Cognition, 21 (1985) 73–93

Level-ordering in lexical development*

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Abstract

This paper examines the claim that lexical word formation rules are ordered at three levels of application (Kiparsky, 1982). Lexical rules of affixation and compounding differ with respect to phonological effects, semantic regularity and productivity. With respect to these properties, rules can be assigned to one of three "levels" and are applied sequentially. Level-ordering predicts that irregular plurals may be formed at level 1 prior to compounding at level 2. Thus, forms such as mice-infested *are acceptable. However, regular plurals formed at level 3 may not precede compounding, therefore predicting that* *rats-infested *is not acceptable. A learnability problem arises since the child almost never hears compounds containing irregular plurals. Given that the input appears to underdetermine the relevant constraints, it is suggested that level-ordering is an innate structural property of the lexicon. It is predicted that children should show no evidence of having to learn the constraints of level-ordering with respect to pluralization and compounding. An experiment with 33 three- to five-year-olds elicited singular, plural and compound forms of regular, irregular and pluralia tantum nouns (also at level 1). Results showed that: (1) Children almost never produced regular plurals inside compounds (e.g.,* *rats-eater*); *(2) As soon as children used irregular plurals, they used them inside compounds (e.g.,* mice-eater*); (3) Pluralia tantum nouns were also used inside compounds (e.g., clothes-eater) although for various phonological and semantic reasons there appeared to be a difference for the individual nouns within this class. The results strongly support the notion that level-ordering constrains the child's word-formation rules, independent of the input received. Some possible mechanisms for assigning rules to their appropriate levels are discussed.*

*The research reported here was carried out while the author was a Sloan Post-Doctoral Fellow at Stanford University. Many thanks to Susan Lierle for running subjects. I am also grateful to Melissa Bowerman, Susan Carey, Kathie Carpenter, Eve Clark, Susan Gelman, Steven Pinker and Meg Withgot for helpful comments. A version of this paper was originally presented at the Ninth Annual Boston University Conference on Child Language Development, October 1984. Requests for reprints should be sent to: Peter Gordon, Department of Psychology, University of Pittsburgh, Pittsburgh, PA 15260, U.S.A.

0010-0277/85/$6.80

Introduction

To say that the child learns a set of rules in acquiring a grammar has become almost a truism in psycholinguistics. Such confidence is built on empirical observations of children who, for example, overgeneralize rules involving past tense or plural morphology (e.g., **goed*, **tooths*, etc.). Furthermore, children are able to apply such inflections to quite novel lexical items as in the "wug" test of Berko (1958). Going beyond these observations, one would like to show that the acquisition of such rules obeys certain underlying constraints. This approach is paralleled by current trends in linguistic theory away from listing sets of rules, toward more general, perhaps universal, principles that govern the form of those rules.

In the present paper I wish to consider the phenomenon of "level-ordering" with respect to lexical rules of word formation. The notion of ordered levels appears in the work of Allen (1978) and Siegel (1977) and more recently has been extended by Kiparsky (1982, 1983) and others. Ordering is implicit in the traditional phonological characterizations of boundary types as either primary (+) or secondary (#). Thus, consider *+ian* in *Darwin+ian*, and *#ism* in *Darwin#ism*. Since there is ordering of "+" affixes before "#" affixes, it is predicted that *Darwin+ian#ism* should be acceptable but not **Darwin#ism+ian* since the latter, but not the former, involves applying a secondary before a primary affix.

These and other properties of word formation can be coherently accounted for in lexical theory by positing ordered "levels" of rule application (see Kiparsky, 1982, 1983). For present purposes, I shall assume the three-level version of Kiparsky (1982). Level 1 is said to include primary (+) affixes (e.g., *+ian*, *+ous*, *+ion*) that characteristically deform their hosts phonologically by stress shifting, vowel reduction, alternation and so on, and are often semantically idiosyncratic in being non-compositional (e.g., the meaning of *populat+ion* appears to go beyond a simple semantic composite of *populate* and the nominalizing *+ion* affix). Also included are irregular inflections (e.g., *tooth* → *teeth*, *ox* → *oxen*), pluralia tantum (e.g., *clothes*, *scissors*, *alms*) and possibly others. Level 2 contains secondary (#) affixes of derivational morphology (e.g., *#er*, *#ism*, *#ness*) and is the site of compounding. The third level contains all of the regular inflectional morphology that characteristically shows neither semantic idiosyncrasy nor stem deformation (e.g., *car* → *cars*).

The three levels are schematized in Table 1 (adapted from Kiparsky, 1982). Rule application proceeds through the three levels such that rules at a later level may not be applied prior to those at a previous level. One very interesting prediction from this model, noted by Kiparsky (1982), is that one should not find regular plurals "inside" compounds. That is, once a compound is

Table 1. *Examples and properties of level-ordered rules*

	Examples	Properties
Level 1	+ion, +ous, +ity, +th, in+ mice, oxen, scissors	Derivational, irregular, semantically idiosyncratic, host deforming, stress shift, vowel reduction, unproductive
Level 2	#ness, #ism, #er, #ist, un# Compounding	Derivational, non-deforming, (more) semantically predictable, productive.
Level 3	#s, #ed, #ing	Regular inflections, non-deforming semantically predictable.
SYNTAX		

formed at level 2, its constituents cannot be inflected at level 3 (although the compound itself may be inflected to the right). However, since irregular inflections are at level 1, then they should be allowed inside compounds in certain cases. This prediction is supported by the difference in acceptability of *mice-infested* versus **rats-infested*, since the former includes a level 1 plural and the latter, a level 3 plural. Pluralia tantum (level 1) also find their way inside compounds in some cases (e.g., *clothes-basket*), although reduction is possible in other cases (e.g., *scissor-legs*).

Such results are quite surprising and combine with many others to provide support for the existence of level-ordering of some sort within the lexicon. What is more, many of these constraints appear to be motivated purely in terms of the geometry of the system rather than by semantic considerations—although certainly semantic considerations are important in word formation itself (see Clark & Clark, 1979; Kiparsky, 1983). But, to take our example, there seems to be no semantic reason why *mice-infested* should be acceptable but not **rats-infested*.

Let us assume that level-ordering (or something like it) is the correct way of characterizing lexical structure and thus accounting for our intuitions. Consider how a child could ever learn such an organization. What evidence in the linguistic input would lead inductively to setting up this system? It would seem that of all the hypotheses available, there would be little to persuade an open-minded learner to choose this, rather than some other path. For example, most compounds that the child hears involve singular forms inside compounds. While this richly specifies the constraints with respect to reducing regular plurals inside compounds (e.g., for *rat-infested*), there appears to be

little evidence available to the child regarding the possibility of placing irregular plurals inside compounds. For example, one finds forms such as *tooth-brush*, *mouse-trap* and *man-eater*, but no *teethbrush*, *mice-trap* or *men-eater*.[1] In fact, an examination of certain high frequency items with irregular plurals (*mouse*, *man*, *tooth*, *foot* and *goose*) was carried out using the Kučera and Francis (1967) word count of about one million words. This revealed that while these forms were listed in a total of 28 compound types in non-head (left) position (token frequency: 153), in only two cases was the noun listed in its irregular plural form (token frequency: 3). This compares with a plural-to-singular ratio of 1181:1436 for the irregular nouns not occurring inside compounds.

Thus our intuitions regarding the acceptability of irregular forms inside compounds seem to arise primarily from cases that are quite novel. If it is true that, in general, the input underdetermines the child's induction of the appropriate ordering of rules in the lexicon, then one might suggest that such ordering does not come about through "learning" per se, but rather it is an a priori characteristic of the way the lexicon is structured to organize its word-formation rules. One might expect therefore, to find evidence for the existence of level-ordering in the child's developing lexicon without finding evidence of the relevant learning having taken place. Strong support for this non-learning hypothesis would be if the child showed evidence for level-ordering as soon as particular morphological rules had been acquired.

Given this hypothesis, there are a number of developmental predictions that arise with respect to the appearance of plurals within compounds:

1. If rules of compounding and regular inflection are correctly assigned to levels 2 and 3 respectively, then as soon as the child acquires the regular plural morphology and shows evidence of regularization (e.g., by over-generalization to irregular forms), the regular forms should be reduced to singulars inside compounds. For example, one should find *rat-infested* but not *rats-infested* being produced by the child.
2. As soon as the child stops overregularizing an irregular form (e.g., **mouses*) and uses the appropriate plural (*mice*), then such forms should be (optionally) allowed inside compounds (e.g., *mice-infested*).
3. As soon as the child learns that pluralia tantum are irregular in the sense of having no singular form, then they too should optionally occur inside compounds (e.g., *clothes-dryer*).

[1]The unacceptability of these forms is probably due to pre-emption by the standard singular form (cf. Clark & Clark, 1979, for a discussion of pre-emption in category shifting).

These predictions constitute a very strong test of the nativist hypothesis. For example, they assume that level assignment immediately falls out from the phonological/semantic properties of particular forms or rules. That is, the predicted synchrony between learning irregular forms and their allowability in certain compound constructions assumes that the child essentially needs no other data to "fine tune" the system. This, of course, could turn out to be an oversimplification. For example, the child might require a certain amount of distributional data regarding ordering of rules. Even if these data do not contain direct evidence regarding the facts about compounding and pluralization (as seems to be the case), other more indirect evidence may be required to trigger the correct assignments (e.g., ordering of affixes in complex words, allomorphic variation, amount of productivity). Be that as it may, the present experiment is aimed at the strongest test as outlined in 1–3.

An opposing position would presumably claim that level-ordering is itself learned from evidence in the linguistic input or, indeed, that there is no level-ordering to be learned. In the former case, it is necessary to show that the child's linguistic input is sufficiently rich to specify the existence of level-ordering for a learning mechanism that is not already committed to searching for such ordering. Given the kind of data alluded to in the examination of word counts above, it would seem that arriving at such an account would not be trivial. There is a similar problem in proposing that there is no such thing as level-ordering. The acceptability of irregular plurals inside compounds would have to be accounted for as a rule to be induced from little or no evidence.

On the assumption that the facts about pluralization inside compounds are learned (rather than being a deductive consequence of innate structures), one would not predict the immediate appearance of constraints on pluralization within compounds. To illustrate this, let us compare another area in which children must clearly learn restrictions on pluralization. For example, it has been found that children are prone to make morphological errors involving pluralization after certain distributive quantifiers that require singular nouns. Errors of the form: **every cars* and **each cars* are very frequently made in tests on 3- to 5-year-olds (Gordon, 1981, 1982) despite the fact that they never hear such constructions in their input. Presumably such errors are at least partly a result of the fact that *every* and *each* quantify over plural sets and the plurality of the reference leads the child to produce an erroneous plural. If a similar situation were to be presented for the case of compounding, one might also expect pluralization errors. Thus, if the child were presented with a context in which there were a number of rats being referred to, one might expect him or her to denote an eater of such animals as a **rats-eater* rather than a *rat-eater*. However, if we assume that level-ordering

constrains pluralization in this case, then such errors should never be found.

With respect to irregular plurals, there is also a different prediction on the hypothesis that constraints are learned. If the child has to learn that reduction of regular plurals is required within compounds, there is little reason to assume that this rule would apply only to regular plurals. This is especially true considering the fact that the child's input data tends not to include compounds containing irregular plurals. Thus, a natural induction from such evidence would be that irregular plurals are also subject to reduction inside compounds. There should be no necessary synchrony between the appearance of irregular plurals in the child's lexicon and their allowability inside compounds. In fact, if the child has to learn from the linguistic input that irregular plurals may occur inside compounds, the paucity of such data suggests that a fairly protracted period of time would be required before such forms as *mice-infested* would be generated by the child's grammar. Generally, the same arguments can be assessed for pluralia tantum, although the inability to reduce these forms to singulars in general might, on either account, lead one to expect their appearance inside compounds in the plural form.

Since there do seem to be quite different predictions for an account in which level-ordering is an innate constraint on word-formation and that in which the properties are learned, the following experiment was designed to test the two accounts. In the experiment, noun-agentive compounds (e.g., *rat-eater*) were elicited from children. The context was biased to predispose the child to use plural forms inside the compound. This was done by both having a plural referent for the non-head (left) noun, and also, by having the child produce the plural form (*rats*) prior to the compound form (*rat(s)-eater*). The three noun-types: (1) regular plural, (2) irregular plural, and (3) pluralia tantum, were examined.

Method

Subjects

Subjects included 33 children divided into three groups of 11 by age. Group I: 3;2 to 4;0 (mean age: 3;8); Group II: 4;1 to 4;11 (mean age: 4;6); Group III: 5;0 to 5;10 (mean age: 5;6). All subjects were of middle class, mostly academic families.

Materials

Training items used to elicit compound production in subjects consisted of

referents for non-pluralizable mass nouns. The stimuli included either real or toy examples of the following: rice, corn, paper, bread, wood, plastic, fruit, soup, cereal, money. Main test items were referents of pluralizable count nouns. These included teeth, beads, mice, rats, feet, hands, men, dolls, geese, ducks, clothes, toys (= airplane, ball, car), pants, shirts, (sun)glasses, shoes, scissors and knives. A "Cookie Monster" puppet was used in the testing and a cassette recorder was used to record responses as a back-up to manual scoring.

Procedure

The design for this task involved eliciting a singular, plural and compound form of each of a set of nouns that either had irregular plurals, were pluralia tantum or else were regularly pluralized nouns. There were five irregularly pluralized nouns including *mouse*, *man*, *tooth*, *foot* and *goose*. These nouns, respectively were (semantically) matched with the regular nouns *rat*, *baby*, *bead*, *hand* and *duck*. Semantically matching *tooth* required a noun whose referents exhibited similar configurational properties to a set of teeth (since we were dealing with pluralization). Beads on a necklace were chosen for this reason despite the lack of more obvious perceptual similarities. The stimuli for the pluralia tantum and their regular equivalents included *clothes/toy*, *pants/shirt*, *(sun)glasses/shoe*, *scissors/knife*. Again, the *clothes/toy* pair, while not semantically/perceptually similar, was chosen because it was felt that the superordinate term, *clothes*, should be paired with another superordinate, *toy*.

Subjects were tested individually by a female experimenter who had previously familiarized herself with the playgroup. Initially, the child was introduced to a Cookie Monster puppet and was told

> Do you know who this is? ... It's the Cookie Monster. Do you know what he likes to eat? (Answer: Cookies.) Yes—and do you know what else he likes to eat?—He likes to eat all sorts of things ...

Objects were then brought out and the child was asked if the Cookie Monster would like to eat X (where X was the name of the stimulus). They were then asked "What do you call someone who eats X?" (Answer: An X-eater.) With this procedure, it was possible to elicit compounds of the form *teeth-eater/rat-eater* and so on.[2] Initially, the subjects required some training in producing compounds. This was done using mass nouns such as *rice*, *corn* and *wood*

[2]Eve Clark and Susan Gelman (personal communication) have previously used a similar procedure to elicit compounds from which I borrowed in designing the present study.

(see Materials section). Since these do not have plural forms and children appear to know this by around 2½ years (Gordon, 1982), it was considered the least contaminating choice of noun class for training purposes. In this training condition, the child was asked what one would call someone who eats, say, rice. If there was no reply, or the child said something like "rice monster" (by analogy with "Cookie Monster") the appropriate form (*rice-eater*) would be given and the child would be asked to repeat it. The child was moved onto the main items after having successfully produced three consecutive compounds without assistance. Compounds of the form "X-monster" were produced quite frequently in the training, but rarely survived into the main test. If they were produced in the main test they were accepted as alternatives to X-eater compounds although correction again was given. Only three children produced such forms on the main items, once, twice and four times respectively. Thus, even these children produced "X-eater" on the majority of the 18 items.

For the main items, singular, plural and compound forms were elicited from children. The first two were necessary to ascertain whether the child was overregularizing irregular forms (e.g., *mouses*). Or, even if the correct irregular form (*mice*) was being produced, it was necessary to ascertain that the irregular plural was a true plural. For example, Ervin (1964) has noted that irregular plural forms are often used by children as if they were singulars, thus producing *one mice*, *two mices* and so on. If the child were then to say *mice-eater*, it could not be concluded that an irregular plural was being used inside a compound since presumably, for the child, *mice* would be a singular in its function. To elicit a singular form, the child was shown a single object and asked to name it. For the plural, four of the objects[3] were presented and the child was told "Here we have a bunch of ... what?" The child was required to complete the sentence with a plural form (cf. Berko, 1958). If she or he said "Mouses" or "Mices" in naming the plural referent, the experimenter continued to use that form in other questions involving *mouse*. Next the child was asked "What do you call someone who eats X?" where X was the form of the noun previously used by the child. The compound form produced by the child for this question indicated whether or not that type of plural was allowed inside compounds. The child was then asked if he thought the Cookie Monster was an X-eater and the puppet either consumed or rejected the objects in question.

Some adjustments were made in the procedure for *toy* and *clothes*, where it was very difficult to elicit a singular form of the superordinate term when,

[3]In the case of teeth and beads there were actually about 12 objects—the teeth were in an oral configuration and the beads on a string.

for example, a single ball or shirt was presented. Thus the experimenter attempted to elicit the superordinate by saying "What do you call something you play with?" or else, in the case of clothes, "... something you wear". Even with such measures, elicitation was very difficult for these cases. If the appropriate form was not forthcoming, it was supplied by the experimenter. This was also necessary for some of the basic-level nouns. Once the singular had been supplied, there was generally no problem in eliciting the plural and compound forms. Main items were presented in one of four predetermined random orders that were evenly distributed among the three age groups.

Results

All subjects remained in the test and completed all items without much difficulty. Occasionally subjects would change their responses spontaneously as if to correct themselves. For uniformity, it was decided to interpret such changes as corrections and score the "corrected" (second) version. For purposes of analysis, the data are represented in patterns of triplets [a-b-c] denoting forms produced for (a) the singular referent, (b) the plural referent and (c) the compound, respectively. A pattern such as [singular-plural-irregular+plural] would characterize responses of the form *mouse* (singular referent); *mouses* (plural referent) and *mices-eater* (compound). Thus, "plural" denotes either a regular or overregularized plural. "Irregular+plural" denotes a regularized plural using the irregular form as a base.

Irregular plurals

For the irregular plurals and their regular controls, there are two main predictions from the hypothesis that level-ordering is innate. First, subjects should consistently reduce regular plurals to singular forms inside compounds (e.g., *rat-eater*) thus producing the pattern [singular-plural-singular]. Compounds of the form **rats-eater* should not be found. Second, subjects should produce compounds containing irregular plurals (e.g., *mice-eater*) as soon as they start producing the irregular form (*mice*) in naming the plural referent. This would result in the pattern [singular-irregular-irregular]. Of course, since inclusion of the irregular plural is optional, one should also find [singular-irregular-singular] patterns (i.e., *mouse* → *mice* → *mouse-eater*). The degree to which the child produces an irregular plural inside the compound might well be subject to the amount of bias in the testing context. The fact that the child's previous utterance would contain *mice*, could well lead to many *mice-eater* responses.

If the child is overgeneralizing the regular plural to an irregular noun (e.g.,

mouses*) then this should be a level 3 rule application and should not therefore occur inside the compound. The resulting pattern should therefore be identical to that of regular nouns, [singular-plural-singular]. Similarly, if the child overgeneralizes the plural but uses the irregular plural as a base (mices*), then this rule application should again be at level 3 and not apply inside the compound. The resulting pattern should be [irregular-irregular+plural-irregular].

The response patterns for irregular nouns and their regular controls are given in Table 2 and are broken down by age in Table 3. The column headings of the "Irregular" section represent the three patterns outlined above based on the first two responses: 1. Correct use of the irregular form [singular-irregular-X]; 2. Overregularization of the plural [singular-plural-X]; and 3. Use of the irregular form as a base [irregular-irregular+plural-X], where X is a variable for the form produced inside the compound. The "Regular" section contains only one pattern [singular-plural-X]. The row headings represent the form produced inside the compound (i.e., the value of X, the third member of the triplet). Main cell values represent the mean number of responses in that category with the absolute values in parentheses. There were a total of 43 cases within these data in which the child had to be told the singular form rather than spontaneously coming up with the appropriate name. The majority of cases were for *bead* ($n = 19$) and *rat* ($n = 12$) for which children seemed to have problems producing the right name. While this fails to tap the children's knowledge of the singular form, these subjects did produce the plural and compound forms which were considered usable data. One item from a 5-year-old was discarded due to experimenter error.

With respect to the predictions, the data are quite unambiguous in supporting them. For regularly pluralized nouns, subjects overwhelmingly showed the correct pattern of reduction inside compounds (e.g., *rat-eater*) at all ages with 161/164 such patterns. Subjects were categorized as supporting the predicted pattern if all regular plurals were reduced inside compounds. The resulting chi-square value tested against chance expectation was extremely significant (χ^2 (1, $N = 33$) = 132.5, $p < .001$). When children overregularized an irregular noun (*mouse* → *mouses*) they similarly reduced to the singular form in compounding (*mouse-eater*) on 86/88 items (χ^2 (1, $N = 30$) = 122, $p < .001$). This pattern held for all ages although, quite naturally, 3-year-olds showed a greater tendency for such overregularizations (see Table 2). Also, when children treated the irregular form as a base (e.g., *mice* → *mices*) they reduced to the irregular form (*mice-eater*) 8/9 times (χ^2 (1, $N = 10$) = 7.46, $p < .01$). When subjects produced the correct irregular pattern (*mouse* → *mice*) they immediately showed evidence that these irregulars were allowable inside compounds. 36/40 responses in this category were of the form *mice-*

Table 2. *Mean response patterns for irregular and regular plurals (5 responses per condition. Frequencies in parentheses)*

Regular nouns		Irregular nouns		
Compound form*	Regular plural [sg pl X**]	Irregular plural [sg IR X]	Overgeneralized plural [sg pl X]	Irregular base [IR IR+s X]
sg	4.9 (161)	0.12 (4)	2.6 (86)	0.03 (1)
pl	0.09 (3)	0	0.03 (1)	0
IR	–	1.09 (36)	0.03 (1)	0.24 (8)

*sg = singular form; pl = regular plural; IR = irregular plural; IR+s = irregular plural plus regular plural (e.g., *mices*).
**X = compound form given in row headings.

Table 3. *Mean response patterns for irregular and regular plurals by age (5 responses per condition. Frequencies in parentheses)*

Regular nouns		Irregular nouns		
Compound form*	Regular plural [sg pl X**]	Irregular plural [sg IR X]	Overgeneralized plural [sg pl X]	Irregular base [IR IR+s X]
3 years				
sg	5 (55)	0	3.4 (37)	0
pl	0	0	0.09 (1)	0
IR	–	0.27 (3)	0	0.36 (4)
4 years				
sg	4.9 (54)	0.09 (1)	2.36 (26)	0.09 (1)
pl	0.09 (1)	0	0	0
IR	–	0.9 (10)	0	0.36 (4)
5 years				
sg	4.7 (54)	0.27 (3)	2.1 (23)	0
pl	0.18 (2)	0	0	0
IR	–	2.1 (23)	0.09 (1)	0

*sg = singular form; pl = regular plural; IR = irregular plural; IR+s = irregular plural plus regular plural (e.g., *mices*).
**X = compound form given in row headings.

eater. In this case, chi-square values were calculated for subjects showing greater than 50% inclusion of the irregular plural inside the compound, since such inclusion is optional. Again, results were very significant (χ^2 (1, $N = 20$) $= 15$, $p < .001$).

There were three other response patterns found in the data for irregular plurals. These included [singular-singular-singular] ($n = 10$); [irregular-irregular-irregular] ($n = 12$); [plural-plural-singular] ($n = 2$). The first two show no differentiation for singular versus plural and are therefore uninterpretable, except perhaps by analogy with *sheep* → *sheep* → *sheep-eater*. The third appears to be quite random. It is noteworthy, however, that the one type of response missing from the miscellaneous group is that in which regular plurals appear inside compounds. This suggests that even when responses appear somewhat random, they still obey the relevant constraints on compound formation. It is also noteworthy that the only subjects who did produce regular plurals inside compounds were two of the older 5-year-olds. One interpretation of this fact is that these subjects may have had superior metalinguistic skills and realized that pluralization was the relevant variable. This could possibly have interfered with their normal responding.

Pluralia tantum

For the pluralia tantum, it was predicted that these should be optionally allowed inside compounds in their plural form while their regular counterparts should be reduced (as in the previous case). As it turned out, the results differed among the items. Basically there were two patterns found among the pluralia tantum, one in which reduction to a singular form occurred (*scissor-eater*, *glass-eater*), and the other in which reduction was not prevalent (*clothes-eater*, *pants-eater*). Table 4 shows the responses for this condition. The column headings represent the two predominant response patterns for the pluralia tantum—[plural-plural-plural] and [plural-plural-singular]. As in the previous analysis, for the regular control condition, the basic [singular-plural-singular] pattern predominated for 128/131 responses (χ^2 (1, $N = 33$) $= 70.2$, $p < .001$).

The dichotomy in these data can be seen between, on the one hand, *clothes* and *pants*, which occurred 58/63 times as plurals inside compounds (χ^2 (2, $N = 33$) $= 56.3$, $p < .001$), and on the other hand, *glasses* and *scissors*, which occurred only 10/54 times as plurals inside compounds (χ^2 (2, $N = 32$) $= 22.5$, $p < .001$). While this latter pattern was consistent across ages for *scissors* the reduction for *glasses* to *glass-eater* appeared to decline with age (though not significantly). That is, as children got older, they tended to be more likely to say *glasses-eater* rather than *glass-eater*. The reason for the dichotomy in

Table 4. *Mean response patterns for pluralia tantum inside compounds (4 responses per condition. Frequencies in parentheses.)*

Pluralia tantum	Clothes		Pants		Glasses		Scissors	
Age (years)	pl	sg*	pl	sg	pl	sg	pl	sg
3	0.9 (10)	0	0.72 (8)	0.18 (2)	0.09 (1)	0.9 (10)	0	0.72 (8)
4	0.9 (10)	0.09 (1)	0.82 (9)	0.09 (1)	0.27 (3)	0.54 (6)	0	0.63 (7)
5	1 (11)	0	0.9 (10)	0.09 (1)	0.45 (5)	0.45 (5)	0.09 (1)	0.72 (8)
Total	0.94 (31)	0.09 (1)	0.82 (27)	0.12 (4)	0.27 (9)	0.64 (21)	0.09 (1)	0.69 (23)

Regular controls

	Pattern	
Age (years)	[sg pl sg]	[sg pl pl]
3	4 (44)	0
4	3.9 (43)	0
5	3.7 (41)	0.27 (3)
Total	3.9 (128)	0.09 (3)

*sg = singular form; pl = regular plural.

results and the age trends will be discussed in the next section. However, it should be remembered that the prediction is that pluralia tantum should be optionally allowable inside compounds, not that they are obligatorily required inside compounds. Thus, an overall analysis shows that there was a significantly greater tendency to produce pluralia tantum inside compounds than regular plurals ($t(1) = 14.87$, $p < .001$).

There was a total of 53 cases in which the child was told the name for the singular referent. Most of these prompted cases were for the superordinate *clothes* in the pluralia tantum group (19/22) and for *toy* in the regular control group (26/29). This was because children usually named at the basic level (e.g., *dress* or *ball*) for a singular referent. Additional response patterns included nine cases in which *scissor* was used in naming the singular referent, and two cases in which *pant* was similarly used. The resulting pattern in all cases was [singular-plural-singular]—comparable to the regular items. Three responses were of the form, *glasses-eater*, and there was one reversal, *eater-clothes* (see Clark & Hecht, 1982, for similar examples). Two responses were

discarded, one where the child failed to produce a compound and one due to experimenter error.

Discussion

The results for this experiment have been surprisingly clear-cut in the case of regular and irregular nouns. Also, for the most part, they are supportive of predictions in the case of pluralia tantum. They showed overwhelmingly that in forming compounds, regularly pluralized nouns are consistently reduced to singular forms. There was no evidence of any overpluralization errors that one finds in other domains where one does not expect rule application to be constrained by innate principles (e.g., quantifier agreement with *each* and *every*). In other words, where the child is required to *learn* the appropriate restrictions from input, errors occur; but where the restrictions follow deductively from the structural constraints, then one finds no errors.

For irregular plurals, as soon as children showed evidence of knowing the irregular forms, they produced them inside compounds. In fact the irregular plural appeared to be preferential inside the compound in the context of the present task, presumably due to the biases set up in the design. That is, children would probably not be so biased to produce a form such as *mice-eater* in an ordinary everyday context. This would be especially unlikely if, like adults, the reduced singular form is preferred. But the point is that such biasing was only effective in the allowable cases (i.e., irregulars and pluralia tantum). Also, there was no age at which children appeared to have assumed the hypothesis that irregular plurals behave just like regulars inside compounds. Such an hypothesis would be entirely reasonable given the kind of evidence available to the child in the form of such words as *toothbrush*, *mouse-trap* and so on. That this hypothesis never appears to be entertained supports the notion put forward here that it is not a "learning" process that we are examining, but rather, a process of filling out existing structures and deriving the consequences in an axiomatic fashion. It does not appear that the child is taking the linguistic input as primary data and inducing that rules are ordered on the basis of those data.

For the pluralia tantum, the results were in accord with our predictions to a large extent, although the dichotomy in the results was somewhat unexpected. Why children should reduce *scissors* and *glasses* to morphologically singular forms, but not *clothes* or *pants* has several possible explanations. In the case of *glasses*, one would predict that adults would not reduce to form *glass-eater*, since this would denote either drinking glasses or glass-material rather than sunglasses. However, since it may take some time for the child

to learn that there is semantic pre-emption for this form, one might very well expect such erroneous responses early on. Note that responses of the form *glass-eater*, did decline with age, suggesting some learning of the appropriate semantic restrictions in this case.[4] The preponderance of reductions in the case of *glasses* and *scissors* may also be due to clustering of sibilants (/s/ and /z/) within the word and in the plural perhaps causing the child to reduce the plural. This could be due to some general phonological principles acting to reduce clustering of similar features. An additional factor is syllabicity. Both *scissors* and *glasses* are bisyllabic whereas all of the other non-regular nouns tested were monosyllabic. Again, some general principles may be involved in simplifying multisyllabic compounded forms. Finally, one does find uses of *scissor* with some adults, and *glass* (in its other sense) is also a word, whereas *pant* and *clothe* are never used as nouns. The fact that a large number of children used *scissor* to refer to the singular object, further suggests a lexical entry for this word in its singular form. Whatever the explanation for these results, their dichotomous nature is not central to present concerns. The fact that at least some pluralia tantum were placed inside compounds suggests, along with the data on irregulars and regulars, that children are applying ordering of rules from very early on.

The force of the present data suggests that the young child's lexicon is richly structured in terms of the way in which rules are applied. The apparent lack of appropriate input to the child, and failure to find evidence of learning taking place, suggests that such structuring might be an innate property of the lexicon. What the child does presumably learn are particular words and morphological rules. From there, it is suggested that the constraints on word-formation follow deductively from the nature of the system. Of course, only a tiny part of the word-formation process has been examined here. In fact, the phenomenon of pluralization within compounds is really quite peripheral with respect to the theory of level-ordering and lexical theory in general. But, in a sense, its peripherality is what makes it interesting. It is a side-effect that seems totally unmotivated by considerations other than conformity to the structural constraints of the system. It is precisely the kind of phenomenon where one expects to find that properties of input are quite superfluous to acquisition.

One possibility that was mentioned only briefly is that the theory of level-ordering may itself be wrong, and therefore could not be an innate property of the lexicon. For example, Selkirk (1982) has argued for an alternative analysis whereby X-bar theory is extended into word structure and does not

[4]A reviewer has suggested that when one eats glasses one ipso facto eats glass and that this may also be a factor in children's errors.

employ level-ordering per se (although some ordering effects are accounted for by positing differential affixation to "roots" vs. "words"). In her model, there is no constraint against affixation of regular plurals inside compounds. Examples such as *Parks Commissioner*, *drinks cabinet*, *Human Services Administration*, *weapons analysis* and so on appear to bear this out and also provide an embarrassment for level-ordering. However, as Selkirk herself points out, these examples tend to have idiosyncratic meanings for the plural forms. For example, the *drinks* in *drinks cabinet* does not denote any old drinks, but alcoholic drinks in particular. In a sense then, they are similar to the case of pluralia tantum in that one might consider the plural form in that particular usage to be a semantically idiosyncratic separate lexical form. Within the theory of level-ordering, such facts would be accounted for, since semantic idiosyncrasy is symptomatic of level 1 processes (see Table 1). This would allow for their presence inside compounds which are formed at level 2. Kiparsky (1982) has also suggested that there may be some recursion back into the lexicon. For example, *Human Services* may be formed at a first pass and then fed back into the lexicon to be compounded with *Administration*.

It is often hard to employ psychological data in adjudicating between linguistic theories. Even if such evaluations are warranted, it is not clear that psychological data should have any more prominence than purely linguistic data. However, it would seem that any psychologically plausible lexical theory would have to account, not only for the fact that we have different intuitions about *mice-infested* and **rats-infested*, but also for the fact that the same constraints appear to be present in very young children, with little or no evidence that any learning has taken place. Furthermore, the relevant constraints appear to operate productively for compounds that the child is very unlikely to have heard before (e.g., *feet-eater*). Thus, the least one would require is that the constraints should follow deductively from the theory. At present, level-ordering fits the bill and is adopted for these reasons.

Parenthetically, the existence of the exceptions noted above, actually serves to strengthen the argument against a learning account of ordering. If children do hear at least some regular plurals inside compounds (e.g., *drinks cabinet*) then this would appear to make learning the restrictions for **rats-eater* even harder. Furthermore, even if children hear some irregular plurals inside compounds, they are probably just as likely to hear regular plurals inside compounds. This would appear to make the present results quite inexplicable in terms of induction over the child's input.

If the present account is correct, then what remains is to specify a set of learning procedures that determine how the child decides at which level particular rules should be assigned. I have outlined certain properties that are

symptomatic of the different levels, and presumably the child would use these in determining level-assignment (e.g., semantic compositionality, regularity, stem deformation, etc.). While such characteristics do guide one in determining level-assignment, they are often neither hard nor fast. Level 1 affixes sometimes produce semantically compositional forms or may not deform their stems. Level 2 affixes may produce non-compositional meanings and so on. Thus, properties for each of the levels tend to 'cluster' rather than be absolute guides to level-assignment.

The process of rule formation in language acquisition presumably involves forming generalizations over semantically and/or phonologically related forms. In general, properties of level 1 rules serve to differentiate the derived form from its base to a greater extent than levels 2 or 3. By this, I mean that it is harder for the child to form a generalization between, for example, *derive* and *deriv+ation* [level 1] than, say, *open* and *open#er* [level 2] or *book* and *book#s* [level 3]. In other words, for both phonological and semantic reasons, level 1 derivations may not possess the kind of relatedness that the child requires to form productive rules. Consequently, the rules themselves turn out to be less productive (viz. being applicable to only a restrictive set of lexical items—those that the child has encountered in the input).

Linda Walsh (1984) has similarly proposed that level 1 derivations[5] are related to their bases only by redundancy rules that state the relationship between two forms rather than being productive morphological rules. If this were the case, then ordering would follow from the fact that the "derived" form of a level 1 process would be available as a separate lexical entry and could be compounded or affixed by rules applying at later levels. For example, if *mice* is simply a separate lexical item from *mouse*, related only by a redundancy rule, then it should be available for compounding. Thus, the issue of relatedness provides at least a partial account of how the child ends up with a distinguished set of level 1 rules.

The remaining question concerns how levels 2 and 3 are distinguished. Clearly this will turn on the child distinguishing between inflectional (level 3) and derivational (level 2) morphology. Anderson (1982), from the point of view of linguistic theory, suggests that the appropriate consideration here is relevance to syntax. That is, only inflectional processes can partake in such things as agreement over sentential constituents. Since the output of the lexicon is fed into the syntax (see Table 1), it is natural that elements that are required for syntactic processes should be affixed last—although, in some

[5]While not using the terminology of level-ordering in her paper, the distinctions Walsh (1984) makes turn out to be equivalent to the levels.

cases such as the irregular plural, phonological characteristics may pre-empt such assignment. Anderson (1982) actually proposes that inflection is a syntactic rather than a lexical process, although Jensen and Stong-Jensen (1984) provide some evidence to the contrary. Whatever the case, relevance to syntax could possibly be the appropriate property used by the child in distinguishing level 3 morphology, if indeed inflection is a lexical process. Otherwise the ordering of lexical rules before syntactic rules would again guarantee the appropriate ordering.

This does beg the question of how the child learns which morphological processes are relevant to syntax, but that is a question that must be addressed on any account either by co-occurrence phenomena or by semantically correlated properties (e.g., implicit plurality of quantifiers correlates with plural affixation). There might be a problem if it turns out that intrasentential agreement phenomena are acquired after there is evidence for level-ordering of inflectional versus derivational processes. If such were the case, it is possible that the child may use other additional strategies. For example, inflectional rules typically do not change category assignment whereas derivational processes often do. An alternative strategy might include a functional determination of level-assignment. It could be the case that the child has an innate set of hypotheses concerning possible inflectional functions, including number, gender, tense, mood, aspect, case and so on (cf. Pinker, 1982, 1984; Slobin, 1982). If this were the case, then the set of level 3 rules would be defined a priori. However, there is evidence that in some languages, functions such as pluralization are derivational rather than inflectional (Anderson, 1982).

The above is clearly just a sketch of various alternatives for what the process of level assignment may look like in acquisition. Considerable research will be required before any kind of evaluation of the proposals can be made. Furthermore, while I have adopted Kiparsky's three-level version of the lexical theory, there is by no means any clear consensus on just how many levels are required. For example, Halle and Mohanan (1985) propose that five levels are needed, although not all of these may be employed in every language. Thus if a certain amount of parametric variation exists, one major test of any acquisition theory will be its equipotentiality in acquiring word-formation rules across various languages.

In this regard, Melissa Bowerman (personal communication) has pointed out that Dutch differs significantly from English with respect to pluralization inside compounds. Whereas there are certain idiosyncratic cases of regular plurals occurring inside compounds in English (e.g., *Parks Commissioner*—see above discussion), Dutch appears to allow such cases quite freely in constructions that would be ungrammatical in English. For example, Bowerman has provided such examples as *tand-en#borstel* (= 'tooth-

[plural]#brush'); *muiz-en#vanger* (= 'mouse-[plural]#catcher'); *paard-en#dief* (= *'horses#*thief'). In all cases, the plural (*-en*) is the most common regular form. Furthermore, it appears that such constructions are quite productive in Dutch.

This would appear to provide a considerable embarrassment to the present proposal for the innateness of level-ordering. It would seem that if a Dutch learner invoked the same strategy as the English learner, then the former would be at a considerable disadvantage. In particular, one might predict that the Dutch learner would start out like the English-speaking child and fail to use regular (*-en*) plurals inside compounds. There would then have to be a reorganization within the lexicon when forms such as *paardendief* were heard. In fact, they would have to be listed as some kind of exception to the principles of level-ordering. However, if such forms were to trigger a reorganization of the lexicon for the Dutch learner, why shouldn't cases like *Parks Commissioner* cause a similar reorganization for the English learner?

I, like Bowerman, have little faith that such a reorganization would be found if tested on Dutch children. More persuasively, it does not make sense, linguistically, for Dutch to be exceptional in such a manner. A partial solution lies in the nature of the Dutch plural itself. Unlike English where there is basically one form of the plural (*-s*), Dutch has two basic forms: *-en*, as in the above examples, and *-s* as in *vleugel-s* (= 'wing-s'). There is also a rarer form, *-eren* as in *been(d)-eren* (= 'bone-s') plus other even less productive forms. While *-en* is the most common form of the plural, it appears that *-s* is not exactly rare. If *-en* is not sufficiently dominating in frequency, it could not in any sense be a "default" value for realization of the plural (as appears to be the case for *-s* in English). Hence, the form of the plural would have to be listed with each lexical item rather than being applied productively in the strong sense (i.e., as an independently stated rule).

A second property of the Dutch plural is that it appears to have access to the internal phonology of the stem. That is, in certain cases, *-en* will change the vowel quality in the stem. This involves laxing of a tense vowel in such pairs as *dag–dagen* (= 'day' – 'days') where the change, though not reflected orthographically, involves /ɐ/ becoming /a/ after adding the plural. Occasionally, the vowel is changed altogether as in *schip–schepen* (= 'ship'–'ships'); *stad–steden* (= 'town'–'towns') (see Smit & Meijer, 1958, for other examples). Such vowel changes are quite characteristic of derivational rules as found in typical level 1 rules in English.

These two properties, lexical idiosyncrasy with respect to productivity, and phonological stem deformation, suggest that the organization of Dutch morphology and phonology is different from English in the case of pluralization. While there are insufficient data at present to propose the exact ordering of

rules in Dutch, it would be quite surprising if "regular" (*-en*) plurals were not ordered before compounding which, presumably is productive, regular and non-deforming. In fact, Dutch plurals may be quite comparable to the English irregular plurals in their level assignment. If true, then this would provide a natural explanation for how two quite similar languages could differ in such an odd way. Furthermore, let us suppose that phonological properties are given a greater weighting in the acquisition procedure than, say, relevance to syntax (which must in any case be abandoned for irregular plurals in English). This is not an ad hoc move, since it is the phonological properties that motivate much of the theory of level-ordering in the first place. In this case, the learner of Dutch should straightforwardly assign pluralization to a prior level than compounding. There is no need to posit reorganization and exceptional marking. Again, the ordering phenomena, or apparent lack thereof, should follow deductively from the theory.

There are clearly many gaps in the present account that will require patching with further empirical evidence and linguistic analyses. If the phenomenon of level-ordering does turn out to be correct in some form, then the results of the present study suggest that ordering, per se, may not be something for which we require a learning model. Level assignment, on the other hand, may be another matter.

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Résumé

Dans cet article on étudie l'hypothèse que les règles lexicales de formation des mots sont ordonnées selon trois niveaux d'application (Kiparsky, 1982). Les règles lexicales d'affixation et de composition diffèrent en fonction des effets phonologiques, de la régularité sémantique et de la productivité. Ces propriétés déterminent l'assignation des règles à l'un des trois niveaux et leur application séquentielle. L'ordonnancement par niveau prédit que les pluriels irréguliers peuvent être formés au niveau 1 avant la formation de mot composé au niveau 2. Ainsi, les formes telles que *mice-infested* sont acceptables. Cependant les pluriels réguliers formés au niveau 3 ne peuvent préceder la formation de mots composés *rats-infested* n'est pas acceptable. Il se pose donc un problème de possibilité d'apprentissage pour l'enfant qui n'entend presque jamais des noms composés avec des pluriels irréguliers. Etant donné que l'entrée est sous-jacente à la détermination des contraintes pertinentes, on suggère que l'ordonnancement par niveau est une propriété structurale innée du lexique. On prédit que l'enfant n'aura pas à apprendre ces contraintes pour le pluriel et la formation de mots composés. Une expérience a été faite avec 33 enfants de 3 à 5 ans pour obtenir le pluriel, le singulier et la composition de formes avec des mots réguliers, irréguliers et pluralia tantum (ceux-ci également au niveau 1). Les résultats indiquent que (1) les enfants ne produisent presque jamais des pluriels réguliers dans les mots-composés (ex **rats-eaters*); (2) que dès qu'ils utilisent des pluriels irréguliers ils les utilisent dans des mots-composés (ex *mice-eaters*); (3) les mots n'existant qu'au pluriel (pluralia tantum) sont également utilisés dans des mots composés (ex clothes-eater) quoique pour des raisons phonologiques et sémantiques variées il existe des différences entre les mots dans cette classe. Les résultats appuient fortement la notion que l'ordonnancement des niveaux contraint les règles de formation de mots chez l'enfant indépendament des exemples reçus. On discute des mécanismes utilisés pour assigner les règles aux niveaux appropriés.