RULES AND SCHEMAS IN THE DEVELOPMENT AND USE OF THE ENGLISH PAST TENSE

JOAN L. BYBEE
State University of New York, Buffalo

DAN I. SLOBIN
University of California, Berkeley

Consistent error patterns in English past-tense forms are reported for three age groups: preschoolers, 8–10-year-olds, and adults. It is argued that, although irregular forms are rote-learned, speakers make generalizations about such forms. Such a generalization is defined as a SCHEMA which describes general phonological properties of a morphological class, and is used in organizing and accessing the lexicon. Schemas for the English past tense develop and change with age, yielding implications for both acquisitional and diachronic theory.*

1. English verbal morphology is rather restricted, compared to that of a full-fledged inflectional language, since it offers only four inflectional morphemes: the 3rd singular present, the past tense, the past participle, and the progressive. Thus it provides no opportunity to study the complex interaction between intersecting inflectional categories within a paradigm, such as person, number, mood, and tense. It does, however, provide the opportunity for a study of a different sort: although English has a demonstrably productive process of suffixation for past-tense formation, in the form of *-ed*, it also has many irregular verbs whose past tense is formed in some cases without suffixation, and in others with changes of vowel (or, less commonly, consonant) in the stem.

These irregular verbs are relatively few in number. Bloch 1947 identifies about 200 (several of which are archaic), but thousands of verbs form their past tense by adding an allomorph of *-ed*. Although irregular verbs are relatively insignificant as to type frequency, the picture is quite different when token frequency is considered: these are among the most frequent verbs of the language. Of the 30 most frequent past-tense forms (Kučera & Francis 1967), 22 are irregular. The situation changes radically in the second 30 most frequent past-tense forms, where 8 are irregular. From the child learner's point of view, irregular verbs are also prominent: Slobin 1971 finds that, in 49 hours of adult speech to Roger Brown's subject Eve, between the ages of 18 and 26 months, irregular past-tense forms account for 292 of the past-tense tokens, while regular verbs comprise only 99. Thus irregular past-tense forms constitute an important core of English verbal morphology.

* A number of people contributed to the research reported here, and we would like to thank them for their help. Susan Ervin-Tripp, Roger Brown, and Zell Greenberg made their spontaneous speech data available to us; Zell Greenberg tested the preschool children and analysed the results; Amy Strage and Ann Eisenberg tested the adults; Mr. B. Harris and his third-grade class at Cornell Elementary School, Albany, CA, played the 'verb game' with us; Tanya Renner, Carol Lynn Moder, and BongHee Choi helped with the statistics; and Brody Hooper let us use his verb forms and his friends.

While this research was being conducted, Joan Bybee held a Postdoctoral Research Training Fellowship from the Social Science Research Council. This research was also supported by the University of California Committee on Research and the Institute of Human Learning, University of California, Berkeley.

The difficulty presented by these irregular verbs, both for the learner and for the linguist, is that so many different irregularities occur. Though most irregulars are characterized by a vowel change, a number of different changes occur, e.g. *stick/stuck, sing/sang, keep/kept, grow/grew*. In addition, some verbs add a *t* or *d*; and some have consonant changes as well, e.g. *make/made*. Jespersen 1942 lists ten classes of irregular past-tense formations, and dozens of sub-classes, while Bloch comes up with twenty conjugation types.

Such variety increases the difficulty of the learning task, but at the same time provides us with an opportunity to investigate the interaction of rule and rote-learning in morphology. It is clear that some rote-learning is necessary in acquiring irregular past-tense forms: the pair *go/went* could not be learned in any other way. What is not so clear is whether speakers must learn all irregulars by rote, or whether they can organize some of the verbs into classes as Jespersen and Bloch do—and even use some minor rules to generate irregular past-tense forms from a base form, as generative phonologists have suggested (cf. Hoard & Sloat 1973).

The two hypotheses—one, that irregular past-tense forms are learned by rote and stored in the lexicon, and the other, that such forms do not need to be stored in the lexicon but are generated by rule from base forms—have been investigated in the psycholinguistic literature. Thus Kuczaj 1977, examining spontaneous speech data from pre-school-age children, takes the position that irregular past-tense forms are learned one by one, by memorization. He shows that chronological age is a better predictor of success on irregular past forms than mean length of utterance (MLU), while the reverse is true for the regular past-tense rule. He argues that chronological age will correlate naturally with amount of exposure to irregular forms—which suggests rote-learning, which depends on exposure to particular forms. By contrast, MLU reflects the child's ability to formulate rules, and is therefore not an expected predictor of advancement in rote-learning. Kuczaj notes further that his data contain no instances of incorrect vowel changes—which would be predicted if the child were formulating vowel-change rules, rather than learning rote forms.

MacKay 1976, however, has examined response times for adults forming the past tense from a base-form stimulus, along with the errors that adults make; on this basis he argues that irregular past-tense forms are not stored in the lexicon, but are derived from a base.

The two positions have counterparts in recent debates on phonological theory. In the tradition started by Chomsky & Halle 1968, it is considered desirable to handle as much irregularity as possible by rules, in order to 'capture generalizations'. Thus Hoard & Sloat formulate a small number of extremely abstract rules that can generate a large percentage of the vowel alterations in irregular verbs. However, a more recent trend in theoretical phonology claims that speakers do not formulate such abstract rules (Vennemann 1971). Evidence from historical change suggests rather that speakers function with surface true generalizations, and must learn irregularities by rote.[1]

[1] The True Generalization Condition (Hooper 1976) applies to fully-specified strings containing morphological, lexical, and syntactic information; and it can be a condition on morphophonemic rules, even if they have exceptions, so long as the exceptions are marked in the string.

The data examined in the present study come from three different age groups; preschool children, eight-and-a-half- to ten-year-old children, and adults. These data suggest to us that neither of the extreme positions is correct. Rather, we find evidence for an alternate view: that irregular past-tense forms are rote-learned and stored in the lexicon, but this does not prevent speakers from formulating generalizations about these forms. These generalizations are not in the form of rules that derive one thing from another by changing features. Thus we will not call them rules, but will rather refer to them as SCHEMAS. A SCHEMA is a statement that describes the phonological properties of a morphological class (in this case, past tense). It does not relate a base form to a derived one, as a rule does, but describes only one class of forms (the product class, in terms used by Zager 1980). It is not a constraint which rigidly specifies what can and cannot occur, but is rather a much looser type of correlation, used in organizing and accessing the lexicon. A schema for which we have found evidence may be stated either as 1a or 1b:

(1) a. A past-tense form may have the vowel [uw].
b. ...uw]
$\begin{matrix}\text{verb}\\ \text{past}\end{matrix}$

Examples are the past forms *drew, blew, flew*. Note that the base forms of these verbs (*draw, blow, fly*) do not all have the same vowel, so the class cannot be defined in terms of the input, nor can a rule be stated that changes a single base vowel into the vowel [uw]. Rather, what these verbs share is the single vowel in their past forms. The existence of this schema does not, of course, exclude other shapes for past-tense forms. In the following sections, we outline our methods of data collection and discuss our interpretation of the results.

We mentioned above that we have collected data from three different age groups. While we are interested in the acquisition process, it is also necessary to be aware of what the outcome of this process will be, i.e. the adult system. Some aspects of the adult system reveal themselves through the errors which adults make when they are forced to perform when tired or under pressure. A comparison of such errors with those made by children reveals both similarities and differences. In particular, both children and adults use schemas, though the particular schemas they formulate are somewhat different.

DATA COLLECTION

2. The data from the preschoolers are spontaneous speech records from four independent sets, collected by Susan Ervin-Tripp and Wick Miller, by Dan Slobin, and by Zell Greenberg. 31 children, between the ages of one-and-a-half and five, were interviewed; they used a total of 69 irregular verbs.

These spontaneous data are supplemented by an elicitation task designed by Slobin and administered to 20 children, 3–4 years old, by Greenberg 1975. This was a sentence-completion task involving 33 real English verbs. The experimenter presented the child with a picture of a person engaged in a particular activity, and said: *This is a girl who knows how to ____. She is ____ing. She*

did the same thing yesterday. What did she do yesterday? Yesterday she ____. The last blank is the one to be filled in orally by the child.[2]

The data on third-graders come from children between the ages of 8;6 and 10;1—eight girls and seven boys—all of whom were students at Cornell School, Albany, CA. The children were given a sentence-completion task utilizing 90 irregular verbs. The verb was read first in its base form, and then a sentence was read using the verb in its base or present-tense form. Each child was then asked to complete a sentence using the same verb. This sentence began with a word that placed the action in the past, e.g. *yesterday*. The test sessions were tape-recorded, and the past-tense forms supplied by the child were transcribed later. The test contained only irregular verbs, but a regular verb was used at the beginning as an example of what the child should do. A typical item would be *Blow: When I get a balloon, I always blow it up. Yesterday I ...*

The task given to adults was designed to produce as many regularizations of irregular verbs as possible. A list was compiled of 90 irregular verbs, mixed in with three times that many regular verbs; thus two, three, or four regular verbs separated the irregular verbs. The subjects were asked to listen to the experimenter read the base form of the verb, and then to produce the past-tense form of that verb as quickly as possible. The subjects were told that the object of the experiment was to see how fast they could go through the list; and the experimenters were instructed to put as much time pressure on the subjects as possible, since the purpose was to induce errors.

The list of 360 verbs was divided in half, and each half was administered to 20 subjects in two orders of presentation. All 40 subjects were adult native speakers of American English, students at the University of California, Berkeley. The subjects' responses were tape-recorded and transcribed later.

The irregular verbs used in all three sets of data can be divided into eight classes as follows:

I. Verbs that do not change at all to form the past tense, e.g. *beat, cut, hit.*

II. Verbs that change a final *d* to *t* to form the past tense, e.g. *send/sent, build/built.*

III. Verbs that undergo an internal vowel change, and also add a final *t* or *d*, e.g. *feel/felt, lose/lost, say/said, tell/told.*

IV. Verbs that undergo vowel change, delete a final consonant, and add a final *t*, e.g. *bring/brought, catch/caught.*[3]

V. Verbs that undergo an internal vowel change and whose stems end in a dental, e.g. *bite/bit, find/found, ride/rode.*

The rest of the irregular verbs are ones that undergo an internal vowel change, and which neither end in *t/d* nor add *t/d*. Several different vowel changes occur

[2] The entire body of tests and the full list of verbs studied may be obtained by writing to either of the co-authors.

[3] *Buy/bought* is included in this class, even though no final consonant is deleted, because its past tense rhymes with the three other members of the class: *thought, caught, brought.* Other evidence suggests that these verb classes are defined in the past form, not the base form.

among these verbs. As Class VI, we have extracted two related groups that seem to be the most productive of the vowel-change verbs, while Classes VII and VIII are distinguished according to whether the verb base ends in a consonant or a vowel:

VI. Verbs that undergo a vowel change of /ɪ/ to /æ/ or to /ʌ/, e.g. *sing/sang, sting/stung.*

VII. All other verbs that undergo an internal vowel change, e.g. *give/gave, break/broke.*

VIII. All verbs that undergo a vowel change and that end in a diphthongal sequence, e.g. *blow/blew, fly/flew.*

The two primary criteria used in making these class divisions were (a) the presence or absence of a final *t/d*; and (b) the presence or absence of an internal vowel change. Slobin 1971 finds that, in spontaneous data from children 1;6 to 4;0 years, strikingly fewer regularizations occurred with verbs that add a *t/d* in addition to making a vowel change (our Classes III–IV) than in verbs that undergo only a vowel change (Classes VI–VIII). Kuczaj 1977 finds only partial confirmation of this distinction in his data. We were interested in discovering if this distinction would emerge in our preschool, third-grade, and adult data.

It is also clear from Slobin's data that children are not as likely to regularize verbs whose past-tense forms are identical to the base forms (Class I). Similarly, Kuczaj 1978 finds that 4-year-olds are more likely to accept Class I verbs as past tenses than other irregular past forms, and more likely to reject regularized verbs of this class (e.g. *hitted*) than regularized verbs of other classes (e.g. *falled*). It is not an accident that all the verbs of Class I have *t/d* as their final consonant. (Examples with *d* are *spread* and *shed.*) As has been pointed out by Stemberger 1981 and by Menn & MacWhinney 1981, it is common among the inflectional languages of the world to avoid adding an affix to a word or stem that already appears to contain that affix. Of course, many English verbs end in *t/d* and DO add the /ɨd/ suffix, e.g. *seated, blasted, shredded;* but the class of verbs that do not has long been significant and partially productive (Jespersen, 34–8). Our hypothesis is that this class exists because speakers apply a schema statable as 2a or 2b:

(2) a. A past-tense verbs ends in *t* or *d.*

b. $\ldots t/d]_{\substack{\text{verb} \\ \text{past}}}$

Verbs such as *cut, set,* and *spread,* then, fit the schema to their base forms, and require no change. If the strategy of forming schemas is available to young children, then we might expect fewer regularizations among Class I verbs than among the other classes. Further evidence that encourages this expectation is reported by Anisfeld & Gordon 1968, who find that fifth-grade children (with a mean age of 10;4) accept nonce forms as past-tense forms more readily if the final consonant shares some features with *t/d*—e.g. the affricate /č/, which contains an alveolar stop. We were interested to determine the extent to which evidence for schemas could be found among the three different age groups.

Class V verbs have base forms ending in *t/d*, like verbs of Class I; but they also undergo a vowel change. A possible hypothesis about these verbs is that they might also resist regularization, because of their final consonant.

With regard to Class VI, we expected fewer regularizations because of the partial productivity of this class—as evidenced, e.g., by dialectal *brang* or *brung*, and by responses obtained by Berko (1958:165) when adult subjects formed the past tense of *bing* as *bang* or *bung* (50%) and the past tense of *gling* as *glang* or *glung* (75%).

Classes VII and VIII were separated to test the hypothesis that one of the important components of the process of acquiring irregular past-tense forms is the matching of base and past forms (Kuczaj 1977). It was hypothesized that this task would be easier for verbs with both initial and final consonants (or clusters) than for verbs lacking final consonants—since, in the CVC-type, the base and past form will share more phonological features than in the CV-type.

Results

3.1. Frequency. Since frequency of exposure is an important determinant of rote-learning, we expect a significant correlation of frequency with correct use of irregular forms, or an inverse correlation of frequency and percentage of regularizations, in children from both the pre-school-age group and the third-grade group. We might even expect such a correlation in the adult errors—since, even though the adults have presumably mastered the irregular forms, some might be 'stronger' than others, if (as MacWhinney 1978 suggests) lexical items gain strength with use, and if this process continues into adulthood.

These predictions are borne out to some degree in all three age groups. For the preschool spontaneous speech data, it was possible to use past-tense form frequencies within the sample to test the hypothesis. A significant negative rank-order correlation ($-.67$) was found between the number of times that adult caretakers used a verb in the speech sample and the number of times that the verb was regularized by the children. That is, the more often a verb was used by caretakers, the less likely it was to be regularized.

For the regularizations made by the third-grade and adult subjects, rank-order correlations with frequency were calculated by verb class. The frequencies used were those of the past-tense form as given by Kučera & Francis. For the *hit* class of no-change verbs, the frequency of the unchanging base was used.[4] Significant negative correlations of frequency with percentage of regularizations were found for both sets of subjects in Class I, the *hit* class, and Class III, the *feel* class (I: third-graders $-.603$, $n = 12$; adults $-.708$, $n = 16$; III: third-graders $-.663$, $n = 12$; adults $-.668$, $n = 12$). Correlations that approach significance were found for both adults and third-graders in Class

[4] Unfortunately, some of these verbs (such as *hit* and *cut*) are also used as nouns, and Kučera & Francis do not distinguish words by syntactic category. Thus our frequency correlations must be considered only a rough approximation. This problem is not nearly as common in the other verb classes where the frequency of the past form can be used, since past forms are less commonly homonymous with nouns.

VII, the *break* class (third-graders −.546, n = 9; adults −.611, n = 11), and for the third-graders in Class VIII, the *blow* class (−.657, n = 6).

Correlations were not attempted for Classes II (*send*) and IV (*catch*) because they are too small. No significant correlation was found in Class V (*bite*). We suspect this is because this class contains such a variety of vowel-change types. No significant correlations were found in Class VI (*sing*), even though only two vowel alternations are involved, because these verbs are all quite low in frequency, and do not present a proper range upon which to test a correlation.

We conclude from these facts that frequency of usage is an important variable in the learning of irregular past-tense forms, as evidenced in the preschoolers' and the third-graders' usage; and that it is important to the maintenance of irregular forms, especially under pressure, as evidenced by the adult errors. However, frequency of usage alone cannot predict the error patterns of our data.

3.2. CLASS I: NO-CHANGE VERBS. When we consider the individual verb classes and compare them across age groups, we find, as expected, that the percentage of regularizations goes down between the preschool and third-grade groups for most verb classes (see Table 1). The most striking exception to this is found in Class I, where the percentage of regularizations across all three groups of subjects is very much the same, between 27% and 29%, even though the over-all percentage of regularizations changes considerably between the preschoolers and the other age groups. Thus, among preschoolers, the percentage of regularizations in Class I is slightly below their over-all average; but for the other two groups, this percentage is considerably above average. In relation to their general performance, then, the third-graders and adults do worse on Class I verbs than preschoolers do.

VERB CLASSES	I (*hit*)	II (*send*)	III (*feel*)	IV (*catch*)	V (*bite*)	VI (*sing*)	VII (*break*)	VIII (*blow*)
Preschoolers	29	57	13	10	34	55	32	80
Third-graders	27	55	20	7	9	8	9	2
Adults	27	20	10	31	6	20	11	8

TABLE 1. Preschool percentages are based on combined data from 31 children; third-grade and adult percentages are averages of individual percentages of regularization. Since our analyses are concerned with inter-column comparisons for each age group separately, the differences in computing percentages should not alter the over-all patterns discussed.

As mentioned above, it is no accident that all the no-change verbs of English end in *t/d*—which may make them appear, at least to the new learner, as though they already contain a marker of past tense. Our hypothesis is that the preschoolers, rather than functioning with a suffixation rule that requires that *t/d* be ADDED to the verb, are functioning with a schema like 2a or 2b, which says that if a verb ends in *t/d*, then it is an acceptable past tense. They are not concerned with the ADDITION of a marker, but rather with how the general shape of the word fits the pattern. Of course, they also show evidence of a suffixation process, but it is not strong enough to apply consistently to words that fit the schema. However, for third-graders and adults, the suffixation

process (the requirement that something be ADDED to form the past tense) seems much stronger.

The elicited past-tense forms of preschoolers show even stronger evidence for this schema. There were 33 verbs in this test. Six were regular: *walk, smoke, melt, pat, smile,* and *climb*. Eight had a vowel change: *drink, break, run, swim, throw, meet, shoot,* and *ride*. Eight had a vowel change and a final *t/d* added: *do, buy, lose, sell, sleep, help, teach,* and *catch*. Seven had no change: *hit, hurt, set, shut, cut, put,* and *beat*. In addition, the list included *go, make, build,* and *lend*. The most significant response patterns for this test were obtained by grouping the verbs into those ending in *t/d* (regular or irregular) vs. those that did not, and computing the number of responses that produced no change in the verb. The results are summarized in Table 2. It can be seen that the children have a regular suffixation rule, but systematically fail to apply it to verbs already ending in *t/d*, even if they are regular (*melt, pat*).

	REGULAR SUFFIX	NO CHANGE
Verb does not end in *t/d*	203	34
Verb ends in *t/d*	42	157

TABLE 2. $\chi^2 = 180.1$; significant at .001 level.

Berko encounters the same phenomenon both in plural formation and past-tense formation in her nonce probe task. She finds that preschool and first-grade children show a highly significant tendency not to add the plural suffix to nonce nouns ending in sibilants, i.e. those nouns that would take the /ɨz/ allomorph, such as *tass,* and not to add the past allomorph /ɨd/ to verbs ending in *t/d*. She interprets this as the late acquisition of the /ɨz/ and /ɨd/ allomorphs. We propose that these results are not related to the acquisition of a particular allomorph, but are caused by the phonological shape of the nonce form—which, in verbs, conforms to the past-tense schema, and in nouns conforms to a similar schema for the plural.

Berko also finds a difference between children and adults in the past tense supplied for nonce verbs ending in *t/d*: the adults consistently add the /ɨd/ suffix to these forms, but the children (as we have just mentioned) add the suffix much less often—only 31% and 33% of the times respectively. Thus the difference we found between preschoolers and adults is the same found by Berko: the preschoolers seemed to apply a schema, and were satisfied that verbs ending in *t/d* were sufficiently marked for past; but the adults applied a suffixation rule.

Since the third-graders treated the no-change verbs much as the adults did, the transition from a schematic analysis to a suffixation process must take place before age 8;6. Berko's subjects ranged between ages four and seven, so the change must take place around age seven. Data from nonce probe tasks conducted by Derwing & Baker 1974 on children aged three through nine give approximate confirmation; see Table 3. Here it can be seen that the addition of a suffix to bases ending in *t/d* begins around age six, and is established for some clusters by age eight for nonce words.

	AGE							TOTAL %
ITEM	3	4	5	6	7	8	9	CORRECT
nt	(Ø)	(id)	id	id	id	id	id	63
t	Ø	Ø	Ø	id	id	id	id	59
l/rt	Ø	(Ø)	Ø	Ø	id	id	id	53
d	Ø	Ø	Ø	id	Ø/id	id	id	46
nd	Ø	Ø	Ø	id	Ø/id	id	id	41
st	Ø	Ø	Ø	Ø	Ø/id	id	id	39
pt	Ø	Ø	Ø	Ø	Ø	Ø	Ø	18
kt	Ø	Ø	Ø	Ø	Ø	Ø	Ø	17
l/rd	Ø	Ø	Ø	Ø	Ø	Ø	Ø	13
ft	Ø	Ø	Ø	Ø	Ø	Ø	Ø	12
mpt	Ø	Ø	Ø	Ø	Ø	Ø	(Ø)	9
kst	–	–/Ø	Ø	Ø	Ø	Ø	Ø	4

TABLE 3.

Kuczaj 1978 also finds a dramatic change in the treatment of no-change verbs. He elicits grammaticality judgments from children by asking them to say which sentences produced by puppets were 'silly'. In the relevant portion of the experiment, the puppets produce pairs of sentences containing verbs such as *hit* and *hitted*. Table 4 shows the percentage of time that a form is treated as acceptable by the child. Note first that grammatical no-change verbs (*hit*) are never judged as unacceptable, whereas grammatical vowel-change verbs (*ate*) are so judged at times by groups 1 and 2. Note further that regularized no-change verbs (e.g. *hitted*) are treated as acceptable in many fewer instances than the regularized vowel-change verbs, especially in groups 1 and 3. These two points support the hypothesis of a schema that says that verbs ending in *t/d* amount to acceptable past-tense forms. Note, however, the increase in the acceptability of regularized forms in the middle age-group; this is the point at which the suffixation process gains strength and partially replaces the schema. The percentage of regularizations judged acceptable in this verb group drops dramatically as the children sort out those verbs which do not take a suffix from those verbs which do. The suffixation process gains strength at a slightly earlier age in these data than in the data we have discussed from Berko and from Derwing & Baker; but this could result from the nature of the task, since Kuczaj asks for acceptability judgments of forms of real words, while the others are nonce probe tasks.

AGE GROUP	GRAMMATICAL NO-CHANGE (e.g. *hit*)	REGULARIZED NO-CHANGE (e.g. *hitted*)	GRAMMATICAL VOWEL-CHANGE (e.g. *ate*)	UNGRAMMATICAL VOWEL-CHANGE (base + *ed*, *eated*)
1. 3;4–4;11	100	28.3	84.7	89.3
2. 5;1–6;7	100	55.0	94.7	60.0
3. 7;2–9;0	100	5.0	100.0	26.7
Over-all	100	29.4	93.1	58.7

TABLE 4.

Further evidence for a change in strategy is evident in Class V verbs (*bite* etc.), which end in *t/d*, but undergo a vowel change. The preschool children

treat them much like the *hit* class, but the third-graders and adults show a difference between these verbs and the no-change verbs. The older two groups, under the influence of the suffixation rule, feel that they must somehow modify the base form to produce a past form. Verbs like *bite* can be modified by vowel change, but verbs like *hit* cannot. Therefore, verbs like *hit* are supplied with a suffix more often than verbs like *bite*.

Even though the suffixation process gains prominence around age seven or eight, the schema remains available—but with a much restricted domain of applicability. Indeed, the schema must remain until adulthood, since the substantial class of no-change verbs remains to be handled. The problem is to attach the proper lexical restrictions to the schema, so that it applies only to the proper set of verbs. Positive evidence for the existence of this schema in the third-graders and adults comes from a study of the instances in which they erroneously gave a past-tense form as the unchanged base form of the verb. Recall that the list of verbs given to the third-graders contained only irregular verbs. Of these, 14 belonged to Class I, where a response with no change in the base form would be correct.[5] Of the remaining 76, final *t/d* occur in 23 (30%). The third-graders made 37 errors in which an unchanged base form was given for a past tense, when some change would have been appropriate. Of these no-change errors, 23 (62%) occurred with verbs ending in *t/d*. These children were more than twice as likely to produce a no-change past tense with a verb ending in *t/d* than with a verb ending in another segment.

The adults erred in not producing a change where one was required on both regular and irregular verbs. Table 5 shows that verbs ending in *t/d* made up 27% of the entire corpus of regular verbs. Among errors made by producing no change in the base, 77.5% were on verbs ending in *t/d*. These subjects were almost three times more likely to produce a no-change error with a verb ending in *t/d* than with a verb ending in something else—which strongly suggests the presence of a *t/d* schema among the adults. Note, however, that the no-change errors made on irregular (vowel-change) verbs were not affected by the final consonant, since the proportion of errors on verbs ending in *t/d* was approximately the same as the proportion of verbs ending in *t/d* in the entire corpus. We cannot explain this difference between regular and irregular verbs.

	Regular		Irregular	
	t/d	Other	*t/d*	Other
Total number of verbs	27%	73%	29%	71%
Total number of no-change errors	77.5%	22.5%	27%	73%

Table 5.

The evidence suggests that two very different kinds of strategies are used in the analysis of the English past tense: a strict segmentation strategy, which considers verbs to be discretely segmentable into base and suffix, and forms the past by suffixing *t/d*; and a strategy that does not require strict segmentation,

[5] *Spit* was included in this class, since none of the children gave *spat* as the past tense, and *spit* is one of the accepted past forms according to the *American Heritage Dictionary* (*AHD*).

but requires only that a word in its general shape fit certain criteria. The former strategy results in a suffixation rule, and the latter in a schema. Both strategies are natural, in that they are both evidenced in the child's original attempts to grapple with English morphology. What must be learned is the place of the two in the English system. The child originally over-uses the schema strategy, and must learn to restrict it.

3.3. CLASS II consists of a small set of verbs that form the past tense by changing final *d* to *t*. The preschool data contain the three examples *bend, build,* and *send;* in addition, the third-grade and adult lists contain *lend.* This small class is anomalous in the sense that it employs neither of the basic methods of past-tense formation—neither addition of *t/d* nor internal vowel change. The regularization percentages in Table 1 show all three age groups responding to the anomalous nature of this class. The preschoolers' regularizations in this class were their second highest; and for the third-graders, this class had the highest percentage of regularizations. The adults' regularizations for this class were also above average.

An examination of the history of this verb class shows that the results reported here are in line with the continuing development of the class, which once had many more members. Table 6 is taken from Jespersen, and is grouped according to past-tense forms listed in the *AHD.*

t:	*ed* OR *t*:	*ed*:
bend	*blend*	*wend*
lend	*geld*	*t* OR *ed*:
send	*gird*	*rend*
spend		NOT LISTED:
build		*shend* 'to shame'

TABLE 6.

It will be noted that the five verbs which still have a final *t* (plus *blend,* which has regularized) are all very common, while the remainder are very rare. Indeed, *shend* does not even appear in the *AHD.* This particular verb class is shrinking rapidly—not so much because the verbs are being regularized, but rather because they are falling into disuse. It is even possible that the anomalous past-tense formation may be partly responsible for the attrition in this class of verbs. Among the adults we tested, four gave *loaned* as the past form of *lend,* suggesting an avoidance of these anomalous past tenses by lexical substitution.

Related, perhaps, to this attrition of Class II verbs is the imminent loss of another phonologically similar class of irregulars, viz. verbs ending in *n* or *l* that formerly took a *t* suffix for the past. These are shown in Table 7 (overleaf).

For all these forms except *dwelt,* the regular suffix *d* is given first as the AMERICAN form. The tendency to regularize these verbs in American English is observed by Jespersen. With these verbs regularized, the only verbs ending in *n* or *l* that have a *t* past tense are the few remaining in Class II. This means that a good deal of support for Class II type past-tense formation has been lost in American English.

	AHD:
burn/burnt	*-ed* or *-t*
learn/learnt	*-ed* or *-t*
pen/pent	*-ed* or *-t*
earn/earnt	*-ed*
dwell/dwelt	*-t* or *-ed*
smell/smelt	*-ed* or *-t*
spell/spelt	*-ed* or *-t*
spill/spilt	*-ed* or *-t*
spoil/spoilt	*-ed* or *-t*

TABLE 7.

3.4. VOWEL-CHANGE VERBS. The remaining verb classes, Classes III–VIII, all require an internal vowel change to form the past tense. The percentage of regularization for these classes in the preschoolers' corpus covers a large range, from 10% to 80%. The third-graders' corpus, however, shows no differences among these verb classes: they all have a very low percentage of regularization, from 4% to 9%. (The 20% for Class III is caused entirely by the three verbs *weep, kneel,* and *deal*, which have relatively low frequency.) This means that difficulties in handling vowel-change past tense for children aged two to five are basically overcome by age 8;6. The adults' regularizations are below average in Classes III, V, VII, and VIII; they are higher only in Classes IV and VI. We will return to a discussion of the adult errors after a discussion of what the preschool data reveal about the acquisition of vowel-change past-tense forms in English.

In order for children to learn an irregular past-tense form, they must be exposed to the word (e.g. *heard, broke*) and must learn the following facts about it (Kuczaj 1977):

(a) The form expresses past tense.

(b) The past-tense form must be matched with the appropriate base verb.

(c) The irregular form is used to the exclusion of a regularized form.

Consider now verb Classes III–VIII, listed in Table 8, in descending order according to percentage of regularization by preschoolers.

		EXAMPLES
VIII	80%	*blew*
VI	55%	*sang*
V	34%	*bit*
VII	32%	*broke*
III	13%	*felt*
IV	10%	*caught*

TABLE 8.

Note that the two classes with the lowest percentage of regularizations are just those in which a *t/d* is added along with the vowel change. This confirms an earlier finding of Slobin 1971, on a somewhat smaller sample of children's speech, that verbs whose past forms end in *t/d* are regularized less than verbs

of other classes. It is not immediately obvious, however, why the addition of *t/d* should aid the child in acquiring the vowel change—unless we consider the steps in the acquisition process, as outlined above. The final *t/d* added to the verb (*felt, heard, left* etc.) can serve as an important clue to the child that the form expresses past tense. By this time, the child has learned the regular rule that adds a *t/d* suffix to a verb, so complete reliance on context is not necessary in order to discover that these forms are past tense. However, with past forms such as *broke, bit, sang,* and *blew,* the child must rely entirely upon the context. We suggest, then, that the head start provided by the final *t/d* in Classes III–IV accounts for the earlier mastery of the past-tense vowel—since the sooner children succeed in analysing the form as past, the sooner they can approach the problem of matching the past form with a base form.

This task must depend upon both semantic content and phonological shape. That is, the child must ascertain that *break* and *broke* mean the same thing, except that *broke* is past while *break* is not; and also that *broke* is actually the past form of *break,* and must be used rather than *breaked.* This process is apparently aided by shared phonological features of the base and past forms. The phonological clue which the child can use in matching base with past is the consonantal structure of the verb. (This is not unlike the task which faces the Hebrew-speaking child, who must identify consonantal roots for all verbs; see Berman 1981.) Some verbs offer more consonantal structure than others, and would therefore be easier to master. Among the verbs considered in this study, we have found a striking difference between Classes V, VI, and VII, which have both initial and final consonants or clusters (e.g. *break, sing, bite*) and Class VIII, which has only initial consonants or clusters, but no final consonants (*blow, know, see* etc.) In the former groups, regularization ranges between 32% and 55%; in the latter, regularization is an overwhelming 80%. The problem is especially clear with verbs like *know* and *see,* where the only shared phonological material between base and past is a single initial consonant *n-* or *s-*.

While the matching problem is completely overcome by the time children reach the third-grade level, our data contain hints of various sorts that phonological distance remains a factor in storage and accessing. Some of these hints are anecdotal. Two of the third-grade subjects reacted to the pair *go/went,* which has the greatest phonological distance of any English base–past pair. One boy (age 8;6) gave the form *goed* initially and then corrected immediately, saying: 'No. Well, you have to use the word *went,* then, because you can't say *goed.*' Note the implication that *went* is a separate word. Another boy (age 9;2) paused for one minute and forty-five seconds without responding to *go.* Finally the experimenter suggested *went*; the subject then acquiesced, somewhat reluctantly, saying *went* was not enough like *go.* One other instance in which a third-grader had difficulty supplying the past form of a common verb was the case of a girl (age 9;7) who could not think of the past form of *make.* She kept saying *maked* and then rejecting it; but she wouldn't accept

made either, when it was suggested by the experimenter. These instances suggest that a greater phonological distance makes the accessing task more difficult.

Phonological distance can also be offered as an explanation for the high rate of regularizations by adults in Class IV. This class contains the verbs *catch, bring, think,* and *buy,* which all have high frequency and should present no problems for adults. But these verbs have past forms that differ from the base in both vowel and consonant. The high percentage of regularizations in this class is caused primarily by *catch* and *think;* and *make* also has a high number of regularizations. This could well be because the phonological distance makes the past forms more difficult to access under pressure. This suggestion is consistent with the findings of Stanners et al. 1979.

To summarize, shared phonological material is important in the preschoolers' task of matching base with past forms. This can be seen clearly in the high regularizations of Class VIII as compared to V–VII. Class IV is apparently mastered earlier by preschoolers, despite the phonological distance between base and past, because the final *t* facilitates the identification of the past form as such, and thus speeds up the matching of past form to base verb. (No conclusion about Class IV should be drawn for the third-graders, because in the week when about half of them were tested, they had all the past-tense forms from Class IV on their spelling list.) The factor of phonological distance remains important for the continuing connection between base and past forms, as evidenced anecdotally for third-graders, and in the high regularizations in Class IV among adults.

Finally, we must consider the relatively high percentage of regularizations made by adults in Class VI. These verbs were isolated from other vowel-change verbs because the change of this class shows some productivity. Indeed, common among the incorrect vowel changes made by adults were forms such as *streak/struck* and *clink/clank* (or *clunk*). Because of this productivity, we expected that there would be fewer regularizations for these verbs, and more correct responses. This turns out not to be true. In fact, just the reverse is true: there were significantly more regularizations in this class than in the other vowel-change classes (with the exception of Class IV), and we do not know exactly why. It is worth noting, however, that the verbs in this group tend to be of relatively low frequency: ten of the twelve are less frequent than other irregular verbs. To find out if frequency is the relevant factor, we averaged the percentage of regularizations for those verbs having a frequency of 23 or less. The average of regularization was 23.3%. Then we averaged the percentage of regularizations for all the other verbs with a frequency of 23 or less, excluding Class I verbs. This average was 17.85%, which suggests that verbs of Class VI are not behaving much differently than other low-frequency verbs.

Novel vowel changes

4.1. Class VI. The novel vowel changes made by the adult and third-grade subjects provide us with information on the storage and accessing of irregular

past-tense forms.[6] Approximately half of these innovations occurred among Class VI verbs. All these innovations were very systematic, and they will be discussed first.

Class VI contains two types of verbs: those with three forms, listed as Class VIa, and those with only two, Class VIb. (For complete lists, see Appendix.) In the first sub-class, the verbs all contain a nasal consonant following the vowel. This is a velar nasal (either /ŋk/ or /ŋ/) in all the verbs except *swim, begin,* and *run*. The verbs of the second sub-class may also contain a velar nasal (*sting/stung*), or a velar without nasality (*dig/dug, stick/stuck*), or a nasal that is not velar (*win/won*). The psychological reality of these phonological constraints is clear from the verbs that are incorrectly put into these classes by our subjects.

Consider first Table 9, which lists the four verbs that were incorrectly given

	NUMBER OF ERRORS	
	ADULTS	3RD-GRADERS
string/strang	2	1
sting/stang	2	1
slink/slank	1	
clink/clank	1	
clanked	3	

TABLE 9.

an /æ/ past form; only *clink* is not from Class VIb. Note that all these verbs have a velar nasal following the vowel. In no examples did /æ/ appear in a verb of Class VIb that did not have a nasal; e.g., we got no forms like *dig/*dag*, or *stick/*stack*. The /æ/ is clearly connected to the velar nasal; in fact, we would suggest that it is the whole complex /æŋ/ that creates the past tense. We suggest a schema of the following form:

(3) $\ldots$æŋ(k)]$_{\substack{\text{verb}\\ \text{past}}}$

Note that the schema defines a prototype of the category (in the sense of Rosch & Mervis 1975), in that *sing* or *drink* are the best exemplars—but *swim* and *begin* may also belong to the category, because they end in nasals, although not velar nasals. All the novel uses of /æ/ involved verbs that would be central to the category, those ending in /ŋ/.

A much larger set of innovations involve past-tense forms with the vowel /ʌ/. Two types of verbs show this innovation: those with this vowel in their

[6] It is possible that some of the novel vowel changes were caused by perseveration from earlier items. We are unable to check for this effect, since it is not clear how recent an item would have to be to cause perseveration. However, we will be glad to supply the lists of verbs in their orders to any interested readers who would like to check. We suspect that such intrusions would be minor.

Note also that the task was designed to elicit regularization errors. A different kind of task might show more productivity of vowel-change patterns.

past participles (the *ring/rang/rung* subgroup) and those of other types. They are listed in Table 10.

		NUMBER OF ERRORS	
		ADULTS	3RD-GRADERS
(a)	*shrink/shrunk*	5	9
	ring/rung	5	6
	swim/swum	5	1
	begin/begun	2	2
	drink/drunk	2	6
	sink/sunk	7	*
(b)	*bring/brung*	1	2
	think/thunk	0	1
	clink/clunk	1	*
	streak/struck	4	*
	eat/ut	0	1
	shake/shuck	0	2

TABLE 10.

* Not given on third-graders' test.

First, it must be observed that many of these responses are not exactly 'errors': some are dialectal variants, and the whole set reflects on-going change in the system. *Shrunk* is, for some speakers, the acceptable past form for *shrink;* it clearly seems to be so for the third-graders. However, the adult subjects were all speakers of standard American English, and would not ordinarily use *rung, swum,* or *brung* as past-tense forms. For them, these forms are innovative. But the third-graders were not being pushed to make errors, but were using these forms in sentences—which should reflect, to some degree, their normal usage. (Some of these same children have been observed using these same forms in their spontaneous speech.)

It is interesting, then, that the adult innovations should show such systematic correspondence with the children's usage. These forms constitute the bulk of novel vowel changes made by the third-graders—only six did not involve Class VI.[7] Errors in Class VI constituted almost half, 41 out of 85, of all incorrect vowel changes made by adults. This correspondence between adult errors and child usage is evidence of very similar grammars, even though normal usage might be quite different (a possibility countenanced by the model proposed in Andersen 1973).

In explaining the errors listed in Table 10 above, we must first discount the possibility that these forms resulted merely from the subjects' responding with the past participle rather than the past-tense form. It is true that the forms given in (a) are the past participles of these verbs, and this contributes somewhat to the likelihood that they will be used; but this is by no means an adequate explanation in itself. First, the similar errors in (b) are not past-participle forms.

[7] Outside of Class VI, the third-grade subjects made only six incorrect vowel changes. These are too few to analyse, but we list them here for completeness: *ride/red* (1) *ride/rid* (1) *set/sat* (2) *fight/fit* (1) *weave/waved* (1).

Second, the third-graders made no other errors that consisted of supplying a past-participle form rather than a past tense. So, for the third-graders, these forms must be explained in terms of this verb class. Finally, though the adults did make other errors of giving a past participle for a past tense, 26 such errors occurred with the six verbs listed in (a), while the other 19 were distributed over 14 different verbs. So 58% of such uses occurred with these six Class VI verbs—a fact that needs explaining.

The forms in (a) do not consist of simply supplying a past participle rather than a past tense, but rather result from the subjects' treating these verbs, which have three principal parts, as though they belonged to the other subclass of Class VI with only two principal parts. In other words, the errors made by both adults and third-graders give evidence for a breakdown in the distinction between the two subgroups of Class VI. To understand this, we must analyse the members of Class VIb to determine the schema that fits them.

It is difficult to state a single past-tense schema for this class of verbs, because some of its members share no phonological features other than the past-tense vowel /ʌ/; e.g., *dug* and *won* share no other attributes. However, this can be considered a coherent class if it is analysed in terms of family resemblances (cf. Rosch & Mervis). The most common and the best examples of this class end in the velar nasal. All other members share some features with this prototypical example—either the feature of ending in a nasal, or of ending in a velar, or both, as in Table 11. The forms in (b) of Table 10 attest to a limited productivity for this class—and further to its family resemblance organization, since the innovations involve verbs ending in /ŋ/, /ŋk/, /k/, and even /t/.

NASAL			VELAR	
/n/	/ŋ/	/ŋk/	/k/	/g/
spin	*cling*	*slink*	*strike*	*dig*

TABLE 11.

A statement of the schema for this class must involve a disjunction, i.e., the verb must end in either a velar or a nasal:

$$(4)\ \ldots \left\{ \begin{matrix} \text{nasal} \\ \text{velar} \end{matrix} \right\} \Big]_{\substack{\text{verb} \\ \text{past}}}$$

The difficulty encountered by our subjects, and by English speakers in general, is that of distinguishing Class VIa from Class VIb, since the prototypes of both classes are verbs ending in a velar nasal.

There are two reasons why this difficulty in distinguishing classes results in more innovations in the direction of past tense in /ʌ/ than in past tense in /æ/. The first is that a past tense in /ʌ/ produces an existing word (the past-participle form); and as we shall see below, a large majority of novel vowel changes actually consist of supplying the wrong existing word. Second, the class with /ʌ/ in the past form is larger and more general than the other class,

and continues the general trend in English not to distinguish the past and past-participle forms.

In fact, the results we have obtained here for Class VI reflect a change that has been in progress for several centuries, by which the /æ/ past form of a Class VIa verb is lost, producing a Class VIb verb. The source of many Class VIb verbs is precisely this: a loss of the distinction between a past-tense form and a past participle (Jespersen, 49–53). The question which we cannot answer at this point is why the participle form, the form in /ʌ/, is the one which survives when the distinction is lost.

To conclude this section, three points emerge concerning the organization of Class VI verbs: (a) the responses show a continuation of the historical trend to collapse the past and participle forms into a single form with the vowel /ʌ/; (b) the phonological shapes of the verbs in this class form a series of family resemblances, rather than sharing a discrete set of phonological features; and (c) the class defined by the schema is one of past-tense forms, not one of base forms. The important property of the past form is that it contains the vowels /æ/ or /ʌ/, and certain consonants; it does not matter what vowel the base form contains. This is clear for the forms *strike/struck* and *sneak/snuck* (both of which are relatively new to the class)—as well as the novel form in our data, *streak/struck,* which occurred four times. Furthermore, if only the past forms are considered, then *run* and *hang* will also belong in Class VI.

4.2. NOVEL VOWEL CHANGES: OTHER VERBS. Considering now only the responses from the adult subjects, 44 of them showed novel vowel changes. Of these, 35 (80%) of the responses were real past-tense forms of some other verb. Of these 35, we find that 29 (83%) were past-tense forms of verbs semantically related to the base forms given as input. To meet the criterion of semantic relatedness, the stimulus and response verbs must either be synonymous (e.g. *search/sought*) or be members of transitive/intransitive pairs (*set/sat*). There were four responses with a verb that was not in the past tense; three of these ended in *d,* thus fitting the past-tense schema. One noun was supplied, and four non-words. (We counted /gluw/, which the experimenter spelled *glew,* as a non-word, because we are confident that the subjects did not intend the noun *glue.*) In all, 40 out of 44 (91%) of these novel change responses were real English verbs.

These results are clear evidence that the production of vowel-change past-tense forms is a matter of lexical selection rather than rule application. If speakers apply phonological rules to base forms, changing the vowels to generate past forms, and if the innovations which they create under pressure result from the misapplication of these rules, then we would expect novel vowel changes to produce mainly non-words of English, such as *hept* and *snoze.* However, if these irregular past forms are stored in the lexicon, then the production task involves lexical selection, and we would expect errors made under pressure to be caused by the selection of the wrong pre-existing word. Since it is precisely the latter type of error which we find in the overwhelming majority of cases, we conclude that irregular past forms are stored in the

lexicon.[8] The few cases that cannot be accounted for by lexical selection will be discussed below.

An analysis of the responses listed in Table 12 gives some information about the nature of the process of lexical access. The errors indicate that syntactic category (verb), morphological category (past tense), phonological shape, and semantic field all play important roles in lexical selection. The errors of novel vowel change which are real words are all verbs (except for a single adjective, *proud*). Thus the constraint on syntactic category is very strong. As mentioned above, 35 out of 44 of the errors were words of the correct morphological category, i.e. past tense. All but one of the errors conform in phonological shape to the initial consonant or consonant clusters of the stimulus word, and only four words do not have matching final consonants: *search/sought*, *sight/saw*, *crawl/crept*, and *glide/glow*.[9] The semantic matches are not quite so strong: of all the real-word responses, 75% were semantically related.

(a) Real past tenses (35)	Numbers of errors
Semantically related	
seat/sat	9
set/sat	5
lend/loaned	4
raise/rose	4
search/sought	4
cite (sight)/saw	1
/sought	1
crawl/crept	1
Not semantically related	
flow/flew	2
lean/lent	2
ride/rid	1
shun/shone	1

(b) Real verb (not past tense)	Numbers of errors
Semantically related	
sled/slide	1
Not semantically related	
glide/glow	1
weed/wed	1
wheel/weld	1
(c) Adjective	
pride/proud	1
(d) Not real words	
glow/glew	2
heap/hept	1
snooze/snoze	1

TABLE 12.

The responses show that speakers can access the lexicon from any one of these four parameters—or, perhaps more accurately, from all four at once. This suggests a complex set of inter-relations among lexical forms. The errors consist mainly of selecting items that match phonologically and syntactically, but may be semantically aberrant. The strength of the phonological constraints over the semantic may result from the nature of the task; but it at least shows

[8] MacKay notes the same phenomenon in his errors of past-tense formation. In fact, all MacKay's results are consistent with our position (that irregular past-tense forms are stored in the lexicon), even though he argues for rules. When he measured response time for subjects supplying past-tense forms, he found that the fastest responses occurred in verbs with 'simple' vowel changes, followed by the regular verbs, then by verbs with 'complex' vowel changes, and finally by verbs with vowel change and a *t* suffix. The problem with interpreting these results as favoring lexical selection or rule derivation is that no one knows whether a lexical search takes a longer or shorter time than derivation by rule.

[9] In only one case was an error semantically related, but without phonological resemblance to the stimulus word: *let/allow*.

clearly that speakers of English have a strong and productive strategy that allows past tenses to be formed by holding the consonantal structure of a verb constant, while changing the vowel.

Several past-tense schemas also play a role in lexical selection. The speaker brings to the task of lexical selection a set of notions about what a past-tense verb should sound like. These notions are expressed in schemas which describe certain prototypical phonological structures corresponding to past tense. A word is more likely to be selected if it conforms to one of these schemas. It seems also (though it is clearly less usual) that new words may be created on the basis of the schemas.

The schemas for which positive evidence exists in the responses are those for the past-tense vowels /ɛ/, /uw/, and /ow/. These are the only ones in which a case could be made for rule application, since they are the only vowels that occur in the non-semantically related, non-past-tense, and non-word errors. The innovations are restated in Table 13, grouped according to past-tense vowel.

(a)	*lean/lent*	2	(b)	*flow/flew*	2
	wheel/weld	1		*glow/glew*	2
	weed/wed	1	(c)	*snooze/snoze*	1
	heap/hept	1		*glide/glow*	1
				shun/shone	1

TABLE 13.

The class of real past forms corresponding to the errors in (b) of Table 13 are listed in Table 14, and must also be described by a schema. The defining properties of this class are that these verbs have a past-tense form ending in /uw/ with no consonant. The vowels in these base forms differ. It will be recalled that this class of verbs has the highest rate of regularization among preschoolers, and the rate is fairly consistent across verbs. But among third-graders and adults, this class has a consistently low rate of regularization. These facts, along with the errors listed in (b) of Table 13, suggest this schema:

(5) $\ldots uw]_{\substack{\text{verb} \\ \text{past}}}$

The schemas are used in two ways—both exemplified by the errors in our corpus. In lexical selection, words are favored that fit one of the past-tense schemas. Thus we have four occurrences each of *rose* and *loaned* among the

	PERCENTAGE OF REGULARIZATION		
	PRESCHOOL	THIRD GRADE	ADULT
blow/blew	100	7	10
draw/drew	100	0	10
fly/flew	82	7	5
grow/grew	100	7	10
know/knew	86	0	10
throw/threw	82	0	0

TABLE 14.

semantically related words; these words fit the same schema as those in (c) of Table 13. Class VI errors include four occurrences of *streak/struck*, plus the past participles of Class VIa which fit the schema for Class VIb. In addition, the schemas (or the prototypes that the schemas describe) can be used to create new words on a limited scale: thus we have innovations such as *snoze*, *hept*, and *glew*.

Discussion

5. Here we attempt to draw together what we have learned about the acquisition and processing of English past-tense verb forms. We have found evidence that bears on the issue of the interaction of rule and rote-learning. In particular, we find, as expected, substantial evidence that English irregular verbs are rote-learned and stored in the lexicon, rather than generated by rule from base forms. But the evidence indicates that at least some of the rote-learned forms are organized into classes according to the phonological shape of the past-tense form. These classes are described by SCHEMAS.

Zager distinguishes two types of morphological modifications by which new words are created: source-oriented and product-oriented. The former type can be described as a specific modification of a basic form to create a derived one, e.g. English regular past-tense formation. Product-oriented modifications are less concerned with the shape of the base form (the source word), and more with creating a product that resembles other words of the same morphological category. We are claiming that English irregular past-tense forms make up product-oriented classes, since these forms are partially similar despite differences in base forms; e.g., *strike/struck*, *stick/stuck*, *sneak/snuck* have different vowels in the base forms, but the same vowel in the past forms. Schemas describe such product-oriented classes. It is important to note, however, that we are not denying the existence of source-oriented modifications or of basic derived relationships between forms (see Bybee & Brewer 1980).

Besides defining product classes, schemas have the following characteristics:

(a) Their defining properties are phonological and can range over more than one segment. In the Class VI verbs, it is not the vowel that defines the class, but the vowel and the consonant together; thus the whole sequence /ʌŋ/ signals that the verb is in the past. This is different from saying that the vowel /ʌ/ marks past in verbs ending in /ŋ/.

(b) Classes of items covered by schemas are defined in sets of family resemblances, not by sets of strictly shared properties. Thus *won*, *stung*, and *dug* can belong to the same class, not because they all share the same phonological properties, but because each has some property in common with at least one other member.

(c) Though schemas do not in themselves change features, they are used in lexical selection; and they may serve as the basis of new formations occasionally, either in speech errors—such as those we elicited, or in so-called analogical formations, such as past *snuck* for earlier *sneaked*.

We envision the following as the use of schemas in past-tense formation in English: When speakers need to use a verb in the past tense, they begin a

process of lexical selection, deciding on a verb with an appropriate semantic representation. If the verb arrived at is not marked as irregular, it is pulled out and the regular past-tense suffixation rule is applied.[10] But if the verb has an irregular past form, then the lexical entry will contain a mark that prevents the selection of the base form, and ensures the selection of the associated past form.[11] The further lexical search will call on semantic and syntactic parameters, just as the original search did. In addition, phonological properties are important, since the past form should share its consonantal shape with the stem, but have a different vowel. The particular vowel is not predictable; but certain vowels are more probable than others, and these are the ones described in the schemas. Thus the schemas aid in the identification of a form as a past-tense form, because they describe the phonological shape expected of such forms. Note, however, that since the forms in question are rote forms, correct lexical selection may proceed without schemas.[12] The schemas simply represent one of many ways that lexical information may be organized for more efficient accessing.

In this postulated lexical search procedure, it is not necessary for a speaker first to access the base form of a verb, and then determine whether it is regular. Rather, when the search arrives at an appropriate lexical entry, both the base form and its irregular past tense are immediately available. The search cannot totally bypass the base form. Stanners et al. have found that accessing an irregular past form can also serve as a prime for the base form. However, it seems that the phonological similarity of the base and past forms determines the extent to which they are accessed together.

The lexical selection of a no-change verb presents a slightly different situation, since the verb must be marked as not undergoing the regular suffixation rule; but there is no associated lexical form that can be chosen as the past-tense form. Under conditions of pressure and fatigue, adult subjects often put these verbs through the regular suffixation rule, despite the mark that should prevent the rule's application. The third-grade subjects responded similarly, as noted above. The correlation of correct responses with frequency in this verb class (noted in §3.1 above) indicates that the strength of the mark which bars the regular rule grows with correct application.

Comparing the use of schemas across age groups, we find that both children and adults formulate and use schemas for the English past tense, but each group uses particular schemas. Preschool children orient both to the source

[10] It is possible that some regular past-tense forms, particularly of high-frequency verbs, are also stored in the lexicon; but we have found no evidence in the current research to support this possibility.

[11] The strength of this particular mark is evident in the small number of 'over-marking' errors (errors in which a vowel change AND suffixation apply to a verb) in the adult and third-grade corpora of errors. The third-graders produced only three: *shrunked, shooked,* and *stucked;* the adults produced *clanked* (3 times) and *clunked* (once), both for the past of *clink*. Note that both *clanked* and *clunked* could be past-tense forms of other verbs.

[12] In this way, schemas resemble 'via rules' (Vennemann 1972), except that they define product classes rather than relations among forms.

and product classes of the regular past tense. They have the regular suffixation rule; but when it appears that a verb already belongs to the product class—i.e. if it ends in *t/d*, and fits their schema for past tense—the children are satisfied not to apply suffixation. Thus preschool children can analyse a past-tense form from two points of view: in terms of its relation to a base form, or in terms of other past forms.

Adults and third-grade children can do the same thing, but they have learned that the suffixation process that modifies the source or base word in a certain way takes precedence. Thus they make more errors of adding *-ed* to zero-marked past forms than preschoolers do. In addition, adults show evidence of having developed a set of schemas for the vowel-change verbs. The strongest of these covers the verbs with past forms in /ʌŋ/ and related verbs. Schemas also exist for past-tense /æŋ/, /ow/, /uw/, and /ɛ/. Many irregular verbs may not be covered by any schemas at all.

These differences between children and adults have important implications for the relation between child language and historical change. It has often been suggested that children's innovations in the morphological system are the source of diachronic changes in this system; but this could be true only if children's creations survived with them into adulthood. Our data show that, in some areas of English verb morphology (e.g. the treatment of no-change verbs), children's and adults' strategies are somewhat different, and that a real change in approach takes place before age eight. This means that whatever tendency younger children manifest to apply a schema to verbs ending in *t/d* is nullified by the strength of the suffixation rule in speakers over the age of eight. As things currently stand, if any changes are occurring in Class I verbs, we predict that they will be in the direction of regularization—e.g. *wetted*—rather than the opposite direction, that of adding new members to Class I. However, it should also be pointed out that the preschoolers' strategy of forming schemas is a natural and universal tendency in adult morphology; even in English, the competition between the schema and the suffixation rules survives in adults. Thus child morphology continues to be of great importance to the study of both synchronic and diachonic morphology.

The tendency we found shared by third-graders and adults to use an /ʌ/ past form for verbs with a standard /æ/ past form is a reflection of a longstanding series of changes in English. The important point here is that the errors elicited from adults under pressure reveal the same system shown in long-term historical changes and in the utterances of children aged 8;6 to 10. This means that elicited errors may be used with some degree of confidence in investigating other aspects of adult morphological systems, and that these errors project both the current system and future changes in it.

The more extensive use of product-oriented schemas in child language may be caused by the acquisition strategy which MacWhinney, as well as Menn & MacWhinney, call the affix-checker. The affix-checker determines whether or not rote forms already contain the desired affix—and if they do, whether it has suppressed the affixation process. We suggest, however, that the phenomena associated with affix-checking (such as the lower regularizations of the *hit*

class) are part of a larger phenomenon (i.e. the tendency of children to form product-oriented schemas). We suggest that such schemas are precursors to source-oriented rules which change or add features. In fact, product-oriented schemas may provide the missing step between amalgams and productive rules. As MacWhinney observes, regular affixes are first used in amalgams, i.e. rote-learned unanalysed forms. From such amalgams, common properties may be extracted to develop a schema, which describes a class of items. It is a further step to relate this class to some other (perhaps more basic) class by rules that specify how to move from the basic to the derived form. In some cases, this final step may not be possible (as in the vowel-change schemas), and the generalization remains product-oriented. It may be useful, then, to look for other cases in child language of product-oriented generalizations serving as a link between amalgams, or rote formulae, and source-oriented rules.

APPENDIX: SUBGROUPS OF CLASS VI VERBS IN ENGLISH.

Class VIa:	*m*	swim/swam/swum	Class VIb:	*n*	spin/spun
	n	begin/began/begun			win/won
		run/ran		*ng*	bring/brung*
	ng	ring/rang/rung*			cling/clung
		sing/sang/sung			fling/flung*
		spring/sprang/sprung			hang/hung*
	nk	drink/drank/drunk			sling/slung*
		shrink/shrank/shrunk			sting/stung*
		sink/sank/sunk			string/strung
					swing/swung
					wring/wrung
				nk	slink/slunk
					sneak/snuck*
					stick/stuck*
					strike/struck*
					shake/shuck*
				g	dig/dug*
					drag/drug*

* Verbs marked with an asterisk were not members of this class in Old English (cf. Jespersen).

REFERENCES

ANDERSEN, HENNING. 1973. Abductive and deductive change. Lg. 49.765–93.

ANISFELD, M., and M. GORDON. 1968. On the psychophonological structure of English inflectional rules. Journal of Verbal Learning and Verbal Behavior 7.973–9.

BERKO, JEAN. 1958. The child's learning of English morphology. Word 14.150–77.

BERMAN, RUTH A. 1981. Language development and language knowledge: Evidence from the acquisition of Hebrew morphology. Journal of Child Language 8.609–26.

BLOCH, BERNARD. 1947. English verb inflection. Lg. 23.399–418. [Reprinted in Readings in linguistics I, ed. by Martin Joos, 243–51. Chicago: University of Chicago Press, 1966.]

BYBEE, JOAN L., and MARY ALEXANDRA BREWER. 1980. Explanation in morphophonemics: Changes in Provençal and Spanish preterite forms. Lingua 52.271–312.

CHOMSKY, NOAM, and MORRIS HALLE. 1968. The sound pattern of English. New York: Harper & Row.

DERWING, BRUCE L., and WILLIAM J. BAKER. 1974. Rule learning and the English inflections. Final report to the Canada Council, MS.

GREENBERG, ZELL. 1975. Overgeneralization of past tense inflections. Senior honors thesis, Dept. of Psychology, University of California, Berkeley.
HOARD, JAMES E., and CLARENCE SLOAT. 1973. English irregular verbs. Lg. 49.107–20.
HOOPER, JOAN B. 1976. Introduction to natural generative phonology. New York: Academic Press.
JESPERSEN, OTTO. 1942. A modern English grammar on historical principles, VI: Morphology. Copenhagen: Munksgaard.
KUČERA, HENRY, and NELSON FRANCIS. 1967. Computational analysis of present-day American English. Providence: Brown University Press.
KUCZAJ, STAN A. 1977. The acquisition of regular and irregular past tense forms. Journal of Verbal Learning and Verbal Behavior 16.589–600.
——. 1978. Children's judgments of grammatical and ungrammatical irregular past tense verbs. Child Development 49.319–26.
MACKAY, DONALD G. 1976. On the retrieval and lexical structure of verbs. Journal of Verbal Learning and Verbal Behavior 15.169–82.
MACWHINNEY, BRIAN. 1978. The acquisition of morphophonology. Monographs of the Society for Research in Child Development, serial 174, vol. 43, nos. 1–2.
MENN, LISE, and BRIAN MACWHINNEY. 1981. Checking morphs. MS.
ROSCH, ELEANOR, and CAROLYN B. MERVIS. 1975. Family resemblances: Studies in the internal structure of categories. Cognitive Psychology 7.573–605.
SLOBIN, DAN I. 1971. On the learning of morphological rules: A reply to Palermo and Eberhart. The ontogenesis of grammar, ed. by Dan I. Slobin, 215–23. New York: Academic Press.
STANNERS, R. F., et al. 1979. Memory representation for morphologically related words. Journal of Verbal Learning and Verbal Behavior 18.399–412.
STEMBERGER, JOSEPH P. 1981. Morphological haplology. Lg. 57.791–817.
VENNEMANN, THEO. 1971. Natural generative phonology. Paper read at LSA Annual Meeting, St. Louis, MO.
——. 1972. Rule inversion. Lingua 29.209–42.
ZAGER, DAVID. 1980. A real-time process model of morphological change. Buffalo: SUNY dissertation.

[Received 11 March 1981;
revision received 3 June 1981;
accepted 11 July 1981.]

REFERENCES

Abductive and Deductive Change
Henning Andersen
Language, Vol. 49, No. 4. (Dec., 1973), pp. 765-793.
Stable URL:
http://links.jstor.org/sici?sici=0097-8507%28197312%2949%3A4%3C765%3AADC%3E2.0.CO%3B2-R

English Verb Inflection
Bernard Bloch
Language, Vol. 23, No. 4. (Oct. - Dec., 1947), pp. 399-418.
Stable URL:
http://links.jstor.org/sici?sici=0097-8507%28194710%2F12%2923%3A4%3C399%3AEVI%3E2.0.CO%3B2-2

English Irregular Verbs
James E. Hoard; Clarence Sloat
Language, Vol. 49, No. 1. (Mar., 1973), pp. 107-120.
Stable URL:
http://links.jstor.org/sici?sici=0097-8507%28197303%2949%3A1%3C107%3AEIV%3E2.0.CO%3B2-U

Children's Judgments of Grammatical and Ungrammatical Irregular Past-Tense Verbs
Stan A. Kuczaj II
Child Development, Vol. 49, No. 2. (Jun., 1978), pp. 319-326.
Stable URL:
http://links.jstor.org/sici?sici=0009-3920%28197806%2949%3A2%3C319%3ACJOGAU%3E2.0.CO%3B2-T