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When do children generalize the plural to novel nouns?

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ABSTRACT
Despite the theoretical importance of the processes of generalization to the development of morphological rules, not much is known about the basic developmental trend or the relevant processes. The present study seeks to answer the question: at what age are children able to generalize the plural to new nouns. In a six-week longitudinal study, children aged 17.5 to 28 months participated in a spontaneous production task in which they were either provided with the singular form of common and novel nouns and asked to generate the plural form, or given the plural form of those nouns and asked to generate the singular form. The results suggest that very young children do generalize the plural to novel forms. The data also strongly suggest that, long before a truly productive regular plural is evident, very young learners of English know that there is a singular and plural form, and they know how they are related.

KEYWORDS
Cognitive development; elicitation task; first language acquisition; generalization; morphological development

INTRODUCTION

Learning is made from specific experiences with specific instances. One question for theories of learning is how these specific experiences make general knowledge that can be applied to new instances. This question is at the core of research on the acquisition of the English plural, the focus for the present paper. When, in the course of learning the plural, do children generalize the plural to new nouns?

Text-book descriptions portray a stage-like progression. First is a rote stage in which children do not generalize but produce only learned instances in both their regular (e.g., *cats*) and irregular forms (e.g., *men*). Second is an over-regularization stage in which children generalize the plural to new instances and also regularize irregular forms (e.g., *mans*). Finally, there is the mature stage consisting of correct production of both the regular plural and the exceptions. The second stage has been considered most critical. Here children produce surface forms, over-regularizations of irregulars, that they have never heard. Early interpretations of these generalizations took them as an indication of the abstraction of a rule, 'nouns are made plural by adding s' (Marcus, Pinker, Ullman, Hollander, et al., 1992).

There are several reasons to question this classic description of the developmental trend, and the progression from a non-generalizing to a generalizing stage. Most critically, over-regularizations – the developmental hallmark of the generalization stage – are rare, occurring less than 4% of the time. Further, they are not restricted to any particular moment in development (Marcus et al., 1992) but may occur throughout development. The rarity of over-regularization errors, however, does not necessarily mean that generalizations themselves are rare in early plural productions, nor that development is not stage-like, moving from non-generalizations to generalizations. Children's spontaneous and correct productions of the *regular* plural rise steadily between the period of 18 and 49 months of age (Anisfeld, 1984; Cazden, 1968; Mervis & Johnson, 1991). Some of this increase is surely due to children simply repeating more of the heard (and thus stored) plural surface forms, but much of it could reflect the increasing (and correct) *generalization* of the regular plural to new instances. The extant data does not distinguish between these possibilities. Thus, at present, it is unclear just how early and how pervasive generalizations of the plural are. The specific goal of the present research is to assess the likelihood and frequency of early generalizations of the regular plural to novel nouns.

This gap in knowledge derives in part from two competing theories about the mechanism of generalization that have focused attention on explaining over-regularizations rather than on the developmental trend and on just when developmentally generalizations start playing a significant role in production. The two competing mechanisms for generalizations are sometimes known as rule or 'dual process' accounts versus similarity-based or 'single process' accounts. The key claim of the rule account is that children learn symbolic (or algebra-like) rules that operate over variables such as 'noun stem' (Marcus et al., 1992). In their strongest forms these accounts predict that once a rule is acquired, it should be extended 'across the board to any representable novel token regardless of [the speaker's] familiarity with this instance or their features' (Berent, Marcus, Shimron & Gafos, 2002: 114). These classes of theories are considered 'dual process' accounts because they traditionally

postulate different mechanisms for the regular plural (rules) and irregular forms (memorized exceptions). The second class of theories, similarity-based, propose that children learn specific instances of pairings between singular and plural forms (e.g., cat-cats, dog-dogs) and that their production of novel plural forms is the consequence of similarity-based generalizations over these specific learned instances (Marchman, Plunkett & Goodman, 1997; Plunkett & Marchman, 1993). By these accounts the production of the plural is expected to be highly dependent on type and token frequency and the similarity of novel forms to specific learned instances. This account is sometimes called the single mechanism account because it proposes a single process for the learning and generalization of both regular and irregular forms.

There are well-specified versions of both classes of theories that do account reasonably well for children's acquisition of the plural, including over-regularizations (Marchman et al., 1997; Marcus, 1995, 2001; Marcus et al., 1992; Plunkett & Juola, 1999; Plunkett & Marchman, 1993). Indeed, if one allows stochastic access to rules based on similarity or highly abstract forms of similarity in similarity-based models, it may not be possible to distinguish the two current theoretical accounts. This theoretical controversy – and the data and mechanisms on which it concentrates – also leaves many developmental questions unaddressed, particularly those concerning just how much children's increasing productions of regular plural forms might be based on generalization rather than the production of stored surface forms. Accordingly, the present study was designed *not* to distinguish between these two theoretical points of view on the mechanism for generalization. Instead the goal is a richer description of the development of generalization. Explaining the developmental processes that underlie children's use and acquisition of the plural (rather than deciding between extreme views of 'algebraic rules' versus 'no rules') requires richer data about when, developmentally, these generalizations occur.

This is a current and critical gap in the empirical literature. Accordingly, we sought to measure just how frequent generalizations of the plural form are likely to be in early development. When children first start producing the plural, are they highly conservative or are generalizations of the plural to new forms relatively likely and thus contribute to increasing rates of plural productions? A highly conservative developmental trend might consist of children producing the plural only for a small number of well-known nouns, with generalization to novel nouns coming much later and all at once. Alternatively, generalizations might be part and parcel of plural productions from the earliest points in development. At present, there is little empirical evidence on which to evaluate these possibilities, as most studies on children's earliest stages of plural production have examined only spontaneous productions, most of which (about 96%; Marcus et al., 1992) are plural forms the child has heard. What is needed is a study of elicited plural productions in very young children with truly novel forms.

To provide these data, we return to the method Berko (1958) used in her classic paper to elicit novel plural productions in children aged four to seven years old. In that study, children were presented with novel nouns, each as a name for a single object and then an attempt was made to elicit the never-before-heard plural forms of these novel words. The task worked as follows: the child and experimenter read a book together in a manner that encouraged the child to fill in the blank.

For example, as illustrated in Fig. 1, a novel picture would be shown to a child and the experimenter would say, 'This is a wug.' On the next page, there would be two wugs and the experimenter would say 'Now there is another one. There are two of them. There are two ……' In her study, Berko found that four-year-olds could sometimes produce the plural form of these novel nouns and that children's ability to do so increased steadily from four to seven years of age. Of interest here is the developmental lateness of a fully generalized regular plural. The difficulty of the generalization of the regular plural to truly novel forms has been replicated in several other studies (e.g., Graves & Koziol, 1971; Marwit, 1977).

In contrast to Berko (1958), and despite the lateness of a fully productive plural, we sought evidence of generalization of the regular plural to novel nouns in 17- to 28-month-olds. These are children who are just beginning to produce the plural for well-known nouns. We incorporated several procedures to increase the likelihood of productions. First, we use a six-week longitudinal study. In this way, children should be comfortable with the procedure and should, at least as the experiment progresses, know the novel stems. Second, we measured children's production of the plural of common English nouns as well as their production of novel plural forms. In this way, we provide information on the similarity or distinctiveness of the growth in production of truly novel plurals and those for familiar nouns. Third, to increase these very young children's talking in the experiment, we trained mothers to read the books and elicit the productions from their children. Finally, we used two versions of the Berko task. One of these tasks, like the original Berko study, presented children with the singular form and asked for the plural. The second Berko-like task is the inverse of the first, as shown in Fig. 1. Here we presented children with two entities that we named with a plural form; we then presented one instance and asked whether children will supply the singular form. Logically, this task taps the same knowledge as the standard Berko task, that nouns have singular and plural forms that differ by adding the morpheme /s/ to the singular form to create the plural. However, singular forms are both more frequent in the input to children than plural forms and also easier to produce. Thus, this inverse version of the task may be easier for children and so a more sensitive test of an early ability to generalize their knowledge of how English makes singular and plural forms.

METHOD

Participants

Participants were 41 children (21 males, 20 females) between 17.5 and 28 months of age ($M = 23$ months). All children were from monolingual speaking families drawn from primarily middle-class town in the Midwestern USA. Twenty-two of the children participated in the singular imitation, plural generalization condition whereas 19 participated in the plural imitation, singular generalization task (both depicted in Fig. 1). Participation required attendance at six weekly sessions, each lasting 20–40 minutes. The main experimental task lasted approximately 10 minutes. In addition, while children played in the playroom, parents filled out the Bates MacArthur

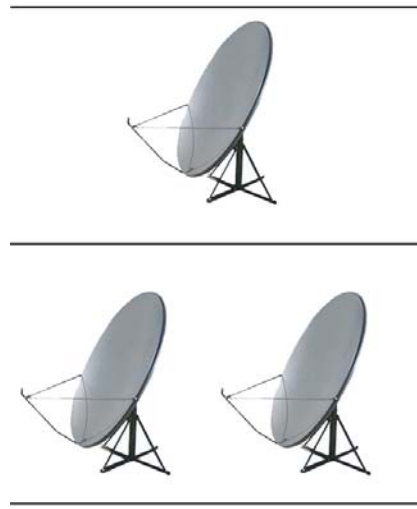

Figure 1 In the Standard task, the top panel was used in the singular imitation portion of the trial, and the bottom panel was used in the plural generalization portion of the trial; in the Inverse task, the bottom panel was used in the plural imitation portion of the trial, and the top panel was used in the singular generalization portion of the trial

Communicative Developmental Inventory (Toddler form) indicating all words in their child's productive vocabulary. The productive vocabulary of these children ranged from 9 to 691 words, with a mean productive vocabulary of 330 words. Two children missed one of their six weekly sessions; their data for the remaining sessions are included in the analyses.

Stimuli

Common nouns

Eight nouns that are typically known by 50% of 18-month-olds learning English (Fenson, Dale, Reznick, Thal, et al., 1993) and that varied in their frequency in adult speech to children were selected. The frequency of both the singular and plural forms of these nouns were determined from the Child Language Data Exchange System (CHILDES). Frequencies in the input were calculated based on speech to children from parents, caregivers and experimenters from 27 studies listed in the CHILDES database (Li & Shirai, 2000; MacWhinney, 2000). The total number of lexical items in this parental corpus is approximately 2.6 million word tokens and approximately 24,000 word types. Table 1 lists the eight familiar words and the frequency of the singular and plural forms in this corpus of adult speech to children.

Novel forms

Fourteen novel consonant-vowel-consonant forms were constructed to meet certain phonotactic constraints. Because recent research suggests that children's

Table 1 Eight familiar words used in the experiment and the frequency of the singular and plural forms as calculated from the CHILDES corpus of adult speech to children (Li & Shirai, 2000; MacWhinney, 2000)

	Frequency in input from adult speech to children	
Word	*Singular*	*Plural*
hat	967	60
shoe	834	345
dog	1529	268
cat	1026	196
ball	1124	237
bunny	588	43
bird	730	195
bottle	385	140

productions particularly of novel forms may be strongly related to the phonotactic probability of those forms (Storkel, 2001), we selected novel forms that included all the allomorphs of the English regular plural. The novel words were also as similar as possible to the familiar nouns listed above, such that the phonotactic probabilities of the singular and plural forms were also comparable. These were calculated as per Vitevitch & Luce (2004). For the familiar nouns the average phonotactic probability for the singular forms was 0.052 (range: 0.016–0.085) and for the plural forms was 0.045 (range: 0.018–0.077). For the novel forms, the average phonotactic probability for the singular versions was 0.047 (range: 0.020–0.073) and the plural version was 0.043 (range: 0.018–0.067). An ANOVA revealed no reliable differences in phonotactic complexity for the 4 classes of forms; all are equally good 'English' forms, $p > 0.25$. The 14 selected novel singular forms were: bik, niz, stipe, wug, zib, zeet, gorp, kib, gip, mub, zug, lun, wap and keeb. For each child eight of these served as the test forms in the experiment such that across children each form served equally often. The remaining forms for each child were used in a production-control task.

The purpose of the production-control task was an added measure to ensure that children's limitations in generalizing the plural (or singular) for a novel form was not due to difficulties in producing the form. In the production-control task the child was simply presented with one of the novel forms that would not be a test form for that child (but would be for other children in the experiment) and asked to repeat it. All novel forms were readily repeated by the children, with 72–96% correctly imitated. There were virtually no incorrect productions. That is, children either correctly imitated the form or said nothing. This level of performance suggests that the phonological and articulatory skills required to produce the novel forms were in the articulatory repertoire of the children participating in this study, a point also supported by the imitation measures in the main experiment.

Books

Two picture books were created for each condition that paired words with photographs of objects. The pictures for the real words were prototypical examples drawn from picture books. The pictures for the novel words were also of real things for which the name was unlikely to be known by young children (an old-fashioned radio, a corkscrew, an unusual stapler, an old-fashioned television antenna, a computer mouse, a shiny compact disc, an old-fashioned microphone, a satellite). Each page was 4 x 6 inches. The picture book for the Standard Berko task was structured as follows: for each trial there were two pages of pictures as illustrated in Fig. 1. The first page had a picture of one object on it (bottle). Opposite that page was a script for the parent to read: 'Look, a bottle. See the bottle. Can you touch that bottle? Can you say "bottle"?' On the second page was a picture of two objects from the same category (i.e., two bottles). Opposite this page was a script for the parent to follow: 'What's here? Can you tell me what's on this page? What do you see?' The first four pages of the book corresponded to two warm-up trials used to familiarize the parents with the task. These two warm-up trials were followed by the pages corresponding to the 16 (8 familiar, 8 novel) experimental words. These were presented in one of two random orders with real and novel nouns intermixed.

The picture books for the Inverse Berko task was structured in the same fashion, except that the first page of each trial had a picture of two objects from the same category (i.e., two bottles). Opposite that page was a script for the parent to read: 'Look, bottles. See the bottles? Can you touch the bottles? Can you say "bottles"?' On the second page of each trial was a picture of one object on it (i.e., bottle). Opposite this page was a script for the parent to follow: 'What's here? Can you tell me what's on this page? What do you see?' Again, the first four pages of the book corresponded to two warm-up trials used to familiarize the parents with the task. These two warm-up trials were followed by the pages corresponding to the 16 (8 familiar, 8 novel) experimental words. These were presented in one of two random orders, again with real and novel words intermixed.

Procedure

Parents were instructed to read the picture book with their child. They were instructed to provide the label on the first page and to encourage their child to *imitate* that form. Once parents turned to the second page in each set, they were told not to name the object(s) and were instructed to use non-specific phrases provided in a script to elicit the label. Parents were given the appropriate time to practice this script and ask the experimenter any questions before proceeding. This is the *generalization* test. Thus, progress through the book can be conceived of as consisting of two kinds of trials as illustrated in Fig. 1: imitation trials in which the child is asked to repeat the surface form provided by the parent and generalization trials in which the child is asked to produce an altered version of that form (the plural in the Standard Berko task and the singular form in the Inverse Berko task). Sessions were video- and audio-taped, using a high sensitivity microphone. Only data from parents who followed the script and experimenter instructions were included. All parents followed instructions.

Coding for productions

Children's productions were coded as to the production of the stem and the plural. One-quarter of the sessions were coded by two independent coders. Agreement among the coders for the production of the singular versus plural form in the Standard Berko task was 0.95 (imitation trials) and 0.94 (generalization trials) and for the Inverse Berko task was 0.98 (imitation trials) and 0.93 (generalization trials). The videotapes were also coded for parent compliance and in particular to ensure that the parent never said the generalization form. All parents complied.

RESULTS

For the main analyses, we count the cumulative number of unique forms (maximum = 8) that children imitate or produce in the generalization test across the six weekly sessions. We concentrate on the cumulative number of types across sessions rather than number of tokens of productions, because the central question of interest is in generalization, that is, in the *first-time* production of a plural (or a singular) form that the child has not heard or produced in the experiment before. Therefore, we do not count repetitions of the same form within or across sessions. However, once children produced a particular form (e.g., 'wugs') they tended to produce that form when appropriate at all subsequent sessions; following this main analyses of cumulative productions of each type, we report analyses of total productions by session.

Growth curves

Figure 2 shows the growth curves, cumulative type productions (maximum = 8), for the imitation trials when the imitated form was singular, or plural, and when it was a common English noun or a novel noun. When children have just heard a form and are asked to repeat that very same form, can they do so? On average, children imitated two to three of the forms at the first session but had imitated six of the eight by the final session. An ANOVA for a 2 (condition: Standard or Inverse) × 2 (form: real

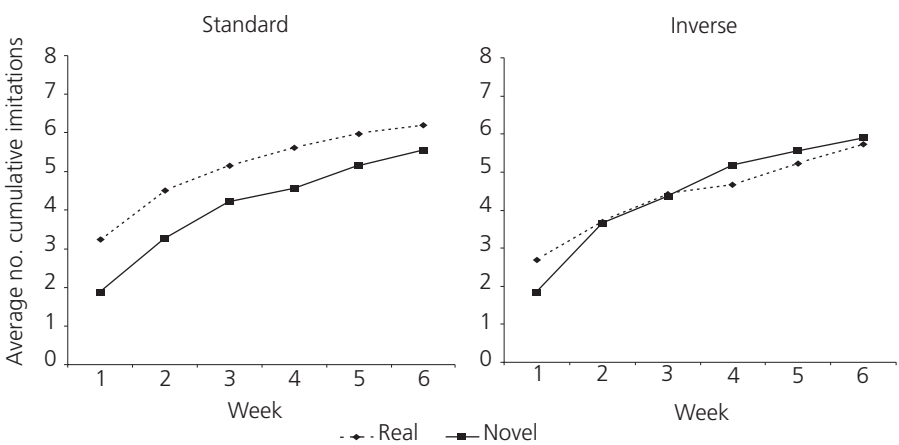

Figure 2 Growth curves of cumulative type productions for imitation trials

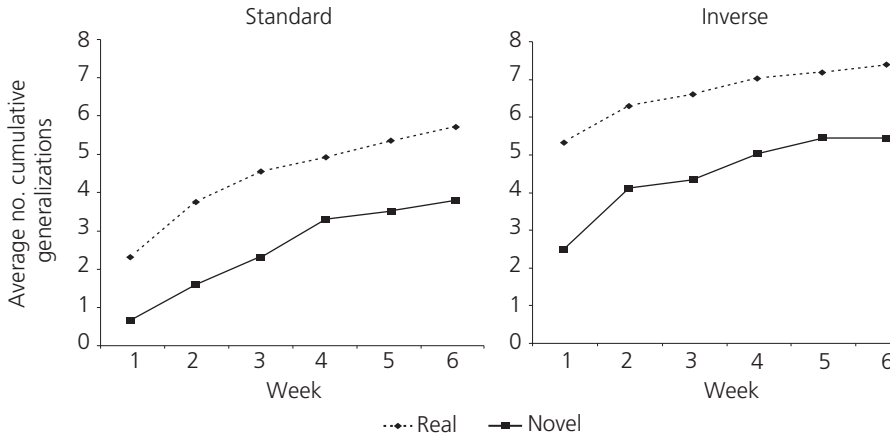

Figure 3 Children's cumulative type productions on the generalization trials, as a function of week

or novel) x 6 (week) mixed design revealed a main effect of week ($F(5, 39) = 66.43$, $p < 0.01$) and a reliable interaction between week and form ($F(5, 39) = 3.61$, $p < 0.01$). There was neither a main effect of form nor an effect of condition. However, the main effect of form approached significance ($F(1, 39) = 3.67$, $p = 0.06$); children were somewhat more likely to imitate the real words than the novel words. *Post-hoc* analyses (Tukey's HSD, $p < 0.05$) reveal that the interaction is due to the fact that children were less likely to imitate the novel forms than familiar forms at week 1, but were just as likely to imitate those forms as familiar nouns at week 6. Importantly, children were just as likely to imitate plural forms as they were singular forms throughout the experiment. At the very least this suggests that the additional articulatory complexity of the plural forms is not a limiting factor.

Figure 3 shows the central result, children's cumulative type productions on the generalization trials as a function of week. If children have just heard the singular form, can they generate the corresponding plural form on their own? If they have just heard a plural form, can they generate the corresponding singular form on their own? The main result is that, across an increasing number of items, these quite young children do make these generalizations.

A 2 (condition : Standard or Inverse) x 2 (form: real or novel) x 6 (week) ANOVA on the cumulative (type) generalizations revealed a main effect of week ($F(5, 39) = 50.35$, $p < 0.001$); children generalized to more types as the experiment progressed. The ANOVA also revealed a main effect of form ($F(1, 39) = 58.58$, $p < 0.001$); that is, children were more likely to make these 'generalizations' for the common English nouns than for the novel words. This is consistent with the fact that children are likely to have heard and even produced at least some of the plural forms of these common nouns in the past, outside the context of the experiment. The analysis also revealed a main effect of condition ($F(1, 39) = 10.15$, $p < 0.01$), children were more likely to generate the singular form (given the plural in the Inverse Berko task) than they were to generate the plural form (given the singular in the Standard Berko task). The analysis also revealed a reliable interaction of week and form ($F(5, 39) = 6.29$, $p < 0.001$). The magnitude of the difference between generalization for novel and real words

tends to decrease as the experiment progresses. This finding is particularly interesting, given that children were equally likely to imitate the singular and plural forms. Apparently generating (not just articulating) a singular form is computationally easier than generating a plural form, and this is true for novel nouns as well as common ones.

The main result from the group curves in Fig. 3 is this: very young children do not produce only specific forms they have heard and stored. Instead, long before the plural is fully productive, young children appear to *generate* the plural and singular versions of novel forms. One possible criticism of this conclusion concerns parent behavior at home, between sessions. In principle, parents could have produced and coached their children to produce the novel forms at home. This seems unlikely on three grounds: (1) parents did not have copies of the books and novel pictures to take home; (2) they were asked not to produce these to-be-generalized forms; and (3) they did not report producing these forms at home. Thus, it appears that generalizations are part of the learning process from early in the acquisition of the plural. Further, the generalization of plural (and singular) forms grows similarly over the course of the experiment as children become more familiar with the task. This is consistent with the idea that the processes that generate novel and familiar forms are similar.

Individual growth curves

In our next analyses, we examine the growth curves of cumulative type productions for individual children, since these may not be the same as the overall averaged pattern. The examination of individual children yielded just four patterns. Figure 4 presents representative results from seven individual children. Table 2 gives the number of children and the mean vocabulary of the children who showed growth patterns similar to these seven children. A very few children, and on average those with the lowest vocabulary, showed a pattern like that of participant 2: no generalizations at all, either for common or novel forms. Interestingly, this pattern occurred only in the Standard Berko task when children were asked to generate the plural from a singular. These four children did not yet produce the plural. All children in the sample, however, were able to generate a singular form from a plural form, at least for real nouns. The second pattern, illustrated by participant 6 in the Standard task and participant 18 in the Inverse task, is also characteristic of only a few children ($N = 6$); this pattern shows generalized versions for the common nouns, but not for the novel ones. Apparently, children showing this pattern can generate a form if they have heard it (or produced it before) but cannot generate a plural from a novel singular form or a singular from a novel plural form. This is the pattern we would expect if one could only produce stored forms without generalizing. The third pattern, illustrated by participant 11 in the Standard task and participant 5 in the Inverse task, is the one characteristic of most children. In both versions of the task, most children showed a pattern much like the group data, generalizing the plural from the singular form and the singular form from the plural form for both common nouns and novel nouns. The generalizations tended to occur earlier in the experiment for familiar nouns, although three children who showed this pattern actually produced generalizations of novel forms earlier than familiar forms. Again, these patterns of individual results strongly suggest that generalization is part of the learning process from early in the development of the plural. Finally, there were

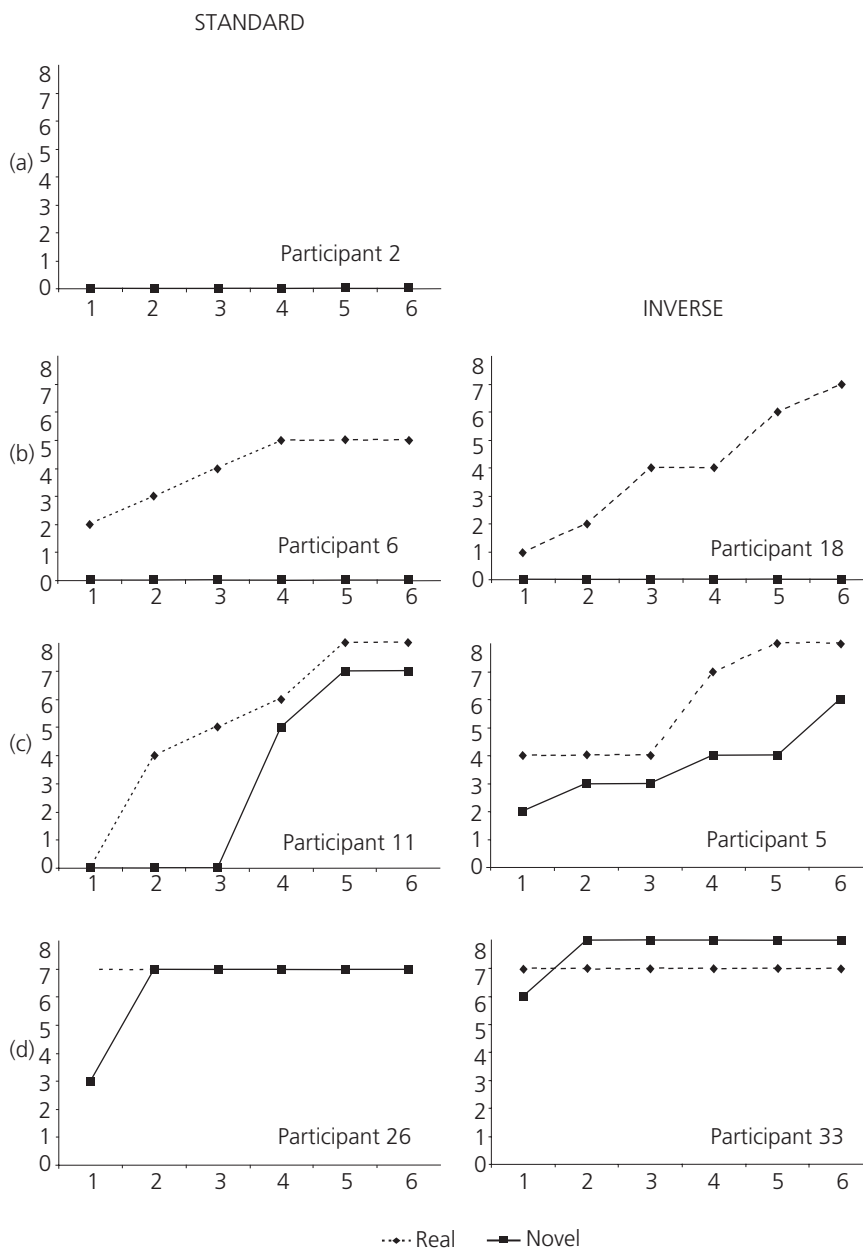

Figure 4 Data from individual participants illustrate four patterns of growth curves shown here as the number of cumulative type productions (y-axis) as a function of week (x-axis). The four patterns are: (a) no production of either real or novel forms (n/a for inverse task), (b) production of real forms only, (c) growth of production of real and novel forms, and (d) fully productive plural from the beginning of the experiment

Table 2 Number of children and mean vocabulary of the children who showed growth patterns similar to those in Fig. 4

	Standard Berko Task		*Inverse Berko Task*	
	No. children	*Mean vocabulary*	*No. children*	*Mean vocabulary*
(a) No production	4	203	0	n/a
(b) Production of real forms only	4	273	2	19
(c) Growth of real and novel forms	13	393	16	355
(d) Fully productive from beginning	1	364	1	380

two children (one in each condition, and both with particularly high vocabularies) who produced the generalized forms – showing fully productive knowledge of the singular-plural relation – from the beginning of the experiment.

Overall, 10 children across the two versions of the task (25% of participants, mean age = 21 months) did not produce generalized versions of novel forms whereas 31 children (75% of participants, mean age = 24 months) did. Although this 25% is a minority of the children, it does indicate a possible developmental point at which children produce *only* stored forms and do not generalize. The children who did not produce novel generalizations had smaller productive vocabularies ($t(1, 39) = 10.64$, $p < 0.01$) than those who did, and thus they presumably have had less practice in producing both the singular and plural forms and fewer stored forms to support generalization. Both productive vocabulary and age were correlated with novel generalizations in the Standard task, $r = 0.71$, $r = 0.69$, respectively. Only productive vocabulary was correlated with generalization in the Inverse task ($r = 0.56$, productive vocabulary; $r = 0.37$, age). This lack of correlation may not be meaningful because of the compressed range of scores in the Inverse task due to the overall higher level of generalization in that task.

The individual curves in Fig. 4 also raise questions about the shape of the individual growth curves over the course of the experiment. Participant 11, who took part in the Standard task, demonstrated a substantial jump in generalizations of the novel forms. Several children showed such a large jump, but most did not. Figure 5 shows the largest intersession jump in generalizations as a function of task and word. There are no reliable differences. The largest jump is, on average, two forms per week. For most children, generalizations increased incrementally. Figure 6 shows the session of the biggest jump as a function of task and week. Here there is a reliable effect of word ($F(1, 39) = 16.443$, $p < 0.001$); children show an earlier 'jump' in generalizations for familiar over novel forms in both the Standard and Inverse tasks.

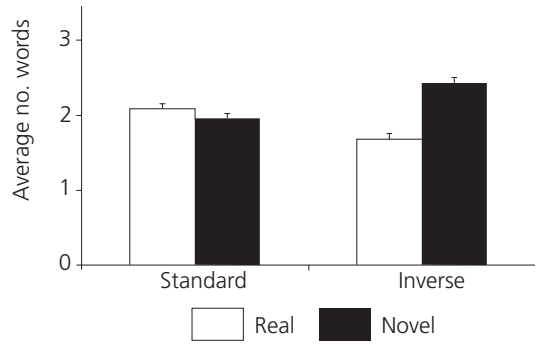

Figure 5 Largest intersession jump in generalizations as a function of task and word

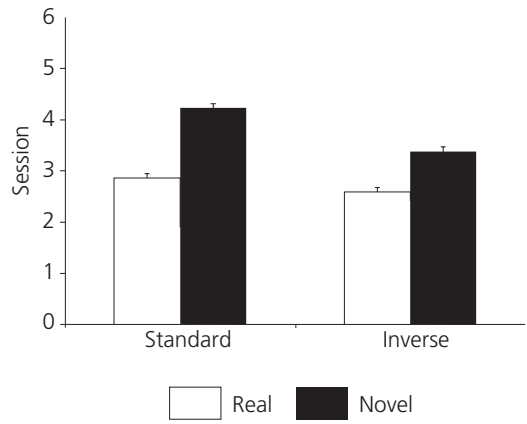

Figure 6 Session of largest jump as a function of task and week

Token productions

Analyses of variance on total productions were conducted for both the imitation trials and the generalization trials. The 2 (condition: Standard or Inverse) x 2 (form: real or novel) x 6 (week) mixed design ANOVA revealed only a main effect of condition ($F(1, 38) = 13.46$, $p < 0.001$) and an interaction between form (real or novel) and condition ($F(1,38) = 8.54$, $p < 0.01$). The main effect of week ($F(5,38) = 2.02$, $p < 0.08$) approached significance. These results are due to the fact that, in terms of token frequency, children imitated the real singular forms more than the real plural forms, but imitated the singular and plural novel forms equally often. These differences between imitation of real singular and plural (but not novel singular and plural forms) are most likely due to effects of frequency of real singular and plural nouns in the input to children (data we present in the 'Frequency effects' section below).

The 2 (condition: Standard or Inverse) x 2 (form: real or novel) x 6 (week) mixed design ANOVA of token productions of singular and plural forms on the generalization trials revealed main effects of form (real or novel; $F(1, 38) = 65.11$,

$p < 0.01$); week ($F(5, 38) = 3.674$, $p < 0.01$); and of condition (Standard or Inverse; $F(1, 38) = 8.00$, $p < 0.01$). An interaction between form and condition ($F(1, 38) = 5.795$, $p < 0.05$) was also reliable. These results are comparable to the type (cumulative) analyses. Children's token generalizations increased over the course of the experiment; they produced more generalizations in the Inverse task than in the Standard task; they produced the 'generalizations' for the real forms more than the true generalizations for the novel forms; and there was a somewhat larger difference between real and novel token productions in the Inverse conditions than in the Standard conditions. This is because, as in the token imitations, children's token productions of the real singular forms, the most frequent forms in the input (see subsequent analyses under 'Frequency effects'), are much greater than their token productions of any other forms.

Errors

Table 3 shows the proportion of all possible responses in the generalization task (summed over the entire 6-week experiment): children could produce the correct generalized form, they could produce the just imitated form (what we will call a perseverative response), or they could produce some other response. The other responses typically consisted of saying nothing or something irrelevant to the task. Perseverative responses were more common in the Standard task than in the Inverse version; children were more likely to repeat the singular than the plural form. However, in both conditions a repetition of the base form on the generalization trials (singular or plural) was not common. Instead, the most prevalent response was no response at all. This was so despite the fact that the just imitated form (for both the Standard and Inverse task) contained the correct noun label for the category. Since children had just said the noun (in one form or another) and since that label was at least close to the desired form, repetitions of the imitated form seemed, *a priori*, a highly likely response. That children did not do this suggests that they know, in at

Table 3 Percentages of all possible responses in the generalization task summed over the entire 6-week experiment

Response	*Standard Berko task*	*Inverse Berko task*
Real words		
Correct	36	71
Perseveration	42	4
No response	22	25
Novel words		
Correct	18	36
Perseveration	33	11
No response	49	53

least some manner, that the same surface form is not used for single and multiple instances from the same category.

Frequency effects

The number of children producing (at least once) the generalized forms for the eight real nouns were strongly related to the frequency of the surface form in adult speech to children, as measured by the frequency in the CHILDES transcripts (Table 1). In the Standard task, children's generalization of the plural form was strongly correlated to the frequency of that surface form in the input (as calculated in CHILDES – see Method section), r (7) = 0.70, $p < 0.05$, 2-tailed. Also, in the Inverse task, the frequency with which children generated the singular form was strongly correlated with the singular form in adult speech to children, r (7) = 0.68, $p < 0.05$, 2-tailed. Of course, strong conclusions are not warranted, given the small number of nouns sampled. However, the results are consistent with the idea that children are more likely to produce forms that have been heard frequently in the past. Examination of frequencies of the singular and plural forms of the nouns studied here in parent speech also indicate that the singular forms of these nouns occur with much greater frequency than the plural forms (singular form: range = 385–1529, $M = 897.9$; plural form: range = 43–345; $M = 185.5$). This difference in the frequency in the input may well underlie the greater token frequency (in imitation and generalization) of singular rather than plural productions of the real nouns in the experiment.

This experiment was not designed to examine systematically children's production of different allomorphs. Nonetheless, for completeness, we report them here. For familiar forms in the Standard and Inverse Berko tasks there were two forms (/s/ and /z/); children produced both forms with equal frequency (/s/ 82% of the items; /z/75% of the items; $t(6) = 0.620$, $p = 0.56$) and dropped the allomorph in the inverse task with equal frequency (89% of the items and 92% of the items, respectively; $t(6) = -0.297$, $p = 0.78$). The novel words presented three allomorphs (/s/, /z/, /ez/), although there was only one novel word 'niz' which called for the /ez/ form. In novel production we find stronger hints that the allomorph matters. In the Standard Berko task, children produced the /s/ form for 60% of the items. This was reliably more than the /z/ form in which children produced only 40% of the items (t (11) = −3.072, $p = 0.01$). Production for the /ez/ form for the one novel item occurred on 36% of the trials. This pattern of production fits previous findings (Berko, 1958; Winitz, Sanders & Kort, 1981). In the Inverse Berko task, children appear just as likely to drop all the forms (/z/ 75% of the items; /s/ 67% of the items; children dropped the /ez/ on one novel form 78% of the time).

GENERAL DISCUSSION

The experiment yielded five main results: (1) a very small number of children produced but did not generalize the plural to novel forms; (2) for most children, generalizations of the regular plural were observed; (3) thus, for most children there

was no obvious discontinuity in the pattern of productions for the real and novel nouns; (4) children more easily generalized the singular form from the plural than the plural from the singular, and this was so despite the fact both singular and plural forms were imitated with equal ease, suggesting that the singular form was the computationally simpler form; and (5) the children tended not to label singular items with the plural and children tended not to label multiple items with the singular form – even though these forms had been primed by their own just-prior imitations, suggesting that they knew there were two fundamentally different meanings that require fundamentally different forms.

Generalizations are early and similar across real and novel forms

Classic accounts of the development of the regular plural suggested discrete stages; children first memorized individual forms and then – via abstracted rules – produced generalizations. A few children participating in this study might be characterized as performing in a manner consistent with these stages, in that there were a very few children who produced only real nouns and made no generalizations for the novel nouns, and there were also very few (two) children who generalized the plural (or singular) for all nouns, real and novel. However, most children's patterns of performance fitted neither description, as most children did correctly generalize the regular plural to a few novel forms but did not generalize it to all forms. Further, for most children, the frequency (and within-experiment developmental trajectory) of the production of the generalized form for real words and for novel words was highly similar, suggesting that the processes through which children generate the regular plural for (potentially) known and novel forms is the same. This implies that when very young children produce the plural of a known word they do not necessarily do so by activating a represented surface form. Rather, they appear capable of generating the plural from a singular and generalizing the singular from the plural. These processes of generation – whatever they are – would seem central to developing a fully productive plural. The present results contribute by showing they are in place in very young children and that generalizations contribute to learning very early.

The results also show (as has previous research, e.g. Berko, 1958; Marcus et al., 1992) that the processes that generate novel plural and singular forms are in some way limited in that most of the young children did not produce the regular plural (or generate the singular form from the plural) for all novel forms. Their performance was quite far from that described by strong rule-like knowledge of a plural that is applicable 'across the board to any representable novel token regardless of [the speaker's] familiarity with this instance of their features' (Berent et al., 2002: 114). Pervasive generalization of this sort is apparently a late achievement (Berko, 1958; Graves & Koziol, 1971; Marwit, 1977).

In sum, the processes that produce early generalizations of the regular plural to novel forms are clearly not yet widely applicable to all and any forms, but there are also processes that do generate new plural forms from singular forms and new singular forms from plural forms and they are part and parcel of children's early plural productions. If there is a stage during which children just produce stored forms, it is very early and, apparently, brief.

Two meanings – two forms

The classic idea that children begin producing the plural simply by reproducing heard plural forms is a reasonable one. Children could simply memorize surface forms and meanings as holistic units, e.g., 'cat' – one cat, 'cats' – several cats, 'banana' – one banana, 'bananas' – several bananas, without analyzing the forms and meanings into constituents, without realizing, for example, that cats = cat + s, or that a group of cats can be analyzed into the meaning components of cat category + multiple instances. At least for the majority of very young children in this study, this characterization of their understanding appears wrong. Our data suggest that very young children in the early stages of learning the plural know that cats = cat + s, and that these point to different meanings.

Children's better performance in the Standard Berko task than the Inverse Berko task supports this. Those results indicate that generating a novel singular form is cognitively simpler and easier than the plural form, despite the fact that both forms are equally likely to be imitated. The children generated novel, never-heard-before plurals *from* the singular form and they generated novel, never-heard-before singular forms *from* the plural version of that same noun. In so doing, young children show that they know that there are singular and plural forms of nouns. The fact that the singular form is generated more easily from the plural rather than vice versa suggests that the singular, as the category label, is semantically and computationally simpler. One way of explaining this directionality effect in the generalizations is in terms of complexity differences in the meaning and/or complexity differences in the form. One morpheme points to one kind of meaning (the category). Two forms (stem+s) pointing to two kinds of meaning (category+multiple instances). This kind of explanation presupposes compositional forms and compositional meanings and thus argues against the idea of early holistic forms and undecomposed meanings.

The frequency of non-responses as opposed to repetition errors is also consistent with the idea that children distinguish two kinds of forms and two kinds of meanings. After having just labeled a single 'wug' as a *wug* and being presented with two wugs to label, these young children either generated the correct plural form, *wugs*, or said nothing. Only extremely rarely did they produce the just-said singular form for multiple instances or the just-said plural form for singular instances, even though doing so would be, at the very least, partially correct, as the produced form would include the category label for the individual entities. The fact that these children – who are imitating and talking throughout the 6-week experiment – chose to say nothing rather than repeat the wrong form strongly suggests that they are aware that at some level an alternative form is called for. Since many languages do not mark the plural, these young children already seem to know something specific about the language they are learning; they seem to know that English has the property of having two distinct forms for referring to single individuals and multiple instances. Clearly, this conjecture is under-determined by the present data but is important to pursue in future work as this kind of knowledge is itself a generalization.

This is an aspect of the development of the regular plural that has received little attention, although it is a component of both 'rule' and 'similarity-based' accounts. Both accounts assume that children are learning a relation between singular and plural forms: a rule that transforms the singular into the plural in one case versus

associations between individual singular and plural forms (which, then, yield similarity-based generalizations to novel forms). But proponents of these accounts have neither specified nor studied how children know that there should be two different forms which distinguish these meanings, nor how they link up the surface forms to those two abstract meanings of individual versus multiple instances. This would seem a crucial step for a learner in acquiring either a rule for the generalization of the regular plural or in forming the singular-plural associations hypothesized to underlie similarity-based generalizations. The present study's results, as well as recent work by Barner, Thalwitz, Wood & Carey (2005), strongly suggest that the young children participating in this experiment have this knowledge.

What limits generalizations of the regular plural to novel instances?

We turn to a critical open question highlighted by the present pattern of results: why is a truly productive regular plural so late a developmental achievement? What is limiting children's generalizations of the regular plural to new forms? These questions have special urgency, given the present results, as they show: (1) that children learning English do generalize the regular plural to new forms from early in lexical development, and (2) that they seem to know that there are two different forms of each noun – one for the single instances and one for multiple instances. This would seem a sufficient basis for widespread generalization. We offer here three hypotheses to be investigated in future work.

The first hypothesis is that the limitation lies in processes of speech *production*. First, the data (and the focus of most of the research in this area) is specifically on production (for some exceptions, see: Fraser, Bellugi & Brown, 1963; Winitz et al., 1981). Thus, the limitations of the generalization of the plural (from an imitated singular form) or the singular (from an imitated plural form) could lie in processes of motor planning and speech production. Our results would seem to argue against this, as children readily imitate singular and plural forms. However, *generalization* of a transformed form could be the source of difficulty. The relevant empirical question that needs to be answered is this: is the *comprehensio*n of novel forms – the interpretation of a novel plural as indicating multiple things and the singular form as indicating individual things – less limited?

The second hypothesis is that the limitation lies in processes of generalization themselves, the processes that underlie knowledge of the regular plural in connectionist similarity-based accounts of morphological development or the processes that might be expected to play a role in rule induction in rule-based accounts. Generalization to a new instance – saying *wugs* upon seeing two instances which are individually each known as 'a wug' – requires linking the task at hand to the knowledge one already has, a link presumably based on some form of similarity. In the current debate on similarity-based versus rule-based accounts, the emphasis has been primarily on phonological similarity (since this is critical in explaining subclasses of irregular plurals). But other kinds of similarity may be relevant too, such as the contexts in which parents talk about the plural or the conceptual (category or semantic) similarity of the entities at hand to known plurals.

The third hypothesis is that the generation of a word form depends on the activation strength of the target candidates (see Gershkoff-Stowe, 2002) and that this activation depends on multiple sources of information. That is, the principle limitation may not be in the knowledge of singular and plural forms or in the processes (rules or similarity-based) that generate one from the other but in more general processes of lexical access. Contemporary models as described in the adult literature propose competitive processes of lexical access (Dell, 1986; Humphreys, Riddoch & Quinlan, 1988; Seidenberg & McClelland, 1989). Words and/or objects activate candidate word forms and concepts. These candidate forms compete. Relevant factors in this competition include the similarity of competing forms, their frequency (and thus hypothesized activation strength), and the inhibitory processes through which near neighbors (as a function of their own activation strength) inhibit each other. These ideas have been shown to have considerable currency in two developmental research programs – one concerning phonological development (Storkel, 2001) and the other concerning lexical access (Gershkoff-Stowe, 2002). Perhaps the limitations in children's plural productions lie not in the processes that generate the plural from a singular form (or vice versa) but more generally in the processes of lexical access, activation strength, and competition among candidates. This may possibly be studied by manipulating such factors as lexical density in phonological or semantic similarity (Storkel, 2001) or the priming of candidate forms (Gershkoff-Stowe, 2002). Lexical candidates from crowded neighborhoods (by either phonological or semantic similarity) compete making lexical access difficult, such that strong singular forms may compete with represented but weaker plural forms.

CONCLUSION

Despite the theoretical importance of processes of generalization to the development of morphological rules, there is much that we do not know about the basic developmental trend or the relevant processes. The present experiment was a first step in addressing this gap. The question was whether young children generalized the regular plural to novel forms or perhaps only produced already stored forms. The answer is that very young children do generalize the plural to novel forms. The data also strongly suggest that, long before a truly productive regular plural is evident, very young learners of English know that there are singular and plural forms, and they know how they are related. This finding emerged in a study designed, through the use of multiple sessions, to yield optimal performance. Admittedly, the present results generate many new questions. The reported research thus may also contribute by encouraging a new empirical agenda, broader than the perhaps too-constraining dispute between rule-based and similarity-based accounts of morphological development.

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