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Phonological Constraints on Children's Use of the Plural

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Abstract

The correct use of an affix, such as the English plural or past tense suffixes, is generally assumed to reflect mastery of the relevant morphological process. An alternate view holds that the use of an affix reflects not only morphological competence, but also additional factors including syntactic, semantic and phonological abilities. The present paper reports on a set of experiments in support of this latter view specifically examining the role of phonology on English-speaking children's ability to produce the plural. Plural productions were elicited from two-year-olds for nouns with different codas, or endings (e.g. *dogs vs. keys*). The results provide evidence that the production of the plural morpheme *–s* is partly governed by children's developing ability to articulate or perceive the phonological form of the plural. This supports a model of language learning in which the acquisition of different components of grammar interact with each other versus a model that is exclusively modular.

Keywords: morphology, phonology, language acquisition.

Introduction

Children learning a language demonstrate variable production of grammatical morphemes in between the onset of morphological knowledge and complete mastery as an adult. One of the earliest acquired grammatical morphemes is the regular English plural (Brown, 1973), appearing in children's speech as early as 18 months (Zapf & Smith, 2007; de Villiers & de Villiers, 1973). However, the acquisition of this morpheme shows a slow, protracted course of development and is not fully generalizable to all new instances until as late as seven years of age (Berko, 1958). This variability, seen in the acquisition of many grammatical morphemes, has generally been attributed to maturing morphological competence (Marcus et al. 1992; Pérez-Leroux & Roeper, 1999) or general processing limitations (Bloom, 1990). An alternate view holds that this variable production is instead the result of a confluence of factors including semantic knowledge (Anisfeld & Tucker, 1968; Zapf & Smith, 2007), syntactic ability (Wexler, 1994) and phonological constraints (Demuth, 1992). This paper argues in favor of this latter account, specifically focusing on the idea that limitations in phonological ability contribute significantly to the variability in the production of grammatical morphemes. As such, it is not only the acquisition of morphology that contributes to the long developmental trajectory of the plural, but also the ability to articulate or perceive certain sequences of sounds.

The English plural is marked by the *–s* morpheme for most nouns, which is pronounced [s], [z] or [əz] following voiceless consonants (e.g. *cats*), voiced segments (e.g. *dogs*), and stridents (e.g. *watches*) respectively. We argue that an important part in learning to use this particular morpheme involves the child's developing ability to produce the phonological form associated with the plural.

This is no trivial task given the fact that the plural suffix is a fricative, a consonant produced by forcing turbulent air through a narrow channel in the mouth (e.g. *s, z, th*), and most English nouns are consonant final. This combination of sounds results in a plural form with a complex coda: two adjacent consonants at the end of the same syllable. Complex codas are generally marked: dispreferred cross-linguistically and illegal in some languages (e.g. Spanish, Italian). Even in English, which allows complex codas, they are governed by a strict set of constraints on what sequences of consonants are allowed. For example, there are no English words with two consonants with the same manner and place of articulation in the coda (e.g. no words like *fedt* or *fepb*). This constraint is what gives rise to the *–ed* allomorph for the past tense (e.g. *seeded*), for example.

Sonority

This particular constraint is partially a manifestation of the more general Sonority Sequencing principle (SSP; Sievers, 1881; Whitney, 1885), which expresses the generalization that syllables rise in sonority through the onset to a peak at the nucleus then fall in sonority through the coda. The sonority of the different classes of speech sounds is shown in Table 1 and the validity of certain syllables according to the SSP is shown in Figure 1.

Manner of articulation	Example	Sonorous
vowel	*i, e*	yes
glide	*y, w*	yes
liquid	*r, l*	yes
nasal	*n, m*	yes
fricative	*s, z*	no
plosive	*d, t*	no

Table 1. Sonority of English phones

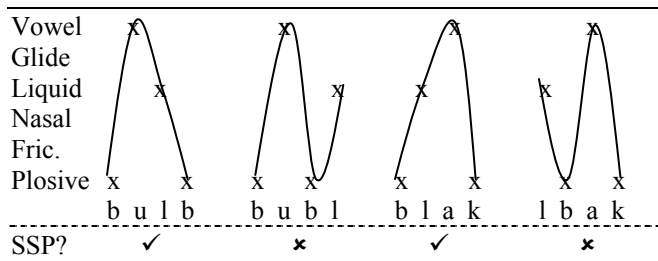|				
Vowel	x	x	x	x
Glide				
Liquid	x	x x	x	x
Nasal				
Fric.				
Plosive	x x	x x	x x	x
	b u l b	b u b l	b l a k	l b a k
SSP?	✓	✗	✓	✗

Figure 1: Demonstration of the validity of certain syllables according to the SSP

While there is strong cross-linguistic evidence for the ranking in Table 1, there is no consensus on how the sonority scale is manifested acoustically or articulatorily (Ohala, 1990). A number of phonetic correlates have been suggested including perceptual salience, loudness (Ladefoged, 1993), air flow (Goldsmith, 1995) and resonance (Clements, 2006). and yet there is also considerable disagreement as to whether the SSP is an independent linguistic concept (Clements, 2006; Vaux, 2006) or is reflective of other more basic phonetic or phonological facts. For example, Steriade (1999) and Blevins (2004) argue that the SSP is a correlate of the fact that the acoustic cues for consonants are difficult to hear on neighboring segments that are not sonorous. Thus the acoustic cues that signal to the listener of the *t* in *fedt* are difficult to hear on the non-sonorant *d* as compared to on the sonorous *l* in *felt*. Conversely, MacNeilage and Davis (2000) argue that the SSP is a reflection of the idea that syllables are derived from a cycle of opening and closing the mouth. Thus *fedt* is invalid because the mouth has already completed a cycle by being closed on the *d* and so no additional segments are allowed in the syllable as compared to *felt* where the jaw is still partially open for the *l* and can accommodate additional segments so long as they are articulated with a closed jaw.

Because of the challenges associated with establishing a fine-grained sonority scale, Table 1 also shows a broader classification with sounds simply categorized as sonorous or not. Sonorous sounds have the property of being produced without turbulent airflow and also are voiced by default. The crucial generalization using this rubric is that non-sonorants are easier to produce and/or easier to perceive after sonorants in coda position while sonorants preferably follow non-sonorants in onset position.

Whatever the actual correlates of the sonority scale, all theories predict that *fedt* is invalid is because it includes a sonority plateau: *d* and *t* have essentially the same sonority.[1] Furthermore, there is evidence that the SSP is a concept available to language learners at the earliest stages of phonological development (Berent, Steriade, Lennertz, &

Vankin, 2007; Ettlinger, Finn, & Hudson Kam, 2007; cf. Hayes, 2007).

Acquisition of Complex Codas

The fact that complex codas are marked is reflected in phonological acquisition data in which children go through an intermediate stage where simple codas are produced correctly and complex codas are not. For example, G (2;3-2;9), a child acquiring English (Gnanadesikan, 1995), went from producing no codas ([dʌ] *duck*) to correctly producing singleton codas ([gep] *grape*) but not complex codas ([fen] *friend*), before finally being able to correctly produce complex codas. Also, Kirk and Demuth (2003) report higher correct production of nasal (e.g. *n, m*) + *s* clusters than plosive (e.g. *t, d*) + *s* clusters (84% vs. 74% respectively) for two-year-old children, suggesting that the sonority profile of the complex coda in question also plays a role.

These limitations on phonological abilities clearly represent a potential factor for the production the plural morpheme since the acquisition of the plural generally occurs around the same time that children are just beginning to master the articulation of complex codas. Thus, the failure to use the plural morpheme around the age of two may reflect an inability to articulate the consonant + *s* coda cluster correctly in addition to lacking mastery of the morphology.

Experiment 1

To test the hypothesis that phonology partially constrains the correct use of the plural morpheme, we conducted a behavioral experiment eliciting productions from two-year-old children. The experimental task, borrowed from Johnston, Smith, and Box (1997), elicits productions by asking children to describe items to a blind-folded teddy bear. In the present version, the child was presented on each trial with an array of objects as illustrated in Figure 2. Each array included two sets: a set of one (S Set) and a set of more than one (P set).

Figure 2: Sample stimuli sets from Experiment 1. In the placement of objects during the experiment, the position of the target was counter-balanced.

The child's task was to tell the bear "to get" one of the sets. On some trials, this was the S set and so a likely word to indicate that set would be the singular term (e.g. *spoon*). On the critical test trials the target set was the P set, potentially generating a plural noun (e.g. *dogs*). The nouns used for the P set were varied such that some had codas (e.g. *dog*

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[1] The SSP is not the only factor dictating legal and illegal coda clusters in English. For example, there is an interesting set of constraints on the appendix (Hammond, 1999; Vaux, 2006) licensing coronal consonants (e.g. *fund* [fun**d**], *dumb* [dum_]).

[dɑ**g**]) and others did not (e.g. *key* [ki_]) with the resulting plurals forms having either simple (e.g *key**s*** [ki**z**] or complex (e.g. *dog**s*** [dɑ**gz**]) codas.

Method

Participants

Participants were 68 children between 23 and 30 months of age (mean age = 26 months). All children were from monolingual speaking families drawn from a primarily middle class town in the Midwestern United States.

Stimuli and Design

Seven words were selected for use in the current experiment. All of these words are common nouns, which, by normative standards, are known by 50% of children who are 20 months of age (Fenson et al., 1994). Three of these words have simple codas in their plural form (*keys, bananas, cows)* and four of these words have complex codas in their plural form (*birds, dogs, pigs, trucks).*

Four unique three-dimensional instances (varying from 9 to 25 cm on the longest dimension) were selected for each of the seven target words. A previous study ensured all instances of the target nouns were readily recognizable by two-year-old children (Zapf & Smith, 2007).

At the start of a trial the child was given the two sets of toys to play with for no more than 30 seconds to minimize subsequent choices based on toy preferences. Next, the experimenter took back the toys and told the child, "In this game I am going to cover teddy bear's eyes and then show you some toys! I will point to some of the toys on the table and then I want you to tell teddy bear in words which toys to get. Do you think you can do that for teddy bear?" At this point, the experimenter covered the teddy bear's eye with a blindfold and arranged the objects into the two segregated sets (S and P). The experimenter said, "Can you tell teddy to get ___?" as the experimenter pointed to either the S set or the P set. After the child told Teddy what to "get," the experimenter took the blindfold off and Teddy "got" what the child said. On each trial, Teddy retrieved whatever the child verbally specified. If the child said nothing or something ambiguous (e.g. "that") the question was repeated once and if the child still did not respond or said something that did not unambiguously indicate one set, the experimenter went on to the next trial without Teddy retrieving anything. If the child used the singular form when a plural was called for, Teddy "got" one instance.

The experimenter ended the trial by telling the child "thank you" after Teddy picked up the object(s) mentioned by the child. Additional feedback was not given, as our goal was not to induce a learning effect throughout the experiment. Previous work by Bryant and Anisfeld (1969) has shown that offering feedback allows the child to demonstrate what can be learned or acquired through the experimental session, whereas a situation without direct feedback allows for the child to show what is known without aid from the experimenter.

Each child received eight trials. The first two trials were "warm up" trials in which the parent was first asked to tell teddy what toys to get in order to demonstrate to the child the task at hand. Immediately following, the child was asked the same question. On the remaining six trials, only the child was queried. Four of these remaining trials queried a response to the P set and the remaining two trials queried a response to the S set.

Results and Discussion

On the critical P set trials, children used the plural 43% of the time (n=86 tokens), the singular 23% of the time (n=46) and their utterances did not include the noun in either the singular or plural form 34% of the time (n = 69). In these trials children either said nothing, a deictic expression (e.g. "these"), or something irrelevant (e.g. "drink Mommy"). When the noun had no coda (e.g. *key_*) and the corresponding plural form had a simple coda (e.g. *key<u>s</u>*) the plural was correctly produced 50% of the time (n=51) whereas when the noun had a coda (e.g. *tru<u>ck</u>*) and the corresponding plural form had a complex coda (e.g. *tru<u>cks</u>*) the plural was correctly produced 35% of the time (n=35). This difference is significant ($\chi^2(1, N=201) = 3.82, p = .05$). As predicted, two-year-old children's plural productions are influenced by whether the resulting plural ended in a simple or complex coda. Complex codas, which are marked and are acquired later than simple codas, are less frequent in young children's production, thus suggesting that the development of this phonological ability influences the production of the plural form.

Experiment 2

Given that the results of Experiment 1 suggest that constraints on the production of complex codas are contributing factors in limiting the appropriate use of the plural, the next question is whether the difficulty associated with different types of complex codas also has an effect. In particular, we explored whether nouns with sonorant codas were correctly pluralized more often than nouns with non-sonorant codas. This particular question allows us to assess the role the SSP has in the production of morphology.

Method

Participants

Participants were 68 children between 23 and 30 months of age (mean age = 26 months). All children were from monolingual speaking families drawn from a primarily middle class town in the Midwestern United States.

Stimuli and Design

Eight words with complex codas were selected for use in the current experiment. As above, all of these words are common nouns. Four of these words have codas that are sonorant in their plural form (*plane, spoon, car, bear)* and four

of these words have codas that are non-sonorant in their plural form (*bird, dog, pig, truck*).

The selection of objects and the children's task in the current study were identical to Experiment 1.

Each child received twelve trials. The first two trials were "warm up" trials, as in Experiment 1. The following ten queries were asked only of the child. Eight of the remaining trials queried a response to the P set and the remaining two trials queried a response to the S set.

Results and Discussion

Overall, children correctly produced the plural form in the P set trials 50% (n=120 tokens) of the time. Otherwise, they produced the singular 22% (n=52) of the time and said nothing, a deictic expression (e.g. "these"), or something irrelevant (e.g. "look, door") 28% (n=67) of the time. For nouns that had sonorant codas (liquids and nasals), the plural was produced correctly 59% (n=68) of the time whereas for nouns with non-sonorant codas (stops), the plural was produced 43% (n=52) of the time. This difference was significant ($\chi^2(1, N=238) = 5.46, p < .05$) suggesting that a greater sonority drop within a complex coda facilitated production of the plural. Therefore, in addition to producing the plural more for simple codas compared to complex codas as shown in Experiment 1, children also are more likely to produce the plural for complex codas with a greater drop in sonority. The results for both experiments are summarized in Table 2.

Table 2: Number and percent of correct articulated plurals based on coda of plural form for both Experiments 1 & 2

	Correct	Incorrect	Total
Experiment 1			
Simple Coda (e.g. *keys*)	51 (50%)	51 (50%)	102
Complex Coda (*dogs*)	35 (35%)	64 (65%)	99
Total	86 (43%)	115 (57%)	201
Experiment 2			
Son + *s* Coda (*spoons*)	68 (59%)	48 (41%)	116
Non-son + *s* (*dogs*)	52 (43%)	70 (57%)	122
Total	120 (50%)	118 (50%)	238

General Discussion

The present results indicate that children's early use of the plural is limited in part by the phonological properties of the nouns being labeled. First, two-year-old children were more likely to use the plural when the resulting plural form had a simple, rather than complex, coda. This suggests that the marked status of complex codas has an impact on the acquisition of this morpheme. Second, when the resulting coda was complex, the plural form was correctly used more often when the noun ended in a sonorant coda versus a non-sonorant coda. This second set of results demonstrates that the use of the plural is also partly governed by the SSP and the sonority profile of the coda. Plurals with complex codas comprised of sonorant + *s* are produced correctly more often than those comprised of non-sonorant + *s* mirroring patterns of phonological development.

These data cannot be explained by frequency effects as frequency predicts the opposite results. A survey of two corpora of child-directed speech from CHILDES (MacWhinney, 1996) reveals that plosive + *s* coda complex codas are far more frequent than sonorant + *s* complex codas (6525 vs. 2476). However, we find sonorant + *s* clusters are produced correctly far more frequently than stop + *s* complex codas.

Thus, the greater markedness associated with complex codas as compared to simple codas and with complex codas that violate the SSP as compared to those that adhere to it, in addition to reflecting cross-linguistic tendencies, also captures rate of acquisition. This accords with the hypothesis of Jakobson (1941) that more marked structures are more difficult to acquire. In this instance, this difficulty in phonological acquisition impacts morphological competence.

These results also suggest that the rate of acquisition of the plural in English may not necessarily mirror the rate of plural acquisition in other languages since the phonological systems will be different. For example, in Italian the plural is formed by changing the final vowel (e.g. *libro – libri* 'book/s') which does not increase phonological markedness. This hypothetically opens the door for the plural to be acquired earlier since phonology is not a limiting factor. Conversely, in Spanish, where the plural is also formed with *–s*, but nouns with codas receive an *–es* ending, plural forms may be more complex than in Italian by virtue of having a coda (e.g. *libro ~ libros* 'book/s') but not as complex as English (e.g. *cuidad ~ cuidades*, 'city/ies', not *cuidads*). Thus, production of the plural may be partially constrained by phonological considerations, though not as much as in English.

Broadly, phonotactic constraints provide a model for exploring the phonology-morphology interface and suggest a principled explanation for some of the variable production of grammatical morphemes. This lends support to theories of language acquisition and performance that argue for interacting linguistic components (e.g. Bates, 1994; Jackendoff, 2002) over those that treat each subsystem as modular (Chomsky, 1986; Fodor, 1983). This is particularly relevant here where, at two years of age, the phonological development necessary for the production of a morpheme runs parallel to the morphological development. If myriad non-morphological factors constrain the acquisition of morphology, as we have shown, then this interaction should be reflected in a model of language acquisition.

References

Anisfeld, M. & Tucker, G. (1968). English Pluralization Rules of Six-Year-Old Children. *Child Development, 38,* 1201-1217.

Bates, E. (1994). Modularity, domain specificity and the development of language. *Discussions in Neuroscience, 10*:136-149.

Berent, I., Steriade, D., Lennertz, T., & Vaknin, V. (2007). What we know about what we have never heard: Evidence from perceptual illusions. *Cognition, 104,* 638-643.

Blevins, J. (2004). *Evolutionary phonology: The emergence of sound patterns*. Cambridge: Cambridge University Press.

Bloom, P. (1990). Subjectless sentences in child language. Linguistic Inquiry, 21, 491–504.

Brown, R. (1973). *A First Language: The Early Stages.* Cambridge, MA: Harvard University Press.

Bryant, B., & Anisfeld, M. (1969). Feedback versus no-feedback in testing children's knowledge of English pluralization rules. *J. of Experimental Child Psychology, 8,* 250-255.

Chomsky, N. (1986). *Knowledge of language: its nature, origins and use*. New York: Praeger.

Clements, G. N., (2006). Does sonority have a phonetic basis? In E. Raimy & C. Cairns, (Eds.) *Contemporary Views on Architecture and Representations in Phonological Theory.* Cambridge: MIT Press.

Demuth, K. (1992). Accessing functional categories in Sesotho: Interactions at the morpho-syntax interface. In Jürgen Meisel (Ed.), The acquisition of verb placement: Functional categories and V2 phenomena in language development (pp. 83–107). Dordrecht: Kluwer.

De Villiers, J. G. & de Villiers, P. A. (1973). A cross-sectional study of the acquisition of grammatical morphemes in child speech. *Journal of Psycholinguistic Research, 2,* 267-278.

Ettlinger, M., Finn, A., & Hudson Kam, C. (2007). The Effects of Sonority on Word Segmentation: Evidence for a Phonological Universal. *UC Berkeley Phonology Lab Annual Report.* 630-653.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. (1994). *Variability in Early Communicative Development.* (*Monographs of the Society for Research in Child Development).* 59 (5, Serial No. 242).

Fodor, J. (1983). *Modularity of mind*. Cambridge, Mass.: MIT Press.

Gnanadesikan, A. (1995). Markedness and Faithfulness Constraints in Child Phonology. In Kager, R., Pater J., & Zonneveld, W. (eds.), *Fixing Priorities: Constraints in Phonological Acquisition.* Cambridge, U.K.: Cambridge University Press.

Goldsmith, J. A. (1995). Phonological Theory. In J. Goldsmith (Ed.) *The Handbook of Phonological Theory* (pp. 1-23). Oxford: Basil Blackwell.

Jackendoff, R. (2002). *Foundations of Language*. Oxford University Press.

Jakobson, R. (1941). *Kindersprache, Aphasie, und algemeine Lautgesetze*. Uppsala: Almqvist & Wiksell [tr. *Child Language, Aphasia and Phonological Universals*, Mouton].

Johnston, J. R., Smith, L. B., & Box, P. (1997). Cognition and communication: Referential strategies used by preschoolers with specific language impairment. *Journal of Speech, Language, and Hearing Research, 40(5),* 964-974.

Kirk, C. & Demuth, K. (2003). Onset/Coda Asymmetries in the Acquisition of Clusters. XXX

Ladefoged, P. (1993). *A Course in Phonetics* (3rd ed.). Orlando: Harcourt Brace & Company.

MacNeilage, P., & Davis, B. (2000). On the Origin of Internal Structure of Word Forms. *Science*, 288, 527 – 531.

MacWhinney, B. (1996). The CHILDES system. *American Journal of Speech Language Pathology, 5,* 5-14.

Marcus, G. F., Pinker, S., Ullman, M., Hollander, M., Rosen, T. J., and Xu, F.. (1992). *Overregularization in Language Acquisition.* (*Monographs of the Society for Research in Child Development).* 57 (4, Serial No. 228).

Ohala, J. (1990). Alternatives to the Sonority Hierarchy. In M. Ziolkowski, M.Noske & K. Deaton (Eds.) *Papers from the 26th Regional Meeting of the Chicago Linguistics Society* (pp. 319-338). Chicago: Chicago Linguistic Society.

Pérez-Leroux, A. & Roeper, T. (1999). Scope and the structure of bare nominals: Evidence from child language. *Linguistics, 37,* 927–960.

Sievers, E. (1881). *Grundzüge der Phonetik.* Leipzig: Breitkopf und Hartel.

Steriade, D. 1999. Alternatives to the syllabic interpretation of consonantal phonotactics. In O.Fujimura, B.Joseph, & B.Palek (Eds.) *Proceedings of the 1998 Linguistics and Phonetics Conference* (pp. 205-242). Prague: The Karolinum Press.

Vaux, B. (2006). The syllable appendix. In E. Raimy and C. Cairns (Eds.) *Contemporary Views on Architecture and Representations in Phonological Theory*. Cambridge: MIT Press.

Whitney, W. (1865). The relation of vowel and consonant. *Journal of the American Oriental Society*, 8, 357-73.

Zapf, J. A. & Smith, L. B. (2007). Meaning Matters In Children's Plural Productions. *Proceedings of the Twenty-Ninths Meeting of the Cognitive Science Society.* 743-748 Boston, MA: Cascadilla Press.

Zapf, J. A. & Smith, L. B. (2007). When do children generalize the plural to novel nouns? *First Language, 27,* 53-73.