a c-command relationship (see n. 3). Consider the examples below, where the prefix on *di-tulo* 'chair' can be null when followed by a possessive that agrees with it in 9a, but cannot be omitted when no agreement form follows in 9b. Note also that the omission of the prefix on a class 1 noun in 10 (with a [−coronal] consonant in the prefix) is ungrammatical even in the presence of a following modifier. That is, the sentence in 10 is unacceptable because it does not satisfy the phonological licensing conditions, even though syntactic licensing conditions are met.

(9) a. Ba-tho   ba-rat-a   (di)-tulo tsa-ka.
        2-people 2.SM-like-FV 8-chairs 8-my
            'The people like my chairs.'
    b. Ba-tho   ba-rat-a   *(di)-tulo.
        2-people 2.SM-like-FV   8-chairs
            'The people like chairs.'
(10) Neo o-rat-a   *(mo)-sadi e-mo-tle.
        Neo 1.SM-like-FV   1-woman 1-1-nice
            'Neo likes the beautiful woman.'

Various types of agreement can license null prefixes, including subject-verb agreement (11), all kinds of modifiers (including demonstratives as in 12, but also possessives, adjectives, numerals, etc.), agreeing copulas (13), nonagreeing copulas (14), and subject and object relative clauses (15a,b).

(11) (Se)-tulo **se**-du-tse   tafole-ng.
        8-chair **8**.SM-sit-PRF.FV 9.table-LOC
            'The chair is sitting at the table.'

(12) Be-a   (se)-tulo **se**-na fatse.
      put-FV 8-chair **8**-DEM down
        'Put this chair down.'

(13) (Se)-tulo **se**   metsi.
       8-chair **8**.COP water
        'The chair is wet.'

(14) (Se)-tulo ke   **se**-fe-ng?
       8-school COP **8**-what-WH
        'Which chair is it?'

(15) a. (Se)-tulo **se**-du-tse-ng   fatse.
          8-chair **8**.REL.SM-sit-PRF.FV-RL ground
            'The chair that is sitting on the ground.'
     b. (Se)-tulo **seo**   ke-se-batl-a-ng.
          8-chair **8**.REL I-8.OM-want-FV-RL
            'The chair that I (it) want.'

   Left dislocations of both subject in 16a and object in 16b also license null prefixes.
These are still in a c-command relationship with agreement. Right dislocations of either
subject or object, however, cannot license null prefixes, as shown in 17a,b. This is
because the subject is adjoined to the VP node (Rizzi 1982), and is no longer in a
c-command relationship with subject agreement (see n. 3). The right-dislocated object
is adjoined to IP, which is outside the c-domain of the object agreement.

(16) a. (Se)-tulo kajeno se-du-tse   fatse.
          8-chair today 8.SM-sit-PRF.FV ground
            'The chair, today, is sitting on the ground.'
     b. (Se)-tulo ke-a-se-batl-a.
          8-chair 1SG.SM-PRES-8.OM-want-FV
            'The chair, I want it.'

(17) a. Se-du-tse   fatse *(se)-tulo.
          8.SM-sit-PRF.FV ground 8-chair
            'It was sitting on the ground, the chair.'
     b. Ke-a-se-batl-a   *(se)-tulo.
          1SG.SM-PRES-8.OM-want-FV   8-chair
            'I want it, the chair.'

Thus, the postposed subject in 17a cannot be null because there is no modifier available
to license a null prefix. It is adjoined to the VP, and is therefore not within the
c-domain of subject-verb agreement under IP. The sentence in 17b is also unacceptable
since the object marker and the right-dislocated object are not within the same c-domain
(see Machobane et al. 2007). Thus, although null prefixes are permitted in the context
of agreement, there are some syntactic restrictions on this process.

   2.3. LEXICAL ISSUES. There are a few cases where null prefixes are attested even in
the absence of agreement. This includes the optional use of prefixes with some class
14 nouns that are typically used without the prefix, as in 18a,b, and some class 5 nouns
that are ungrammatical with the prefix in the locative, as in 19a–c. Both appear to be
lexicalized forms. Other locatives, including other class 5 locatives, must be used with
the noun-class prefix in the absence of agreement licensing, as shown in 20a–c.

(18) Optional prefixes for some class 14 nouns
     a. (bo)-jwala   'beer'
     b. (bo)-jwang   'grass'

(19) Null prefixes obligatory for some class 5 nouns when locative
    a. *le-hano-ng   'in (poss.) mouth'
    b. *le-sake-ng   'at the kraal'
    c. *le-ifo   'at the hearth'
    (note: *ifo* does not take the locative *-ng* suffix)

(20) Prefixes obligatory if no agreement
    a. *(le)-oto-ng   'on (poss.) foot'   class 5
    b. *(se)-dibe-ng   'at the well'   class 7
    c. *(di)-kolo-ng   'at the schools'   class 10

Silozi, a language that was historically Sotho but that has been subsequently influenced by the Bantu languages of Zambia where it is now spoken, does not permit null prefixes to the same extent as the Sotho languages spoken today in southern Africa. It does, however, have a few lexicalized forms that occur with no prefix, many of them from class 5. This may be part of a larger Bantu tendency for the prefix of class 5 nouns to be phonologically reduced from CV to V (as in Nguni languages) and eventually reduced to Ø (as in Swahili).

Aside from these few lexicalized forms, null prefixes are permitted in the southern Sotho languages under certain phonological, syntactic, and discourse conditions. Speakers, however, do not always omit these prefixes even when these conditions are met. This raised the possibility that some of the variability in the use of null prefixes might be due to lexical effects. That is, perhaps adults tend to omit prefixes more often on certain high-frequency lexical items.

To investigate this issue, we conducted an analysis of the Demuth Sesotho Corpus, a collection of ninety-eight hours of adult-child spontaneous-speech interactions recorded in rural Lesotho (Demuth 1992b; see http://childes.psy.cmu.edu/). The corpus includes three different data sets, one for each two-to-three-year-old child (Hlobohang (boy), Litlhare (girl), and 'Neuoe (girl)), and the adults in each of their households. The three sets of adult data included 2,105 tokens of nouns from the four noun classes that begin with a coronal consonant (henceforth [+coronal] prefixes). Of these, 530 (25%) occurred with some form of c-commanding agreement, thus being eligible for being realized with a null prefix. Of these, less than half actually occurred with a null prefix in adult speech to each of the three children (Hlobohang—30%, Litlhare—37%, 'Neuoe—46%). Further examination of the adult data revealed that the prefix was dropped 80% of the time with the high-frequency lexical item *di-ntho* 'things' but only 30% of the time for the less frequent lexical item *di-eta* 'shoes'. This suggested that null noun-class prefixes might be lexically licensed, with high-frequency words more likely to be phonologically (and morphologically) reduced. Further analysis of the adult data, however, showed no correlation between lexical frequency and the use of null prefixes, suggesting that *di-ntho* 'things' is a special case. Thus, factors other than lexical frequency must play a role in determining when prefixes are realized as null.

The corpus analysis also provided further information about the adult use of class 14 prefixes. Of the ninety-three adult tokens of class 14 nouns, only twelve (13%) occurred with some form of agreement (indicated in italics in 21). This is much lower than the 25% use of agreement with the coronal nouns. Furthermore, none of these occurred with a null prefix. That is, from a corpus of ninety-eight hours of speech there were no examples of null prefixes used by adults with class 14 nouns except for five instances of the lexicalized form *(bo)jwala* 'beer'. Perhaps this is due to the semantics of the words in this class, many of which are abstract nouns, and thus less likely to occur with modifiers.

(21) Class 14 nouns used by adults in the Sesotho Corpus

bobe	'evil'	*bokudube*	'horse dung'
bohale	'sharpness'	bolekana	'tin can'
bohata	'lie'	bophoqo	'foolishness'
bohobe	'bread'	borikhwe	'trousers'
bokako	'conceit'	*boroko*	'sleep'
boko	'brain'	bosiu	'night'
		botswa	'bluntness'

Further investigation found that Sesotho speakers do not permit the use of a null noun-class 14 prefix when the nominal stem is monosyllabic. Thus, although class 14 prefixes can be realized as null when they occur under appropriate agreement conditions, as in 22, they cannot be realized as null with monosyllabic nominal stems, as shown in 23. Interestingly, this contrasts with the coronal classes, where monosyllabic stems are permitted when immediately followed by a modifier in 24a (though not when left dislocated with no adjacent modifier, as in 24b).

(22) M-ph-e   (**bo**)-hobe ba-ka.
     1SG.OM-give-FV 14-bread 14-my
        'Give me my bread.'

(23) M-ph-e   *(**bo**)-ko ba-ne.
     1SG.OM-give-FV   14-brain 14-that
        'Give me that brain.' (e.g. of a slaughtered sheep)

(24) a.   M-ph-e   (**di**)-jo tsa-ka.
           1SG.OM-give-FV 8-food 8-my
              'Give me my food.'

     b. *(Di)-jo ke-a-di-batl-a.
           8-food 1SG.SM-PRES-8.OM-want-FV
              'Food, I want it.'

Since Sesotho (like many other Bantu languages) has no coda consonants and no contrastive vowel length or diphthongs, a monosyllabic word is also monomoraic. These languages have a strong word-minimality requirement that all open-class words must contain at least two moras of structure (i.e. a disyllabic foot) (e.g. Doke & Mofokeng 1985, Myers 1987). In the case of monosyllabic lexical stems, adjacent grammatical morphemes are typically co-opted to fulfill these prosodic requirements, or, if none are available, a compensatory vowel will be inserted (e.g. *ja!* 'eat!', but *eja* or *jaa* 'eat!'). Thus, it appears that the monosyllabic stem *-jo* in 24a is permitted only because it can prosodify with the following modifier as one prosodic unit. The same solution, however, is not available for class 14 nouns, as shown by the unacceptability of 23. This suggests that the syntactic structure of class 14 nouns may differ from that of other nouns. With the exception of loanwords (e.g. *borikhwe*, from Afrikaans *broek* 'trousers'), class 14 nouns are primarily mass or deverbal nouns. Thus, many class 14 nouns (and their prefixes) are derived (e.g. *mohale* 'brave man, warrior' > *bohale* 'anger, wrath'). It is therefore possible that these derived forms may not be represented at the same level of syntactic structure within the lexicon. This may also help explain why monosyllabic class 14 stems cannot prosodify with a following agreement form. These issues are pursued further in §4.

In the foregoing discussion we have seen that, with the exception of lexicalized forms such as high-frequency *di-ntho* 'thing', there are no obvious lexical or lexical frequency effects that can explain the variable use of null prefixes when phonological

and syntactic licensing conditions are met. Rather, there appear to be discourse/prag-matic constraints that further determine when a prefix is realized as null. We turn to these issues below.

2.4. NULL PREFIXES ARE DISCOURSE-LICENSED. To examine the discourse licensing of null prefixes, we again consulted the Demuth Sesotho Corpus, identifying conversational exchanges where the same referent/lexical item was used multiple times. Consider the excerpt in 25 from mother (M) and child (C). (Parentheses in the utterance line indicate the child's elided segments, and parentheses in the gloss line indicate null noun-class prefixes.)

(25) a. M: Ke di-ng?
          COP 10-WH
           'What are they?'

    b. C: Ke ntho   t(s)e-kwa(h)el(w)-a-ng.
          COP (10)thing 10.REL-cover.PASS-FV-RL
           'It's the things that are covered.'

    c. M: Ke di-ntho tse-kwahel-w-a-ng?
          COP 10-thing 10.REL-cover-PASS-FV-RL
           'Is it the things that are covered?'

                                  [C nods]

    d. M: Ee, ntho   tse-kwahel-w-a-ng.
          yes (10)thing 10.REL-cover-PASS-FV-RL
           'Yes, the things that are covered.'

In the first turn in 25a, the mother points to the referents in the child's hand. Once identified, the child then omits the prefix in the following turn in 25b. In 25c, however, the mother makes a clarification request, this time using the full prefix. When the child confirms her clarification with a nod, the mother then confirms verbally in 25d, this time using a null prefix.

The examples in 25 indicate that prior identification of the referent in the discourse context may be one of the conditions needed to license a null prefix. This is not sufficient, however. Null prefixes apparently cannot occur when the noun is in the scope of focus, as is the case in the clarification question in 25c. Consider the following passage, where the mother again first identifies the referents (shoes) in her hand in 26a. Note, however, that a null prefix is used in the second turn in 26b, despite the fact that it is a question. But in this case the noun itself is not in the scope of the question. Rather, the question is about the owner of the shoes, not the shoes themselves. Since the referents have been previously identified in the discourse, the noun occurs with a null prefix. In the third turn 26c, however, the shoes themselves are now in focus, and the prefix is used.

(26) a. M: Ke di-ng? M?
          COP 8-WH WH?
           'What are these? Uh?'

    b. M: Eta   ts-ee ke tsa-mang?
          (8)shoe 8-DEM COP 8-whose
           'Whose shoes are these?'

                                  [C What?]

    c. M: Di-eta tseo?
          8-shoe 8.DEM
           'These shoes?'

A similar situation appears in 27, where the conversation still centers on shoes, and the prefix is null in 27a, where focus is neutral. Once the child refuses to give the mother her shoe, however, the focus is no longer neutral, and the prefix is used in 27b.

(27) a. M: M-ph-e   eta   sa-ka ke-y-a   se-dibe-ng.
             1SG.OM-give-FV (7)shoe 7-my 1SG.SM-go-FV 7-spring-LOC
             'Give me my shoe (so) I can go to the spring.'

                                                                          [C I refuse]

     b. M: M-ph-e   se-eta sa-ka, Hlobohang
             1SG.OM-give-FV 7-shoe 7-my H.
             'Give me my shoe, Hlobohang.'

Thus, it appears that the variable use of null prefixes in Sotho can be largely explained by the requirement that the referent be previously identified in the discourse and not in the scope of Focus, broadly construed. That is, the referent must have neutral, 'unmarked' focus; it cannot be in the scope of a clarification question in 25c, and it cannot be emphatic (as in 26c or 27b). Thus, although most contexts where null prefixes appear will be definite as a function of being previously identified in the discourse, it is not clear that definiteness per se is what underlies the licensing of null noun-class prefixes. In fact, definiteness issues are already resolved as a function of agreement (this is further discussed in §4). Rather, null prefixes occur with topical, given, nonfocused referents (cf. Chafe 1976, 1994). That is, they occur in 'unmarked' discourse contexts.

In sum, null noun-class prefixes are licensed in Sesotho (and other Sotho languages) at the intersection of phonological, syntactic, and discourse factors. When all of these are realized as 'unmarked', null prefixes are used. This raises the question of how and when children learn that null prefixes are licensed only at the intersection of three of these conditions. Perhaps learners tune in early to the phonology, overgeneralizing coronal noun-class prefixes in all contexts. Or, perhaps they become aware of the syntactic licensing conditions first, overgeneralizing the use of null prefixes to all classes when agreement conditions are met. Alternatively, they might assume that once a noun has been introduced into the discourse it is available for realization with a null prefix. Finally, they might use null prefixes on only those lexical items they have previously heard realized as null, exhibiting an item-by-item approach to learning with little grammatical generalization (e.g. Tomasello 1992). We turn now to examine the learning process in this complex licensing domain.

3. LEARNING THE LICENSING CONDITIONS THAT GOVERN NULL NOUN-CLASS PREFIXES IN SESOTHO. The noun-class data were drawn from three children in the Demuth Sesotho Corpus. This included ten sessions for the younger two children and seven sessions for the older child, each recorded at approximately one-month intervals. Each session consisted of three to four hours of spontaneous speech interactions between the child and family members, including parents, grandparents, and older siblings (Demuth 1992b). The total number of items containing a coronal prefix analyzed for the children was 2,119, approximately the same as that for the adults. The children's ages, number of coronal tokens for each, and the number of coronal tokens that occurred with some form of agreement are provided in 28.

(28) The number of coronal items, and those followed by agreement, for each child

	AGE	[+cor]	[+cor] [+AGR]
Hlobohang (boy)	2;1–3;0	746	254
Litlhare (girl)	2;1–3;2	995	304
'Neuoe (girl)	2;4–3;3	378	139

Note that Litlhare, who was very verbal, had the largest amount of data, whereas 'Neuoe, who spoke very little, had few tokens. In order to increase the number of items per time period assessed, we collapsed the data from two consecutive recording sessions for each of the children, and binned 'Neuoe's last three sessions together. We then calculated the number and percentage of prefixes produced for all noun classes ($[+/-$coronal], $[+/-$Agreement]). Those prefixes that were realized as a filler syllable (i.e. only a vowel rather than full CV prefix) were coded as 'produced' as opposed to 'null'. All three children showed a significant difference in production between $[+$cor]$[+$AGR] and $[+$cor]$[-$AGR] prefixes (Hlobohang: $\chi^2(1, N = 746) = 19.553$, $p < 0.001$; Litlhare: $\chi^2(1, N = 995) = 59.874$, $p < 0.001$; 'Neuoe: $\chi^2(1, N = 378) = 117.915$, $p < 0.001$). To determine when this difference was achieved, we also examined this issue developmentally. Since the number of items in each session varied, we conducted chi-square analyses for each data point. The results are provided for each child in Tables 1, 2, and 3, respectively.

	2;1–2;2	2;3–2;5	2;6–2;7	2;8–2;9	2;10–3;0
$-$cor, $-$AGR	36/59 (61)	40/45 (89)	76/81 (94)	82/85 (96)	130/132 (98)
$-$cor, $+$AGR	2/5 (40)	13/13 (100)	25/27 (93)	25/27 (93)	30/30 (100)
$+$cor, $-$AGR	54/94 (57)	41/68 (60)	70/87 (80)	96/105 (91)	138/138 (100)
$+$cor, $+$AGR	11/22 (50)	15/31 (48)	27/36 (75)	59/93 (63)	57/72 (79)
$+$cor statistics	$\chi^2(1, N = 116)$ $= 0.401$, $p = 0.526$	$\chi^2(1, N = 99)$ $= 1.229$, $p = 0.268$	$\chi^2(1, N = 123)$ $= 0.455$, $p = 0.500$	$\chi^2(1, N = 198)$ $= 22.723$, $p < 0.001$	none

TABLE 1. Hlobohang's number (percentage) of prefixes produced across conditions.

	2;1–2;2	2;4–2;5	2;6–2;7	2;9–2;10	2;11–3;2
$-$cor, $-$AGR	82/98 (84)	29/38 (76)	115/122 (94)	162/165 (98)	123/128 (96)
$-$cor, $+$AGR	18/20 (90)	12/15 (80)	25/26 (96)	32/33 (97)	46/50 (92)
$+$cor, $-$AGR	81/194 (42)	61/75 (81)	83/111 (75)	156/170 (92)	116/141 (82)
$+$cor, $+$AGR	10/48 (21)	9/28 (32)	25/47 (53)	48/80 (60)	49/101 (49)
$+$cor statistics	$\chi^2(1, N = 242)$ $= 7.177$, $p < 0.01$	$\chi^2(1, N = 103)$ $= 22.657$, $p < 0.001$	$\chi^2(1, N = 158)$ $= 7.111$, $p < 0.01$	$\chi^2(1, N = 250)$ $= 36.558$, $p < 0.001$	$\chi^2(1, N = 242)$ $= 30.906$, $p < 0.001$

TABLE 2. Litlhare's number (percentage) of prefixes produced across conditions.

	2;4–2;6	2;8–2;9	2;11–3;3
$-$cor, $-$AGR	13/13 (100)	65/66 (98)	82/82 (100)
$-$cor, $+$AGR	12/12 (100)	40/40 (100)	32/32 (100)
$+$cor, $-$AGR	42/42 (100)	97/103 (94)	91/94 (97)
$+$cor, $+$AGR	10/18 (56)	28/61 (46)	30/60 (50)
$+$cor statistics	none	$\chi^2(1, N = 164)$ $= 49.255$, $p < 0.001$	$\chi^2(1, N = 154)$ $= 47.660$, $p < 0.001$

TABLE 3. 'Neuoe's number (percentage) of prefixes produced across conditions.

Hlobohang showed no difference between the two coronal conditions until the age of 2;8–2;9. Both of the other children, however, showed a consistently significant difference between the production of coronal prefixes with and without agreement throughout. These developmental patterns can be seen more clearly in Figures 1–3 respectively.
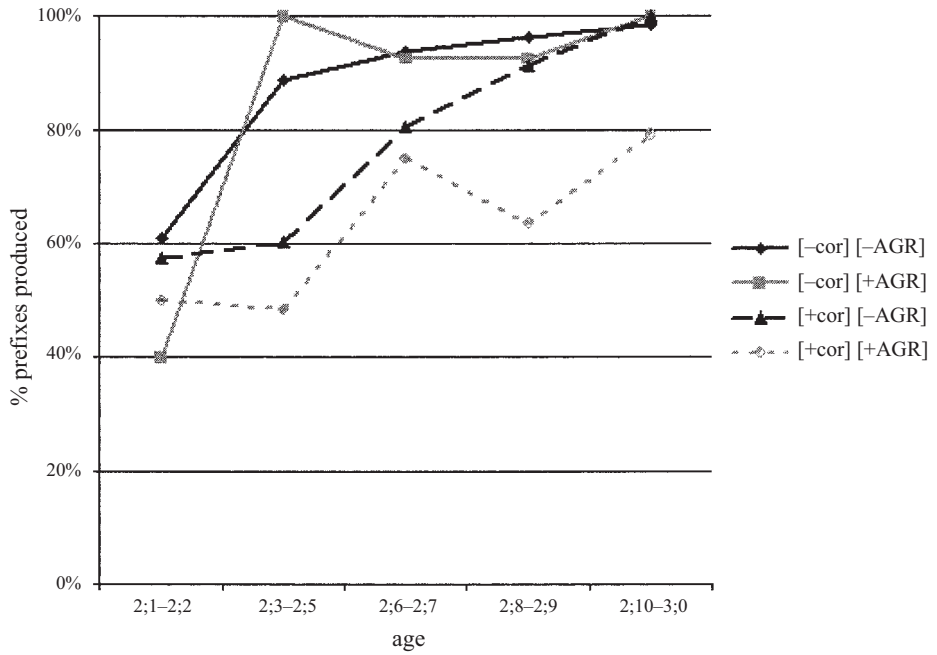
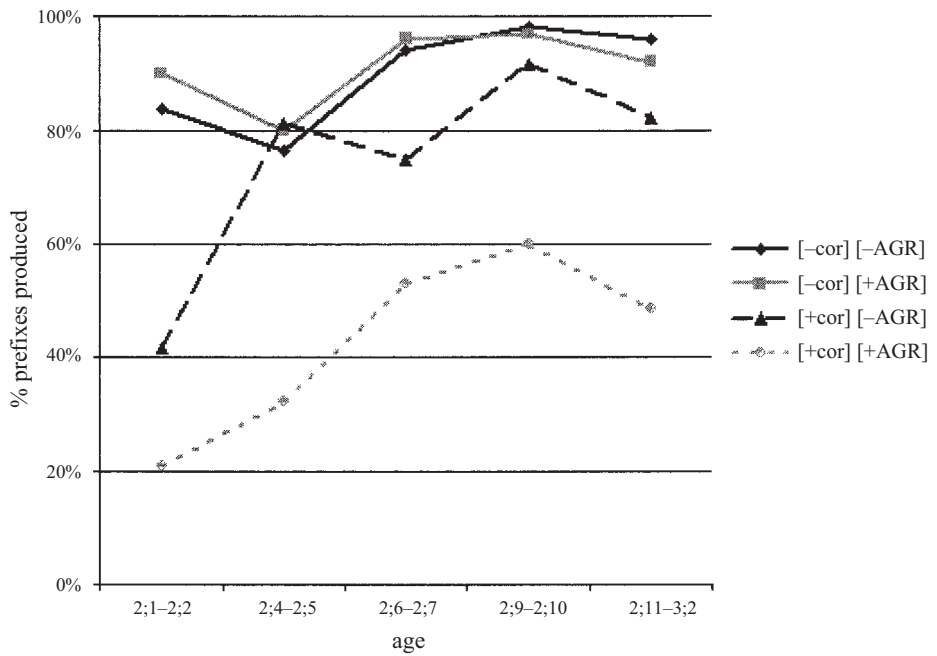FIGURE 1. Hlobohang's production of noun-class prefixes across conditions.

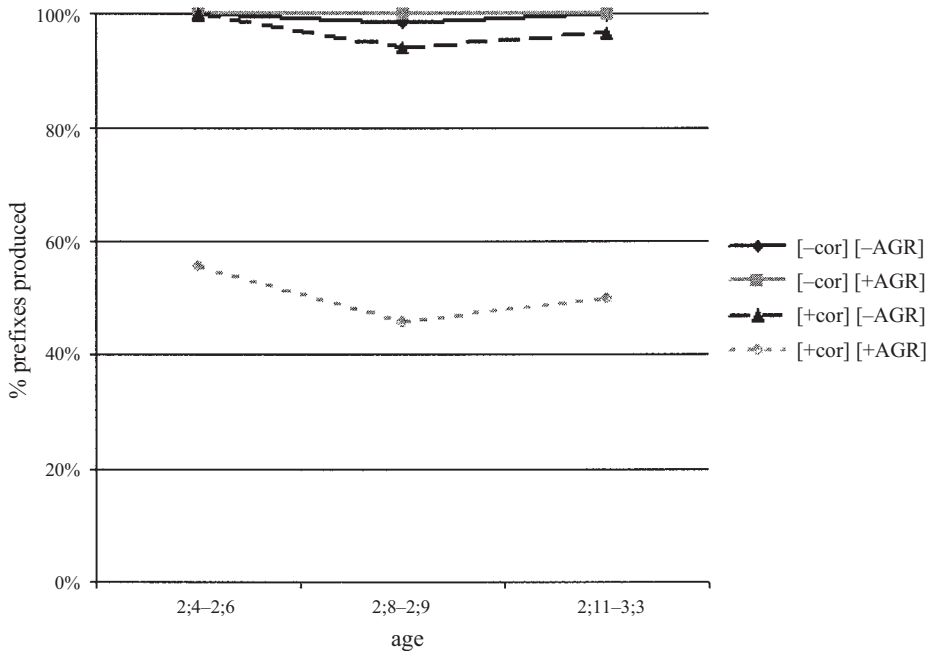FIGURE 2. Litlhare's production of noun-class prefixes across conditions.

FIGURE 3. 'Neuoe's production of noun-class prefixes across conditions.

3.1. EVIDENCE OF PHONOLOGICAL AND SYNTACTIC OVERGENERALIZATION. One of the hallmarks of learners' ability to make grammatical generalizations is overgeneralization, or application of a linguistic generalization to inappropriate (or novel) forms. For example, young English-speaking children are known to apply the regular plural -*s* morpheme to nouns that form the plural by irregular means (e.g. *feet > feets*). By producing forms that have never been heard, children provide evidence of their hypotheses regarding linguistic structure. Given the multifaceted problem of learning to license null noun-class prefixes, we might wonder if perhaps children would overgeneralize on phonological or syntactic grounds. This would also provide evidence that children were not merely memorizing what they heard on an item-by-item basis.

It is therefore of interest that Hlobohang shows an early period of coronal overgeneralization, where he appears to drop coronal prefixes on nouns both with and without agreement. This can be seen in Fig. 1 at the age of 2;3–2;5. That is, Hlobohang goes through a brief period of development where he exhibits phonological licensing of null prefixes, but appears unaware that these must also be syntactically licensed by agreement. By 2;8–2;9 he has learned the syntactic licensing conditions as well, producing null prefixes with [+cor] [+AGR] nouns at the same rate as found in the input he hears. As seen in Fig. 2, Litlhare also shows some early evidence of phonological overgeneralization at 2;1–2;2. But she has learned both the phonological and syntactic licensing conditions by 2;4–2;5. Her less-than-perfect production of other prefixes is due to her tendency to truncate long three- and four-syllable words. Despite the fact that older 'Neoue has much sparser data than the other children, her patterns in Fig. 3 show that she has learned both the phonological and syntactic licensing conditions for null prefixes by 2;4–2;6. Thus, Sesotho-speaking children appear to learn the phonologi-

cal and syntactic licensing conditions for null noun-class prefixes sometime between the ages 2;4 and 2;9.

But how do we know that children have full syntactic knowledge of the licensing conditions for null noun-class prefixes, including the condition that these must stand in a c-domain relationship with agreement? To address this issue we examined the contexts where children used postposed subjects or objects. These begin to appear at 2;6 and 3;0 years respectively (Demuth 1987). All postposed subjects and objects that contained a null noun-class prefix were followed by a nominal modifier. Thus, it appears that these children may have learned the syntactic licensing conditions for null prefixes by this point in development.

3.2. THE ACQUISITION OF CLASS 14 PREFIXES. One might wonder if children use null prefixes with class 14 nouns. Recall that there were few cases of modified class 14 nouns in the adult data, and this was true for the children as well. Of a total of 109 class 14 nouns used by the children, only seventeen cooccurred with agreement. As with the adults, there was no indication of productive null prefix use with class 14 nouns, since all but three were produced. Those where the class 14 prefix was omitted were all cases where Litlhare truncated long words to disyllables (e.g. *(boku)dube* 'horse dung'). Thus, the children appeared to behave much the same as adults, rarely omitting prefixes with class 14 nouns.

3.3. DISCOURSE LICENSING OF NULL NOUN-CLASS PREFIXES. We then investigated children's ability to use null prefixes in the appropriate discourse contexts. Because two-year-olds frequently change the topic of conversation, however, this was more difficult to evaluate than for the adults. Consider the example in 29, where a child uses the prefix with the first mention of a noun in the discourse with no modifier in 29a, and then realizes it as null when subsequent mention is followed by a modifier 29b.

(29) Hlobohang (2;10 years)
    a. A(bu)ti (Le)hlonolo n-kadim-e   le-p(o)lanka.
      Brother L.   1SG.OM-lend-FV 5-plank
        'Brother Lehlohonolo, lend me the plank.'
                            [Boys playing with pieces of wood, boxes . . .]
    b. N-kadim-e   polanka le-na.
      1SG.OM-lend-FV (5)plank 5-DEM
        'Lend me that plank.'

Despite the fact that both utterances are in the imperative, the repetition of the imperative does not prompt the use of the prefix as it did for Hlobohang's mother in 27b. It is possible that this child knows the syntactic, but not the discourse, conditions for null prefix use, despite the fact that his production of prefixes at this point mirrors that of the input he hears. Alternatively, this item may not be in the scope of focus. Consider the example in 30.

(30) Hlobohang (2;10 years)
    a. Mololo sheba nna   ke-du-tse   se-tulo-ng.
      M.   look 1SG.PN 1SG.SM-sit-PRF.FV 7-chair-LOC
        'Mololo look, me, I'm sitting on the chair.'
      [Another child climbs up onto rock, tries to sit, making hard for H to sit.]
    b. A-s'ka-dul-a   tulo-(ng)   sa-ka.
      1.SM-NEG-sit-FV (7)chair-LOC 7-my
        'He must not sit on my chair.'

Here again, Hlobohang uses the full prefix with first mention and no following modifier (30a), but produces a null prefix when he mentions it again with a modifier in 30b.

Litlhare similarly exhibits full prefix use on first mention of the referent with no modifier in 31a, and then uses a null prefix in her next mention where agreement licensing conditions are met in 31b.

(31) Litlhare (2;4 years)
    a. Ho-thwe   se-sepa.
       17.SM-say.PASS.FV 7-soap
         'It is said soap.'
              [Mother: Yes, what do you mean when you say it is 'se-sepa'?]
    b. Sepa   ke se-na.
      (7)soap COP 7-DEM
        'Here is the soap.'

Likewise, 'Neuoe uses the full form at first mention with no modifier in 32a, followed by a null prefix at next mention with a modifier in 32b. She then uses the plural with the full prefix, even though the modifier is present (32c). In effect, this represents a shift to a new, plural referent, requiring that the prefix be used.

(32) 'Neuoe (2;8 years)
    a. Le   ntho   e-no   ke le-kotikoti.
       CONJ 9.thing 9-DEM COP 5-tin.can
        'And that thing is a tin can.'
    b. Ke-le-etsits-e   mona . . . kotikoti   (l)e-e.
       1SG.SM-5.OM-made.PRF-FV LOC   (5)tin.can 5-DEM
        'I made it here . . . this tin can.'
    c. Ma-kotikoti a-ka.
       6-tin.can   6-my
        'My tin cans.'

Thus, by at least 2;10, Sesotho-speaking children appear to control at least some of the discourse contexts in which null noun-class prefixes are licensed, producing these at approximately the same rate as that of the input they hear. In particular, they may realize that first mentions of a new referent require full use of the prefix. Further study will be needed to examine these issues further, perhaps with more controlled discourse contexts, with both children and adults.

These findings provide strong evidence that Sesotho-speaking two-year-olds are making robust grammatical generalizations that fall at the intersection of phonological, syntactic, and discourse effects. As far as we know, this is the first illustration in the literature of learning at the interface of three very different levels of grammar. One might wonder if there is an alternative explanation for these findings. For example, children's variable use of null prefixes might be due to lexical effects. That is, learners might be more likely to produce null prefixes with lexical items that occur most frequently with null prefixes in the input they hear, simply learning that some nouns can 'optionally' occur with a null prefix, independent of any grammatical generalizations. We examine these issues below.

3.4. LEXICAL EFFECTS. Recall that we found no lexical frequency effects for adults, aside from the highly frequent item *di-ntho* 'things'. To explore the possibility of lexical effects on children's use of null prefixes we conducted a series of two-tailed Pearson correlation analyses. First, we compared children's likelihood of producing a null prefix in terms of their own lexical frequency. We then compared each child's likelihood to produce a null prefix as a function of the lexical frequency with which they heard a particular item in the input. Finally, we explored the possibility that the frequency with

which an item was produced with a null prefix in the input children heard might be correlated with their own use of null prefixes. The results from Pearson correlations are shown in Table 4. Only the latter (adult use of null prefixes) was correlated with child production of null prefixes, but only for two of the children (Litlhare and 'Neuoe). Thus, there was some correlation between adult and child use of null prefixes on the same lexical items.

	Hlobohang	Litlhare	'Neuoe
child lexical frequency	$r(80) = 0.136,$	$r(83) = 0.061,$	$r(49) = 0.229,$
	$p = 0.224$	$p = 0.580$	$p = 0.105$
adult lexical frequency	$r(80) = 0.162,$	$r(83) = 0.011,$	$r(49) = 0.181,$
	$p = 0.145$	$p = 0.921$	$p = 0.203$
adult null prefix	$r(22) = 0.318,$	$r(30) = 0.393,$	$r(24) = 0.474,$
	$p = 0.131$	$p < 0.05$	$p < 0.05$

TABLE 4. Lexical effects on children's use of null prefixes.

It is not clear, from these corpus data, how to interpret these findings. On the one hand, one could argue that the use of null prefixes on the same lexical items by both children and adults provides evidence of lexical learning. That is, children hear adults use a limited set of nouns with a null prefix, and then learn under which conditions those null noun-class prefixes are licensed. This would be consistent with an item-based approach to learning (e.g. Tomasello 1992), where the full conditioning environment would still need to be learned. On the other hand, children hear these nouns with a null prefix only in the appropriate discourse and syntactic/agreement environments; perhaps they learn them as 'constructions' (Goldberg 1995), complete with all of the licensing conditions. This approach, however, would be problematic for Hlobohang, who showed evidence of phonological overgeneralization to those [+ coronal] prefixes that did not occur with agreement. Alternatively, it is well known that children and their caregivers tend to talk about the same referents. It would therefore not be surprising that the same nouns would be available for use with null prefixes during caregiver-child speech interactions. That is, the overlap in nouns used with null prefixes could be merely an artifact of the discourse contexts sampled. The fact that there was a significant correlation between adult and child use of nouns with null prefixes for only two of the three children provides further support for this possibility; it is possible that a higher proportion of Hlobohang's utterances came from interactions with his five-year-old cousin rather than from adults, resulting in a less good fit between his and his caregiver's use of lexical items with a null prefix (though many of 'Neuoe's interactions are also with her four-year-old cousin Tsebo). Further research, including experimental study using novel nouns, could shed additional light on the nature of children's knowledge of the conditioning factors that license null prefixes. However, the examples in 30–32 also make it clear that children's use of null prefixes is not random, but principled, being sensitive to aspects of the discourse. This suggests that children's variable production of null prefixes is phonologically, syntactically, and discourse constrained, much in the way that it is for adults.

In sum, it appears that all three children in this study have successfully determined the grammatical conditions required to license null prefixes by or before the age of 2;10. That this involves learning complex interactions between constraints from three very different linguistic domains makes this accomplishment all the more remarkable. Thus, although early stages of the learning process may well involve lexical and construction learning, the outcome of this process seems to be grammatical generalization. These findings therefore raise many interesting questions regarding the limits of natural

language learning and the factors that influence the course and rate of learning along the way (cf. Thompson & Newport 2007, Wonnacott et al. 2008). They also raise questions about how and why such licensing conditions might have arisen in the first place.

4. Discussion. In the foregoing section we showed that Sesotho-speaking children have learned the grammatical conditions under which null noun-class prefixes are licensed before the age of 3;0. Questions remain, however, about the structure of the Sotho noun-class prefix, and why only some can be realized as null.

There have been several analyses of DP structure in Bantu languages. These can be roughly grouped into syntactic versus morphological treatments of the noun-class prefix. The first of the syntactic approaches was Carstens's (1991, 1993) treatment of Kiswahili. She suggested that the noun-class prefix plus the noun are generated together in N, raising to Num(ber)P to check features. Myers (1987), in a treatment of Chishona, suggested that noun-class prefixes are actually syntactic determiners that, like in Carstens's proposal, are base-generated in N.

In contrast, Bresnan and Mchombo (1995) proposed that noun-class prefixes in Chichewa are bound morphemes. In keeping with this morphological approach, Machobane (2003) suggested that noun-class prefixes in Sesotho are actually functional categories located in the head of the DP. Support for this analysis comes from Visser's (2001) proposal for IsiXhosa that givenness/definiteness is a syntactic feature located either in the noun-class prefix or on a nominal modifier. Recall that null prefixes in Sesotho can only appear if agreement conditions are met. Recall also that null prefixes tend to appear only in given/definite nonfocused contexts. Thus, under 'unmarked' conditions (coronal prefix, agreement features already checked, topical nonfocused information), the Sesotho noun need not raise to D. That is, noun-class prefixes in Sesotho and other Sotho languages are functional categories, which need not be realized under unmarked grammatical conditions. The same may be true for Aghem (Hyman 1980), though the phonological and discourse licensing conditions are different.

This raises the question of why null prefixes are not permitted in other Bantu languages. Bantu languages exhibit several different means for marking definiteness. For example, many Bantu languages permit a prenominal demonstrative. Although this is permitted in Sesotho, its occurrence is rare, resulting in an emphatic reading, where the demonstrative and following noun form one prosodic unit (e.g. *sena sefate* 'this very tree' vs. *sefate sena* 'this tree', Doke & Mofokeng 1985:113).

Some Bantu languages also have an augment, or pre-prefix, which is typically a copy of the vowel of the prefix. This is shown in 33 for IsiXhosa (Doke 1967).

(33) IsiXhosa noun-class (pre-)prefixes

CLASS	SINGULAR	CLASS	PLURAL
1	u-mu-	2	a-ba-
1a	u-	1a	o-o-
3	u-m-	4	i-mi-
5	i-li-	6	a-ma-
7	i-si-	8	i-zi-
9	i-N-	10	i-ziN-
11	u-lu-		
14	u-bu-		

De Blois (1970) suggests that these arose historically from a CV determiner (e.g. *bá ba-ntu* 'the people'). In some languages the pre-prefix indicates definiteness, specificity,

or focus. Meeussen (1967:99) noted that the Proto-Bantu augment may have had the function of a 'weak demonstrative . . . with definite meaning'. The presence of the pre-prefix, however, may also be syntactically conditioned, tending to occur on affirmative main-clause subjects, but not in negative constructions (cf. Luganda—Hyman & Katamba 1991, 1993). This suggests that some Bantu languages may have undergone a process of reanalysis, where definiteness is still carried by the augment in those languages that maintain it, but has been shifted to agreement in those languages that do not (see Guthrie 1948 and Katamba 2003 for further discussion).

This raises the possibility that the historical nature of the augment itself, which was originally added to the noun stem, might be able to account for the synchronic facts found in Sotho languages today. Meeussen (1967) reconstructs Proto-Bantu as marking class 9/10 with the augment *N-* (i.e. a homorganic nasal). Only the form of postnominal agreement then distinguished singular from plural. Many languages, including the Sotho languages, however, reinterpreted the class 10 augment as a plural prefix, and general-ized class 10 to class 8 as well (as shown in 8). Similarly, the *lɪ-* augment for class 5 was reinterpreted as the actual class 5 prefix in many languages, since the original class 5 prefix was only a vowel (e.g. lɪ + ɪ- > lɪ). Phonologically similar class 11 *lʊ-* was incorporated into class 5 in Sesotho and other languages (though not in Setswana). Perhaps some of these historical changes might be able to account for the fact that null prefixes are permitted for Sotho classes 5, 8, 10, and 11 today. It is not clear, however, how these processes would account for the appearance of null prefixes for class 7 *sɪ-*. Furthermore, the learner has no access to this historical record, unless some reflexes of it remain in the grammar today, perhaps in lexicalized null forms (see examples 18–20).

It is also not clear why class 14 prefixes are allowed to be null, but only on polysyl-labic stems (*(bo)ko bona 'this brain'). This indicates that, unlike nouns that take a coronal prefix, class 14 monosyllabic stems cannot prosodify with a following modifier. One possibility is that class 14 nouns, many of which are derived, have a different underlying syntactic structure from other Sotho nouns, perhaps being listed along with the prefix in the lexicon, as Carstens proposes for Kiswahili. But this would not explain why prefixes can be realized as null with polysyllabic class 14 stems. Recall, however, that many class 14 nouns are abstract nouns, with no productive plural. Perhaps the lack of a productive singular/plural contrast has created a situation where class 14 nouns can be realized with a null prefix, as is already the norm for high-frequency *(bo)jwala* 'beer' and *(bo)jwang* 'grass'. This would suggest that the mechanisms underlying null class 14 prefixes are fundamentally different from those of markedness used to license the use of null prefixes in the coronal classes. Further research on the possible historical underpinnings of these phenomena, combined with a more in-depth investigation of possible lexical effects, will be needed to shed more light on these issues.

Given the foregoing discussion, it is interesting to note that other groups of closely related languages also exhibit both synchronic and diachronic differences in the lexical realization of definiteness. For example, English exhibits definiteness through lexical means in the form of determiners (e.g. *a*, *the*, *that*, etc.). In contrast, Norwegian marks definiteness either through the use of grammatical features or with agreement, and Old Norse employed a lexical clitic or agreement with an adjective (e.g. Marit 2002, 2005). In addition, there is abundant language variation in the use of morphologically realized structural Case as opposed to Agreement for the marking of such relations (see e.g. Chomsky 1995, Baker 1991). This suggests that the grammatical means used to mark definiteness may be especially susceptible to change over time. Further psycholinguistic

research will be needed to determine the possible role that learners may play in the reorganization of such systems.

5. CONCLUSION. This article showed that Sotho languages license the use of null noun-class prefixes at the intersection of unmarked phonological, syntactic, and discourse conditions. Specifically, noun-class prefixes that begin with a coronal consonant can be realized as null when they occur in the c-domain relationship with agreement in a given, nonfocused, noncontrastive discourse context. Using longitudinal developmental data from three Sesotho-speaking children, it then showed that, after a brief period of early phonological/syntactic overgeneralization, children demonstrate knowledge of these licensing conditions before the age of three. Thus, despite the fact that the licensing conditions for null prefixes lie at the intersection of grammatical phenomena from three different linguistic domains, this appears to be learned early and easily. We suggest that the unmarked nature of these licensing conditions may facilitate this learning process.

These findings hold implications for several areas of study. From a learnability perspective, they suggest that learners are quite adept at making grammatical generalizations across very different levels of grammatical structure at a very early age. This has been shown independently at the levels of phonology (Anderson et al. 2003) and syntax/discourse (Demuth et al. 2009), but not at the confluence of all three. Yet, these can be easily understood in terms of markedness, where null prefixes are licensed under unmarked conditions at all levels of grammatical structure. This suggests that such interactions may also be found in other languages, and in other domains. Finally, these findings exemplify a close connection between the realization of discourse focus and definiteness, where the latter can be construed by a number of concurrent morphological and syntactic means. Perhaps it is due to a certain redundancy in the system that such domains are subject to extensive crosslinguistic variation, even within closely related languages.

In sum, this study provides a new look at the evolving developments of the noun-class system in Bantu languages. Much more research is required to better understand the nature of definiteness marking across Bantu languages, how this is realized morphosyntactically, and the implications for DP syntax. The evidence from comparative Germanic suggests that the syntax, semantics, and morphophonology of this domain is inherently unstable and subject to ongoing reanalysis. This study provides further evidence that the same is true for Bantu languages. We hope that the findings presented here will help frame the investigation of these issues in future comparative Bantu research, as well as how the structure of these languages is learned.

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