The effects of allomorphic variation on children's acquisition of plural morphology

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Abstract

While children begin producing plural words in their natural speech from around two years, it is unclear when they acquire a full understanding of plural morphology. Two intermodal preferential looking (IPL) experiments using eye-tracking examined the effect of allomorphic variation on children's acquisition of English plural morphology. Experiment One looked at 24-month-olds' understanding of segmental plural allomorphs /s/ and /z/. It was found that, while children at this age did not understand the number condition of nonce CVC singular words, or for nonce plural words inflected with voiced plural /z/, they did demonstrate understanding of the voiceless plural allomorph /s/. Experiment Two then tested 36-month-olds' understanding of the syllabic plural /əz/, finding that at this age children are able to demonstrate understanding of CVC singular nonce words, and of nonce words inflected with syllabic plural /əz/. These results add to our understanding of how allomorphic variation affects children's acquisition of nominal plural morphology.

Index Terms: language acquisition, morphology, plural

1. Introduction

English-acquiring children begin using plural words in their day-to-day speech from around the age of two [1, 2, 3], and non-linguistic research shows that a semantic contrast of *one* vs. *more-than-one* has developed by around this age [4, 5]. It is not clear, however, when children develop an understanding of nominal plural morphology. That is, when they understand that a word such as *cats* has an internal structure comprising of a root morpheme, /kæt/, denoting its referent, and a plural morpheme, /s/, denoting its number (i.e., singular or plural). It is also not known what effect allomorphic variation has on children's acquisition of plural morphology. Children must learn that form of the plural morpheme is dependent on the phonological properties of the root morpheme. There are three plural allomorphs in English: voiceless plural /s/, which occurs when the final segment of the root morpheme is a voiceless consonant (e.g., *cats* /kæt**s**/); voiced plural /z/, which occurs when the final segment is voiced (e.g., *dogs* /dɔg**z**/); and the syllabic plural /əz/, which attaches to strident fricative (e.g., buses /bʊs**əz**/). Understanding plural morphology and allomorphy not only allows children to inflect words into plural forms, but gives them the ability to readily identify the number condition of newly heard words. Children with an understanding of plural morphology and allomorphy would readily be able to identify *peas* /pi:z/ as being plural, and *piece* /pi:s/ as being singular, even without explicitly knowing the meaning of those words.

One research method that has been used to explore children's understanding of plural morphology and allomorphic variation has been the wug task [6]. In a wug task, children are presented with a picture of an unknown animal and a nonce label, such as *wug*. Next, they are presented with a picture depicting multiple of that same animal, and asked what they see. An understanding of plural morphology should allow children to inflect that nonce label into a previously unheard plural form, in this case, *wugs*. However, studies suggest that, while children have some fledgling ability at two years of age [7], they still lack a solid grasp of plural morphology even at the age of seven [6]. Results also suggest that allomorphic variation contributes to children's difficulty, as their performance with the syllabic plural /əz/ is especially poor compared to its segmental counterparts, voiceless /s/ and voiced /z/ [6].

Because wug tasks necessitate the production of segments that are perhaps difficult for children to pronounce, an alternative and potentially less demanding research method used to explore young children's linguistic knowledge is the Intermodal Preferential Looking (IPL) paradigm [8]. In a typical IPL study, children are presented with two pictures, one a target, the other a distractor. They are then played an auditory stimulus. Looking preferences between the two pictures are compared before and after hearing the stimulus. If children's looking preferences change towards the target picture, this is seen as evidence of understanding the task at hand.

One such IPL study examined children's understanding of plural morphology in task which shared some similarities to a wug task [9]. Children were presented with two pictures, one depicting a solitary object (singular picture) and the other depicting multiple unknown objects (plural picture). Children were then told to "Look at the [nonce-word]". The nonce word was either inflected for plural or singular. The study found that, when children's only cue was the presence/absence of the plural morpheme, 36-month-olds shifted their looking preference towards the target picture, but 24-month-olds did not. That is, 36-month-olds showed understanding of plural morphology, but 24-month-olds did not.

That study, however, was not designed to look at allomorphic variation, and tested children with an unequal mix of plural allomorphic variants /s/, /z/ and /əz/. Closer scrutiny, furthermore, revealed two points of interest in the results. Firstly, while 24-month-old participants appeared not to understand voiced plural /z/ or syllabic plural /əz/, they did show a potential sensitivity to voiceless plural /s/. However, this result was only approaching significance. Secondly, while 36-month-olds showed understanding of plural morphology overall, closer analysis raises doubts over their understanding of syllabic plural /əz/; unlike segmental plurals /s/ and /z/, post hoc analyses did not reveal /əz/ to be significantly above chance. This is interesting, as not only is the syllabic plural /əz/ the least frequent plural allomorph [1], it is also the one that has proven to be the most difficult in wug tasks [6].

Furthermore, it is unclear whether these results reveal that children have an understanding of plural morphology *per se*, as the auditory stimuli used in the task make it unclear as to whether children interpreted the plural-inflected nonce words as *root+plural morpheme*, or whether they simply identified fricative-final words as being plural.

Therefore, two IPL experiments were carried out to further probe children's understanding of nominal plural morphology, and to explicitly look at the effects of allomorphic variation. Experiment One tested 24-month-olds' understanding of segmental plural allomorphs /s/ and /z/ in phonologically simple CVC or CVCs/z contexts. While it has been shown that plural /z/ is more frequent in children's input [1], plural /s/ has been shown to be longer in duration and therefore more perceptually salient [10]. It was predicted that children would demonstrate some understanding of at least voiceless plural /s/, if not also voiced plural /z/.

Experiment Two then tested 36-month-olds' understanding of syllabic plural /əz/. Given that it is the most perceptually salient allomorphic variant, it was predicted that the children would be able demonstrate understanding of syllabic plural /əz/. Experiment two also tested on whether children would correctly identify the number condition of fricative-final singular nonce words, in CVs and CVz forms. Despite being fricative final, these words must be singular, as they cannot be decomposed into *root+plural morpheme*. It was not known whether children would identify these words as singular, or interpret them as plural.

2. Method

2.1. Experiment One

2.1.1. Participants (Ex 1)

Nineteen 24-month-old children participated (7 girls, 12 boys; Mean = 24 months; Range = 23 to 25 months). An additional 12 children were excluded for failure to return a sufficient number of trials (minimum 2 each of plural /s/, /z/ and singular trials), due to fussiness, inattention, or poor eye-tracking.

2.1.2. Auditory Stimuli (Ex 1)

Stimuli were produced by a female speaker of Australian English, using child-directed speech. Auditory stimuli included 12 nonce words, recorded as both CVC singular and CVCs/z plural conditions (see Table 1).

Table 1: *Experiment One Nonce Words*

	Singular	Plural
Voiceless /s/	mip	mips
	tep	teps
	gop	gops
	nep	neps
	gip	gips
	dup	dups
Voiced /z/	kib	kibz
	gub	gubz
	pog	pogz
	nug	nugz
	deg	degz
	tig	tigz

Audio were recorded as complete utterances with the carrier phrases "*look at the...*" and "*find the...*"

2.1.3. Visual Stimuli (Ex 1)

Visual stimuli were 16 unknown animals depicted with happy faces and closed eyes. The eyes were closed as it was thought open eyes would create the impression of being stared at from the plural picture, thus making it more visually attractive. Each animal was made as both a one-animal (singular) picture and a five-animal (plural) picture. Two versions were created so that no child saw both the singular and plural forms of the same animal.

2.1.4. Procedure (Ex 1)

Children sat on their parent's lap in a darkened room in front of a widescreen monitor. During each trial, two pictures (one singular, one plural) were displayed side-by-side for 5 seconds. A looming red ball in the center of a black screen then replaced the pictures for 1 second. The audio stimulus was then played over a black screen. The nonce word presented was either singular (e.g., *gop, deg*), inflected with voiceless plural /s/ (e.g., *gops*), or inflected with voiced plural /z/ (e.g., *degz*). The pictures then returned for 4 seconds. Children's looking behavior was recorded using a Tobii x120 eye tracker.

2.2. Experiment Two

2.2.1. Participants (Ex 2)

Twenty 36-month-old children participated (8 girls, 12 boys; Mean = 36 months; Range = 35 to 36 months). An additional 6 children were excluded due to fussiness and inattention.

2.2.2. Auditory Stimuli (Ex 2)

Auditory stimuli were 12 monosyllabic, fricative-final novel word stems (six /s/-final and six /z/-final). Each word stem was recorded as both a CVC singular word and a CVCəz plural-inflected word (see Table 2). Only short vowels were used to ensure CVC words were singular (as long vowels in CVz contexts can be both plural and singular e.g., cheese, fleas).

Table 2: *Experiment Two Nonce Words*

Singular	Plural
bess	besses
dass	dasses
dozz	dozzes
giss	gisses
gozz	gozzes
kazz	kazzes
koss	kosses
nass	nasses
nizz	nizzes
pezz	pezzes
poss	posses
tizz	tizzes

Auditory stimuli were recorded as complete utterances with the carrier phrase "*find the...*"

2.2.3. Visual Stimuli (Ex 2)

Similar to Experiment One, visual stimuli consisted of 16 unknown animals. However, visual stimuli for Experiment Two had an additional dancing animation (see below). Each animal had both a one-animal (singular) picture and a five-animal (plural) depiction.

2.2.4. Procedure (Ex 2)

In order to maintain children's attention and minimize participant exclusions, slight modifications were made to the procedure employed in Experiment One. During each trial, the two pictures (singular and plural) were displayed side-by-side for 4 seconds. The looming red ball replaced the pictures for 1 second. The audio stimulus was played over a black screen. The nonce word was either singular (e.g., *koss*, *nizz*), or inflected with segmental plural /əz/ (e.g., *kosses, nizzes*). The pictures then returned for 3 seconds. After 3 seconds the target picture danced for 1.5 seconds to a happy tune. The dancing was added to help maintain children's interest throughout the task.

3. Results

Difference Scores were used as the dependent measures for both experiment one and two. A difference score is calculated on a trial-by-trial basis, and is a measure of how much a child's looking preference shifts towards the target picture after hearing the audio stimulus. In order to calculate a difference score, children's looking preference towards the target picture is calculated for both before and after hearing the auditory stimulus (the dancing phase in Experiment Two was excluded from the analysis). Looking proportions are calculated by dividing the total fixation duration of the target picture by the sum total fixation durations recorded for both the target and distractor picture. Any time spent not looking at either picture was therefore excluded from the calculation. Difference scores were then calculated by subtracting the proportion looking to target pre-auditory stimulus from that of post-auditory stimulus. This figure was then multiplied by one hundred to gain a percentage. Positive difference scores indicate a child's preference shifted towards the target picture after hearing the audio stimulus, and vice versa for a negative shift.

3.1. Experiment One

With alpha set to 0.05, planned *t*-tests were first carried out on the 24-month-olds' difference scores for singular and plural (/s/ and /z/ collapsed) trials. Neither singular nor plural were found to be significantly above chance. Next, the plural allomorphs /s/ and /z/ were compared to chance. The voiceless plural allomorph /s/ was found to be significantly above chance ($t(18) = 2.33$, $p=0.03$), but the voiced plural /z/, was not different from chance (figure 1).

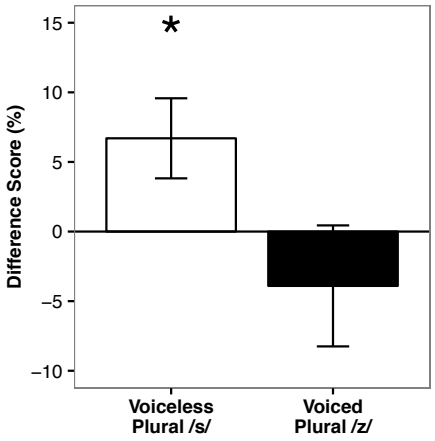

Figure 1: *24-month-olds' difference scores for voiceless plural /s/ and voiced plural /z/. Error bars 1 SE. *p=.03*

3.2. Experiment Two

With alpha set to 0.05, planned *t*-tests were carried out comparing the singular and syllabic plural /əz/ difference scores to chance. For children aged 36-months, both singular and plural were significantly above chance (singular: $t(19)=3.50$, $p<0.01$), and plural: ($t(19)=3.05$, $p<0.01$) (figure 2).

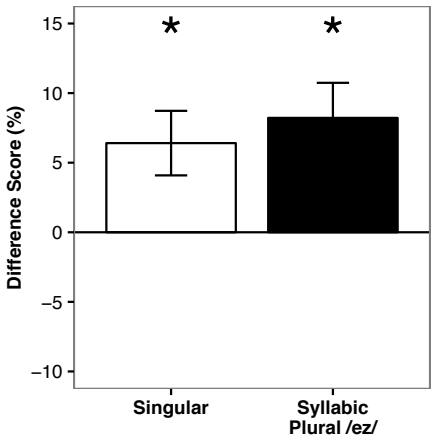

Figure 2: *36-month-olds' difference scores for singular and syllabic plural / əz/. Error bars 1 SE. *p<.01*

4. Discussion

Two IPL studies were carried out to examine whether allomorphic variation affects children's acquisition of plural morphology. Children aged 24 months were tested on their understanding of segmental plural allomorphs /s/ and /z/. Children aged 36 months were tested on their understanding of the syllabic plural allomorph /əz/, and whether they would interpret CVs and CVz nonce words as singular.

The results show that 24-month-olds understood the number condition of a never-before-heard nonce word so long as it was inflected with the voiceless plural allomorph /s/. Children at this age did not seem to understand the number condition of nonce words inflected with voiced plural /z/, or indeed even CVC singular nonce words.

These findings raise questions about how children acquire English plural morphology, and also raise questions about the role that allomorphic variation plays. At 24 months, children do have some understanding of plural morphology (which we should expect from studies of spontaneous speech [1], and also wug tasks [6]), but this understanding appears to be limited to the voiceless plural /s/. This does not look to be driven by language input, as plural allomorph /z/ accounts for over 70% of plurals children hear [1]. Potentially this may be driven by acoustic salience, as, in American English /s/ has been shown to have a longer frication duration than /z/ [10]. However, at this age, children do not appear to understand the number condition of novel CVC singular words. Perhaps children need to acquire an understanding of the complete set of English plural allomorphic variants before they are able to comprehend that the absence of a plural morpheme signifies singular. This is potentially demonstrated by the results of Experiment Two.

In Experiment Two, 36-month-olds were able to demonstrate an understanding of not only the syllabic plural /əz/, but an understanding of the singular as well. These results build upon the findings of previous IPL research [9], showing that 36-month-olds can, and do, comprehend all three English nominal plural allomorphs: /s/, /z/ and /əz/, despite the latter's relatively low frequency and proven difficulty in production tasks [11]. Furthermore, 36-month-olds' understanding of fricative-final singular nonce words suggests that they interpret plural morphology as *root+plural morpheme*, and are not simply parsing fricative-final words as being plural at this age.

These findings contribute to the small, but growing literature showing allomorphic variation affects children's acquisition of grammatical morphemes. A better understanding of this issue will help inform the gradual and variable nature of children's emerging linguistic abilities. It also provides a much-needed baseline against which to evaluate plural development in children developing bilingually, as well as with various types of language delay.

5. References

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