Two-year-olds' acquisition of the possessive morpheme: An acoustic analysis

Kiri Mealings and Katherine Demuth

Department of Linguistics, Macquarie University, Sydney, Australia

kiri.mealings@students.mq.edu.au, katherine.demuth@mq.edu.au

Abstract

Previous research shows that 2-year-olds' production of third person singular *-s*, but not plural *-s*, is affected by coda complexity, though both are more accurately produced in durationally longer utterance-final compared to utterance-medial position. This study explores these effects with possessive *-s*. Acoustic analysis of 10 two-years-olds' elicited imitations examined children's use of simple versus complex codas (e.g. *Sue's* vs. *Doug's*) both utterance-medially and utterance-finally. Morpheme production was surprisingly robust across contexts, but coda clusters were often simplified to *-s* singletons utterance-medially (e.g. *Doug's* [dɐz]). The findings raise many questions about lexical and morphological development in typical and language-impaired populations.

Index Terms: child language acquisition, morpheme production, speech acoustics

1. Introduction

The use of grammatical morphemes is highly variable in early child speech. This variability depends not only on which morpheme needs to be produced [1], but also on the phonological environment in which the morpheme appears [2]. In English, there are three grammatical morphemes that take the suffix *-s*. The first *-s* morpheme acquired is the plural (e.g. *cats*), the second acquired is the possessive (e.g. *Sue's*), and the third acquired is the third person singular (e.g. *sits*). Previous studies have looked at both plural and third person singular production in two-year-olds. None to date, however, have studied the acquisition of the possessive morpheme from a phonological or acoustic perspective. While the possessive morpheme differs from the others syntactically and semantically, it is phonologically the same. Fricatives such as /s/ are difficult for children to produce as they require complex tongue and airflow control. They are therefore later acquired compared to speech sounds such as stops [3, 4]. Between the ages of two and three, only 60% of word-final /s/ phonemes are correctly produced [4]. When first acquired, /s/ morphemes tend to be produced sporadically [1]. Several studies have investigated this variable use of *-s* morphemes, looking particularly at the possible effects of phonological context, such as coda complexity and position in the utterance.

Regarding coda complexity, Song, Sundara, and Demuth [2] found that two-year-olds' production of third person singular *-s* was better for verbs with simple codas (e.g. *sees*) compared to coda clusters (e.g. *needs*). When the inflection resulted in a coda cluster, the children often simplified it to a singleton by omitting the *-s* morpheme. Theodore, Demuth, and Shattuck-Hufnagel [5] explored this effect further by conducting a similar study to investigate plural production in two-year-olds' speech. Their results, in contrast, did not reveal an effect of coda complexity, with the plural equally as robust in simple codas compared to coda clusters. This difference in plural compared to third person singular morpheme production may be because the plural is acquired earlier, hence the lexical representations are more intact and therefore more robustly produced than the third person singular morpheme [1]. The possessive is typically acquired later than the plural, but earlier than the third person singular morpheme. It is therefore not clear if its acquisition will pattern more like that of the plural or the third person singular.

Coda complexity is not the only factor affecting morpheme production. Variability in coda production has also been attributed to the position the word appears in an utterance [2]. Utterance-final codas are typically produced more accurately than utterance-medial codas due to phrase final lengthening. This makes the morpheme easier to produce as it gives the child more time to approximate the intended articulatory target. In contrast, when the morpheme is utterance-medial, the child still has to plan and articulate the following words [5]. Both the third person singular study and plural study found this utterance position effect, with morpheme production significantly worse when the target word was utterance-medial compared to utterance-final. It would hence be predicted that use of the possessive morpheme would also be influenced by utterance position.

The aim of the current study was therefore to acoustically investigate two-year-olds' productions of the possessive *-s* morpheme as both a simple coda and a coda cluster in utterance-medial and utterance-final position. In light of the previous findings, it was hypothesised that children would be worse at producing the possessive morpheme when it results in a consonant coda cluster compared to a simple coda, shown by omission of the morpheme, or that there would be cluster simplification. It was also hypothesised that children would be worse at producing the possessive morpheme in utterance-medial position compared to utterance-final position for both coda conditions, but more so for complex codas.

2. Method

2.1. Participants

The participants were 10 typically developing children (3 male, 7 female) from monolingual Australian-English-speaking homes in the Sydney region. The age range was 1;11-2;6, with a mean age of 2;3 years. All children were healthy on the day of testing and were reported by their parents to be typically developing in their speech and language skills. The children were screened using a tympanometer to ensure no middle ear blockage on the day of testing. The children's parents were asked to fill out a brief demographic survey and the MacArthur Communicative Development Inventories (CDI) 100-word checklist in order to estimate the child's vocabulary size [6]. The MacArthur vocabulary test raw scores were 83rd percentile, ranging from 69-99 out of 100 with a mean of 85 (*SD*=12). There were no significant effects of age, gender or CDI score. An additional 7 children participated in the experiment but were not included in the analysis due to incomprehensible speech (*n*=1) or ceiling performance on both the morpheme and cluster (*n*=6). This attrition rate is consistent with those found in studies involving similar tasks with children of a similar age group [2, 5].

2.2. Stimuli

Eight target proper names were selected for the experiment. Four had a CV syllable structure, so with the possessive they had a simple coda (e.g. *Sue's* /sʉːz/), and four had a CVC syllable structure, so with the possessive they had a CVC's complex coda cluster (e.g. *Doug's* /dɐɡz/). For the simple codas, two of the names ended in a long vowel and two ended in a diphthong. For the complex codas, the vowel was always short, with two of the names ending in velar consonant and two in an alveolar consonant, one voiced and one voiceless in each case. Each target name appeared in two sentence conditions; utterance-medially and utterance-finally. Each sentence was in the present tense and consisted of three monosyllabic words with similar sentence structures. When in utterance-medial position, the possessives were followed by a noun that began with either a voiced or voiceless bilabial stop, so it was at a different place of articulation to the alveolar possessive morpheme *-s*. This makes the context more challenging and reduces the possibility of resyllabification of the possessive with the following word [5]. The stimulus sentences are shown in Table 1.

Table 1: *Target names and their corresponding stimulus sentences.*

Coda	Target	Utterance-medial	Utterance-final
Simple	Sue's	There's Sue's bag	This one's Sue's
CV's	Dee's	Here's Dee's pot	This one's Dee's
	Di's	There's Di's bike	That one's Di's
	Kay's	Here's Kay's pig	That one's Kay's
Complex	Doug's	There's Doug's book	This one's Doug's
CVC's	Dick's	Here's Dick's pet	This one's Dick's
	Todd's	There's Todd's pen	That one's Todd's
	Pat's	Here's Pat's bin	That one's Pat's

The target words were high frequency, familiar names with similar summed lexical frequencies across the two conditions to avoid a confounding frequency effect. These were extracted via ChildFreq from the CHILDES database which calculates the child's frequency of saying the target word per 1,000,000 words between 2;0-3;0 [7], and assessed for Australian appropriateness. The sum of the frequencies for the CV's simple coda words was 178 (range=9-118), and the sum of the frequencies for the CVC's complex coda words was 164 (range=4-128). An adult female native speaker of Australian-English was recorded producing the sixteen sentences using child-directed speech. The recording took place in a sound-attenuated room using a Behringer C-2 microphone and Pro Tools LE software at a sampling rate of 44.1 K, and segmented using Praat software [8].

2.3. Procedure

The child and their parent were invited into a sound-attenuated test room to 'play a language game'. The room was equipped with two computers (one used for the stimulus display and the other for recording), Sony SRS-55 speakers, and a Behringer C-2 microphone. The microphone was placed on a table near the child in order to best capture his or her speech. The child was asked to look at the pictures on the computer monitor and repeat what they heard. The presentation began with the auditory prompt '*Say what I say!*'. After a brief warm-up to familiarise the child with the task and to check the sound levels, the test items began. For each item, a picture of a child representing the corresponding name appeared on the monitor along with the auditory prompt. If needed, three attempts were allowed for each utterance in order to obtain an acoustically acceptable recording to be analysed. The child was encouraged with praise and stickers for each trial. The entire procedure took approximately 30 minutes. The child was given a T-shirt and/or stickers and the parents received a gift card for their time.

2.4. Acoustic Coding and Analysis

The children's utterances were recorded using Pro Tools LE at a sampling rate of 44.1 K, then excised and coded by a trained coder using Praat. Of the 160 tokens, 15 were excluded for the following reasons: the child did not produce the target word or it was inaudible (*n*=8), or the acoustic quality was poor due to noise interference (*n*=7). The remaining 145 tokens were acoustically coded for morpheme and coda cluster realisations. The acoustic measurements used were based on Stevens' [9] feature-cue-based model in which distinctive feature bundles representing speech segments are derived from the acoustic cues of the vocal tract configuration. Each acoustic cue was identified by visual inspection of the waveform, spectrogram and listening to the utterance. We were interested in two aspects of the children's productions; firstly the production of the possessive *-s* morpheme, and secondly the production of the stop coda of the name (e.g. the /ɡ/ in *Doug's*). For CV names with a simple *-s* coda, there needed to be high frequency, aperiodic word-final frication noise representing the vocal tract constriction for the sibilant phoneme /z/, for the morpheme to be considered produced (see Figure 1). (See Li, Edwards, and Beckman [10] for spectral analysis of fricative acquisition).

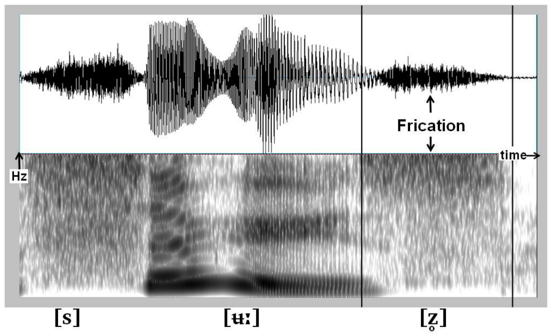

Figure 1: *Waveform and spectrogram of acoustic cues from adult speaker for target word Sue's.*

For names with final clusters, we looked for evidence of both closure (usually followed by a burst release) for the word-final stop, as well as high frequency, aperiodic frication noise representing possessive *-s* morpheme (see Figure 2). Therefore, for the target word *Doug's*, we coded both [dɐɡz] and [dɐz] as the possessive morpheme produced, but only [dɐɡz] as a correct coda cluster production. All of the tokens were initially coded by one trained coder, then 20% were coded by a second trained coder. Reliability between the two coders was 99%.

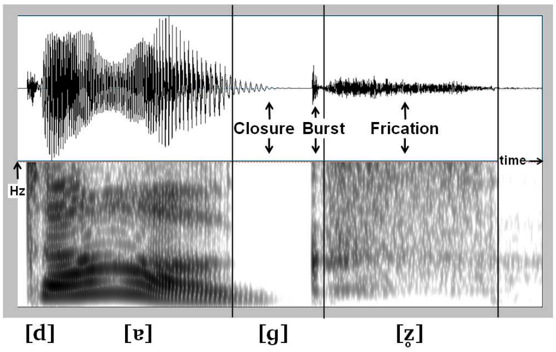

Figure 2: *Waveform and spectrogram of acoustic cues from adult speaker for target word Doug's.*

3. Results

3.1. Possessive morpheme productions

Recall that possessive production was hypothesised to be worse in complex compared to simple codas, and utterance-medially compared to utterance-finally. To examine this, the mean numbers of possessive *-s* realisations across children were submitted to a repeated-measures ANOVA. The factors of coda type (simple vs. complex) and utterance position (medial vs. final) were used. The ANOVA results, however, revealed no significant differences for coda type $F(1,36)=0.104$, $p=0.749$, or utterance position $F(1,36)=0.935$, $p=0.340$, and there was no interaction between factors $F(1,36)=1.546$, $p=0.222$. This shows that possessive *-s* morpheme production at this age is highly robust as shown by the near ceiling performances in each condition (see Figure 3).

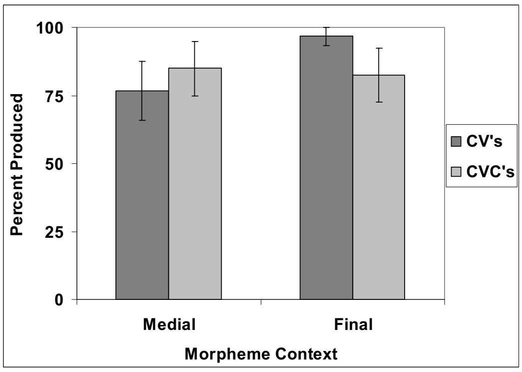

Figure 3: *Mean percent of possessive -s morphemes realised for medial and final utterance positions. Error bars indicate standard error of the mean.*

Thus, Australian-speaking children aged 1;11-2;6 have little difficulty using possessive morphemes in this task, even with names embedded utterance-medially. This may be due to their high mean score on the CDI, indicating good vocabulary size for their age. Or, it may mean they are focussing on the morpheme at the cost of producing the entire coda cluster.

3.2. Coda cluster realisation

A second analysis was conducted to examine more closely the acoustic realisation of the coda cluster. Even though there were no significant differences in possessive morpheme productions, this did not necessarily mean correct production of the target coda for the complex coda words. A stop-fricative coda cluster may have been simplified to just the fricative (e.g. *Doug's* becoming [dɐz]), hence the morpheme was produced, but not the entire coda cluster. Recall that for the complex coda to be realised, both the final stop consonant of the name (represented by closure on the spectrogram) and the word-final fricative for the possessive *-s* morpheme needed to be produced. Therefore, there were four possible types of production, illustrated here using the target name *Doug's*: no coda ([dɐ]), stop coda ([dɐg]), fricative coda ([dɐz]), and the target-like stop + /s, z/ ([dɐgz]). Figure 4 provides a breakdown of how the coda clusters were produced by the children in both utterance-medial and utterance-final position. The bottom two shaded bars combined represent possessive *-s* morpheme production, but notice that in utterance-medial position, although morpheme production was high (82%), half of the morpheme productions involved cluster simplification with the stop deleted. It is therefore of interest that, in most of the coda cluster simplifications, the possessive *-s* morpheme was retained rather than the stop.

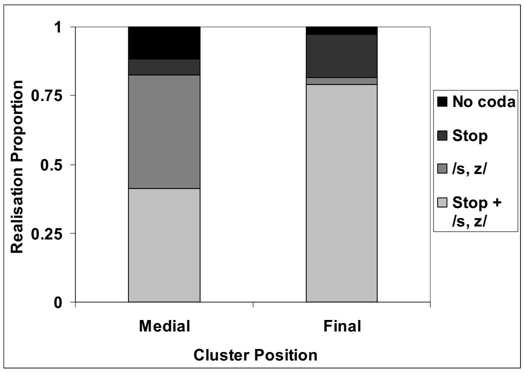

Figure 4: *Realisation of coda clusters for target CVC's possessive words.*

A paired t-test was conducted to compare coda cluster production in the two utterance positions. As anticipated, the results revealed that complex coda production was significantly worse utterance-medially compared to utterance-finally ($t(9)=-3.258$, $p<0.01$) (see Figure 5).

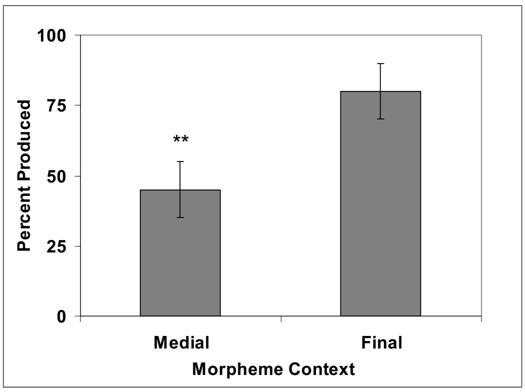

Figure 5: *Mean percent of coda clusters realised for medial and final utterance positions. Error bars indicate standard error of the mean.**p*<0.01.

Some may wonder if cluster simplification is due to children's lack of ability to produce certain syllable structures.

These results, however, clearly show that this is not the case: the children were much better at producing the entire cluster in utterance-final compared to utterance-medial position, probably due to the increase duration of phrase final syllables in English [11]. Therefore, the processing and planning factors needed to execute the same morphological cluster are mediated by phonological context.

4. Discussion

Previous studies have found that children's production of the third person singular *-s* morpheme was worse when it was part of a coda cluster compared to a simple coda [2]. Interestingly though, using a similar population and similar methods, this was not found for the earlier acquired plural *-s* [5]. Both morphemes, however, were omitted more often in utterance-medial compared to utterance-final position. In the current study we explored the acquisition of the possessive *-s* morpheme, which is typically acquired later than the plural but before the third person singular. Surprisingly, the results showed high morpheme production in all contexts, with no coda complexity effect for morpheme production, and no utterance position effect.

A second analysis, however, revealed worse coda cluster production in utterance-medial position. Although the possessive *-s* morpheme was produced at a high rate (82%), half of these realisations involved cluster simplification (e.g. [dɒz] for *Doug's*). This finding differs from both the plural [5] and third person singular studies [2], where cluster simplification mostly resulted in morpheme rather than stop omission (e.g. *dog* for *dogs*; *need* for *needs*).

These findings are interesting for several reasons. Firstly, the plural morpheme is typically thought to be acquired before the possessive [1], yet the possessive morpheme in the current study was produced at a much higher overall rate than that reported for previous studies of the plural using almost identical methods [5]. The American children in the plural study, however, had a lower overall MacArthur CDI mean percentile score (M=47.5) compared to 83 in the current study. Given these high CDI scores and near ceiling performance found for some of the children in our study, it is possible that our participants had above average vocabulary even though the mean age was the same. This may have resulted in better overall morpheme production.

Secondly, although cluster simplification was also found in utterance- medial position in the plural study [5], the type of cluster simplification differed: for the plurals, the stop coda tended to be preserved, whereas the stop coda tended to be omitted and morpheme preserved for the possessives. This is very interesting, firstly because it was the *lexical* item that was reduced, and secondly because stop codas are typically acquired earlier and produced more accurately than fricative codas [3], so we would expect they would be preserved.

These results raise many questions about children's lexical and morphological representations of the possessive, and how these are stored, retrieved and produced. Little is known about these processes in the young language learner. However, a recent ultrasound study examining the articulatory gestures used to produce morphemic and non-morphemic coda clusters shows early sensitivity to morphological structure [12]. Focusing again on 2;0-2;6-year-olds, that study examined the production of /ks/ clusters in the words *box* and *rocks*. For the lexical item *box*, the articulators appeared to target the /k/, whereas for *rocks*, the articulatory target was the plural /s/ for both children and adults. This suggests a difference in articulatory planning for producing morphemic versus non-morphemic coda clusters. Thus, although being able to produce a particular consonant cluster is a prerequisite for producing the same cluster in a morphologically complex form, this is no guarantee that the form will be accurately produced in all phonological contexts.

5. Conclusions

This paper shows that English-speaking children as young as 2;3 are very good at producing the possessive morpheme regardless of coda cluster complexity and regardless of the prosodic context/utterance position in which the morpheme appears. Nonetheless, these children reduce the stop portion of the coda cluster when the duration of the context is short – i.e., in utterance-medial position. These findings raise many questions about the nature of /s/ morpheme acquisition in children with language delay, such as those with hearing loss or SLI (Specific Language Impairment). They also add to a growing body evidence that the segmental accuracy of children's early word productions is highly influenced by the phonological contexts in which these words appear.

6. Acknowledgements

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7. References

[1] Brown, R. (1973). *A first language: The early stages.* Cambridge, MA: Harvard University Press.

[2] Song, J. Y., Sundara, M., & Demuth, K. (2009). Phonological constraints on children's production of English third person singular *-s*. *JSLHR, 52,* 623-642.

[3] Koenig, L. L., Lucero, J.C., & Perlman, E. (2008). Speech production variability in fricatives of children and adults: Results of functional data analysis. *JASA, 124(5),* 3158-3170.

[4] Smit, A. B. (1993). Phonologic error distributions in the Iowa-Nebraska articulation norms project: consonant singletons. *JSHR, 36,* 533-547.

[5] Theodore, R., Demuth, K., & Shattuck-Hufnagel, S. (2011). Acoustic evidence for position and complexity effects on children's production of plural *-s*. *JSLHR, 54,* 539-548.

[6] Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short-form versions of the MacArthur Communicative Development Inventories. *Appl. Psycholinguist., 21,* 95-116.

[7] Bååth, R. (2010). ChildFreq: An Online Tool to Explore Word Frequencies in Child Language. *LUCS Minor*, *16*.

[8] Boersma, P., & Weenink, D. (2011). Praat: doing phonetics by computer (Version 5.2.23) [Computer program]. Retrieved May 4, 2011, from http://www.praat.org

[9] Stevens, K. N. (2002). Toward a model for lexical access based on acoustic landmarks and distinctive features. *JASA, 111(4),* 1872-1891.

[10] Li, F., Edwards, J., & Beckman, M. E. (2009). Contrast and covert contrast: The phonetic development of voiceless sibilant fricatives in English and Japanese toddlers. *J. Phon.*, *37(1),* 111-124.

[11] Snow, D. (1994). Phrase-final syllable lengthening and intonation in early child speech. *JSLHR, 37*, 831-840.

[12] Song, J. Y., Demuth, K., Shattuck-Hufnagel, S. & Ménard, L. (in submission). The effects of coarticulation and morphological complexity on the production of English coda clusters: Acoustic and articulatory evidence from 2-year-olds and adults.