German Inflection: The Exception That Proves The Rule

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Abstract

Connectionist models of language equate default inflection (e.g., *fax-faxed*) with high frequency, while symbolic models compute regular inflection through the application of a mental rule which is independent of high frequency. The German *-s* plural is low frequency (7.2% of types) but in an experiment with novel nouns, we show that *-s* behaves as a default. This argues against the connectionist model of inflection, but in favor of symbolic models.

Introduction

The human language mechanism is often thought to consist of a finite lexicon of memorized forms and a set of rules that assemble them into words and phrases. This view has been challenged by connectionist theorists, focusing on English inflection. The regular past tense takes the same form in thousands of verbs (e.g., *walk-walked*, *slip-slipped*) and is automatically applied to new verbs (e.g., *fax-faxed*, *wug-wugged*), so it has traditionally been attributed to the rule "add *-ed* to a Verb." The fixed list of 180 irregular verbs with idiosyncratic forms like *break-broke* would be listed in memory.

Some theorists have argued that connectionist pattern associators could produce all past tense forms, with irregular and regular patterns differing only in degree of productivity owing to the different number of verbs displaying them; the regular rule would be superfluous. For example, Bybee (1991) argues that inflectional systems such as the German plural system do not have qualitative differences between regular and irregular morphology, but that "all types of morphological patterns can be acquired by the same process ... The differences among them are due largely to the number of distinct lexical items involved."

We present evidence that the regular rule is indispensable. Because the rule creates forms by concatenating a suffix to a symbol standing for the verb stem, it does not require access to memorized verbs or their sound patterns, but applies as the "default," to any verb, in any circumstance where access to lexical information does not occur.

Table 1 provides over 20 heterogeneous circumstances where such access is ruled out, including lack of an entry or similar entry in memory (e.g. unusual-sounding novel verbs like to *ploamph*) and absence of the kind of grammatical structure that allows memory information to be passed to the whole word (e.g., words with different properties from their roots, such as to fly out, a verb that is based on a noun, or *sabre-tooth*, which is not a kind of tooth). In every case, people inflect the words using the regular suffix (explaining regularization quirks like *flied out*, *casted his ankle*, *sabre-tooths*, *walkmans*.)

Table 1
Regular Inflection is Applied Despite Lack of Access to Memory Patterns

Circumstance	Kind of Word	Example
Lack of Entry or Similar Entries in Memory:		
1. No root entry	Novel words	snarfed, wugged
2. Weak entry	Low-frequency words	stinted, eked
3. No similar entries	Unusual-sounding words	ploamphed, krilged
Competing Entries or Similar Entries in Memory:		
4. Competing root entry	Homophones	lied/lay, hanged/hung
5. Competing similar root entries		
	Rhymes	blinked, glowed
Entry is Not a Canonical Root:		
6. Rendering of sound	Onomatopoeia	dinged, peeped
7. Mention versus use	Quotations	"man"s, "woman"s
8. Opaque name	Surnames	the Childs, the Manns
9. Foreign language	Unassimilated Borrowings	latkes, negligées
10. Distortion of root	Truncations	synched, man.'s, OXes
11. Artificial	Acronyms	PACs, MANs
Root Cannot Be Marked for Inflectional Feature:		
12. Derivation from Different Category		
	Denominal verbs	high-sticked, spitted
	Deadjectival verbs	righted
	Nominalized conjunctions	ifs, ands, buts
Features Cannot Percolate from Root to Whole Word (Exocentrism or Headlessness):		
13. Derivation Via Different Category		
	Denominal nominalized vbs	flied out, costed
	Nominalized denominal vbs	wolfs, gooses
14. Derivation Via Name	Eponyms	Mickey Mouses, Batmans
	Products	Renault Elfs, Top Shelfs
	Teams	Toronto Maple Leafs
15. Referent Different from Root		
	Bahuvrihi compounds	sabre-tooths, low-lifes
	Pseudo-English	walkmans
16. Lexicalization of a Phrase		
	Nominalized VPs	bag-a-leafs, shear-a-sheeps
Memory Difficulties:		
17. Children	Overregularizations	comed, breaked
18. Normal Speech Errors	Overregularizations	comed, breaked
19. Alzheimer's Disease	Overregularizations	comed, breaked
20. Williams Syndrome	Overregularizations	comed, breaked

Most important, we show that this default behavior is not a consequence of regular words being in the majority in English, the principal connectionist counterexplanation. The intricate German plural system provides a strong test of the type frequency hypothesis, because no single plural form applies to a large percentage of nouns. Noun plural formation in German seems much less systematic than plural formation in English. Mugdan's (1977) description of German plural formation, for example, contained 10 rules and 19 lists of exceptions.. There are five plural affixes, *-(e)n*, *-s*, *-e*, *-er* and zero, three of which also allow a variant with an umlaut. We assume that the presence of umlaut within plurals is governed by a phonological rule of fronting which applies under specific morphological conditions (Wiese, 1987); we thus ignore umlaut (and likewise, the allomorphy between *-en* and *-n*) for the remainder of the paper.

The use of these forms with specific nouns is somewhat arbitrary. There exist preferred plural allomorphs according to the gender and/or the morphophonological characteristics of the noun; the list of exceptions, however, is long (e.g., Mugdan, 1977). For example, masculine and neuter nouns ending with final schwa syllables such as *-er* and *-El* usually form the plural with -∅, yet plural forms such as *Bauern* 'farmers', *Vettern* 'cousins', *Muskeln* 'muscles' and *Pantoffeln* 'slippers' exist as well. Even families of rhyming words exhibit exceptions, such as *Kind-Kinder*, *Rind-Rinder*, but *Wind-Winde*.

The *-s* plural affix is in a decided minority in the German language. On the basis of CELEX database (which consists of about 6 million tokens and over 381,000 types taken largely from written text from a variety of discourse domains) we estimate that just 7.2% of the noun types and only 1.9% of the noun tokens take *-s*.

Although the affix *-s* is rare, it is special in several ways -- exactly the ways that make up the default circumstances of inflection (c.f. van Dam, 1940; Janda, 1990.) First, the use of *-s* is morphophonologically free; that is, *-s* appears when the phonological environment does not permit any other plural allomorph (cf. Table 1, # 3). The morphophonological space of German noun plurals varies on several dimensions, including gender, syllable structure, and rhyme structure. Irregular affixes are restricted to particular regions. For example *-er* applies predominantly to neuter nouns, and never to feminines. But non-canonical words may fit in regions outside of the phonological space in which the only affix that treads is *-s*. This is especially obvious in the case of unassimilated borrowings (Table 1, #9). For example *Café*, which has non-canonical stress, takes the *-s* plural, as does unusual-sounding *Kiosk*. Köpcke (1988:325) found that of 182 recent German borrowings, about half were formed with *-s* (as in other languages, some historical borrowings can become assimilated into the canonical template for roots; in such cases an irregular can be applied: e.g. *Computer-Computer*, *Firma-Firmen*, *Manuskript-Manuskripte*).

Second, *-s* can even appear with stems that rhyme with existing irregular nouns (cf. Circumstance 5 of Table 1, hence *Reelings* vs. *Ringe* (rings), *Schecks* (checks) vs *Flecken* (spots), *Labels* vs *Kabel* (cables), *Tiefs* (lows) vs *Briefe* (letters), *Riffs* (reefs) vs *Kniffe* (tricks), etc. (examples from Bornschein and Butt, 1987).

Third, there is a wide variety of special grammatical circumstances in which *-s* plural trumps all other plurals, regardless of phonology. In German, as in English (Table 1, # 8), pluralized nouns based on names homophonous with irregular nouns must take regular inflection, hence *Manns/*Männ/*Männer*. This occurs not only with semantically opaque surnames, but with product names (Table 1, #14) that have salient canonical roots but are headless. For example, the car model *Kadett* would be pluralized as *Kadetts*, despite the fact that the common noun *Kadett* `cadet` forms its plural as *Kadetten*. Furthermore, *-s* is used as the exclusive plural for onomatopoeic nouns (e.g., *Kuckucks* "cuckoo", *Wauwaus*, "dogs"); (Table 1, #6), quoted nouns (e.g., *nach korrekturlesung für sexistische wortwahl fand ich drei 'man's auf seite 1*; cf. Table 1, #7), nouns based on other categories like conjunctions (e.g., *wenns* and *abers* "ifs" and "buts"; Table 1, #12), acronyms (e.g., *Gmbh-Gmbhs*; cf. Table 1, #11), and truncations (e.g., *Wessis* from *Westdeutsche*) cf. Table 1, #10).

A final corroboration of the special status of -s comes from the circumstance in which it cannot occur. In German, as in English, regular plurals are generally excluded from compounds, though the other plurals can appear inside them. For example, the compounds containing irregular plurals with *-e*, *-en*, and *-er* in the following examples are acceptable, whereas the compounds containing regular plurals with *-s* are not. (An *–s* affix is sometimes permitted in compounds, e.g. the *-s* in *Wirtschaftskrise* 'economic crisis', but only as a linking element , similar to *huntsman* and *bondsman* in English. See Wiese, 1992.)

Frau-en-laden "women's center"
Schwein-e-stall "pigsty"
Hühn-er-ei "hen egg"
Sozialist-en-treffen "socialists' meeting"
*Sozi-s-treffen "socialists' meeting"
*Auto-s-berg "cars heap"

Köpcke (1988) conducted a study in which adult speakers were asked to provide plurals for 50 novel noun stems which varied by gender (masculine, feminine, and neuter) and syllabic structure (nouns with suffixes, nouns ending in schwa, etc.). Each type of word had a preferred affix, e.g., feminine nouns ending in schwa nearly always took *-(e)n*, and monosyllabic nouns tended to take *-e* if neuter or

masculine, *-(e)n* if feminine. But this experiment simply does not test whether there is a default pluralization process in German. Each noun was presented in isolation, so subjects presumably treated them as canonical roots. Any model that acknowledges that the memory for word roots fosters analogies would predict that novel roots may take the affix of similar existing roots. To test whether there is a default plural rule in German, one must examine the pluralization of novel nouns in various circumstances in which access to memory for roots is ruled out.

We test pluralization in heterogeneous circumstances held together only as the default. The design crosses three factors: Regularity (Regular vs. Irregular), Rhyme (Rhyme vs. Non-Rhyme), and Root (Root vs. Name vs. Borrowing).

The Regularity factor classifies *-s* as the Regular plural affix, for reasons just discussed. Conversely, *-e* and *-er* are clearly Irregular. Although *-en* may be produced by a rule for certain polysyllabic nouns, we also classify *-en* as Irregular here because it clearly is not rule-generated in the case of monosyllabic nouns, the kind of item we use in the experiment.

The Rhyme factor tests the hypothesis that novel roots are likely to receive irregular inflection if they are similar to existing words; otherwise, the default inflection is available to inflect them. Similarity was defined by rhyme structure, that is, number of existing words that rhyme with the novel noun. Thus the novel nouns were either "Rhymes," words that rhyme with existing German irregular nouns (and that do not rhyme with regular nouns), and "Non-Rhymes," words that do not rhyme with existing German nouns. If the *-s* is applied by a default rule, German speakers should judge the *-s* plural as better for Non-Rhymes than for Rhymes, because Non-Rhymes are less likely to evoke clusters of irregular roots in memory, allowing them to slip directly into the default process. Judgments of irregular affixes should show the opposite pattern: they should sound poorer with the unusual-sounding non-rhymes, which fail to evoke the relevant analogy-fostering existing irregulars. In contrast, a single pattern associator appears to predict that all affixes should be weaker for unusual-sounding words than for canonical-sounding words.

Because the morphophonological space of German noun plurals is vast, we can sample only a small region, monosyllabic nouns. Because the *-s* plural rarely applies to monosyllables, this restriction works against our hypothesis. As our stimulus items are all monosyllables, they should be particularly drawn to the irregular clusters of *-e*, and to a lesser extent *-er*, since those affixes are the ones most commonly used to inflect monosyllables.

The Root Factor has three levels. A third of the words were presented as Roots, that is, as normal German words in a neutral context. All of these words are grammatically eligible either for regular or irregular inflection, and the choice should be determined largely by Rhyme: though all the roots could be analogized to the irregular patterns, since they are all monosyllables, the analogy clearly should be stronger for Rhymes, which should thus take irregular plurals to a greater extent (and regulars to a lesser extent) than Non-Rhymes would.

Another third were presented as Names, a circumstance that should elicit the regular or default plural form, *-s*. Since information about the phonological structure of roots is systematically withheld from the representation of the entire word, in principal Rhyme should make no difference; all names should be affixed by the default process.

The remaining third were presented in a context that suggested that they were Borrowed from a foreign language. As in English, German contains cues as to the native versus borrowed status of morphemes; for example, Latinate affixes can be distinguished from Germanic ones because only the former may bear stress. Borrowings can sometimes be assimilated to root status, especially if their phonological patterns fit the canonical template for the language. The prediction is that when speakers assimilate a borrowing, it should behave like a Root and hence take irregular inflection when similar to existing irregulars, regular inflection otherwise. But when speakers treat a borrowing as a borrowing, it should take regular inflection across the board (for similar reasons that Names do). The Rhyme factor thus enters into the predictions in two ways, because while all the novel forms, as monosyllables, should have some likelihood of being assimilated, the Rhymes, which resemble existing forms more than the Non-Rhymes do, should have an even greater likelihood. In addition, once assimilated, Rhymes should be more likely to elicit irregular suffixes by analogy to existing forms than Non-Rhymes. The overall predictions for the Borrowings, then, are straightforward, if a bit complex: Among the Borrowed Rhymes (assimilable and analogizable) there should be a preference for the irregular forms over the regular ones, though not as big a preference as seen among the Roots, since the question of assimilation does not arise for them. Among the Non-Rhymes, there should be a preference for the regular forms over the irregular ones, though not as big a preference as seen among the Names, since some of the Borrowed Non-Rhymes might still be assimilated and elicit analogization, generally impossible for the Names. In other words, for the Borrowings, the interaction between Affix and Rhyme should fall somewhere in between what is found for the Roots and what is found for the Names.

The predictions of the theory that all inflection is computed in a single pattern associator are quite different, because they neither easily generalize low-frequency affixes, nor unite the different default

circumstances (phonological and derivational) as defaults. Associative models that rely solely on phonological information (e.g. Rumelhart and McClelland, 1986; Plunkett and Marchman, 1991; Daugherty and Seidenberg , 1992) must predict that Root has no effect, since it cannot even be represented in the input. These models predict that *-s* should be eschewed across the board: driven only by phonological similarity, the models should always prefer the common *-e*, *-en*, and *-er* plural forms to *-s*, even for Non-Rhymes, since there is no reason that very rare *-s* would scoop up the words that have lower similarities to existing irregulars and no similarity to existing regulars. Precise predictions about a hypothetical pattern associator model that would somehow represent root and head structure in the input (and hence the difference among Roots, Names, and Borrowings) must remain somewhat conjectural. Assuming that such a model could be given a plausible "Roothood" feature node or its surrogate, such a model presumably could learn from the few *-s* forms in its input, presumably all non-roots, that this feature predicts an -s plural. But given the rarity of *-s* plurals both typewise and tokenwise, it would have no way of knowing that *-s* is also more applicable to unusual roots, and that for Names, it actually overrides any effects of phonological similarity and applies to all pluralized names, Rhyme and NonRhyme, equally strongly.

Method

40 adult subjects were recruited from Northern Germany. Subjects received an untimed paper and pencil test in which they were asked to judge plurals for novel words. There were 4 versions of the questionnaire, each containing 24 items. Each item contained a novel word presented as a singular form in a context sentence, followed by a set of test sentences containing each possible plural form for the novel word. Subjects were asked to rate each sentence on a scale from 1 "perfectly natural" to 5 "perfectly unnatural", so as to correspond to the sequence of grade scores familiar in German schools. For convenience, we subtracted each rating from 6, so that higher numbers correspond to ratings of greater naturalness. The subjects were asked to rate each item in terms of how "normal" or "good-sounding" as opposed to "funny" or "wrong" they were, and were told not to pay attention to the orthography of the words, only their sounds, that there were no right or wrong answers but that only their personal evaluation were of interest, and that nouns could have any number of natural or unnatural plural forms.

The 24 items were divided into 2 (Rhyme/Non-Rhyme) x 3 (Root/Name/Borrowing) = 6 conditions, with 4 novel words appearing in each condition. Rhymes were selected to rhyme with large clusters of irregular German nouns. For example Pund was used on analogy to *Hund-Hunde, Pfund-Pfunde, Grund-Gründe* and so on. The rhyming items consisted of *mur, bral, raun, nuhl, pisch, pund, vag, kach, spert, pind, spand, klot*. Non-rhymes were created using a table from Seiler (1970:417) which contained lists of permissible and non-permissible combinations of German onsets and codas. Possible but non-existing combinations were selected: *bnaupf, bneik, bnöhk, fnähf, fneik, fnöhk, plaupf, pleik, pnöhf, pröng, snauk*.

Items were presented as Roots by introducing them as novel but otherwise ordinary German nouns. For example, one lead sentence was

> Wußten Sie, daß dieses kleine Dingsbums ein KLOT ist?
> "Do you know that this little thingamajig is a KLOT?"

Subjects then were faced with each of the following continuations:

> Es gibt 3 KLOT in meiner Werkzeugkiste.
> Es gibt 3 KLOTE in meiner Werkzeugkiste.
> .....
> Es gibt 3 KLOTS in meiner Werkzeugkiste.
> "There are 3 KLOTS in my toolbox"

Similarly, Items were presented as Names by introducing them as the surname of each of a set of people, and then subjects were tested on continuation sentences containing each possible plural. Items were presented as Borrowings by introducing them as foreign words for various objects.

Except for some names, which were unmarked for gender, half the items in each questionnaire were masculine, half feminine; across subjects, each item appeared an equal number of times as masculine and as feminine. (Masculine and neuter nouns do not behave fundamentally different with respect to pluralization.) The questionnaires were presented in one of two orders, counterbalanced across subjects; one order was assembled at random, the other was its mirror image.

In conducting the analyses, we were maximally charitable to the pattern associator hypothesis by comparing each subject's rating of the -s-affixed form of a given noun to his or her highest rating among all the irregularly-affixed forms of that noun. For example, if a subject rated *Klote* as 4, *Kloter* as 3, and *Klots* and *Kloten* as 2, we would use 4 as the rating of the "Irregular" form for that item, for that subject. The comparison between best Irregular vs. *-s* was treated as a within-subjects factor, Regularity, in the analyses of variance to be presented below. (Alternative measures, e.g. the mean rating of the irregular forms, would systematically underestimate the strength of irregulars in default contexts and thus help our hypotheses.) The zero-affix or no-change forms were not analyzed because subjects actually saw these forms in the context sentences, possibly biasing them to rate it higher, and because subjects might interpret the no-

change form as reflecting their willingness to pluralize the noun at all, as opposed to reflecting their choice of how to pluralize it given that it must be pluralized. In any case, adding back the zero forms has little effect on the results.

Results and Discussion

Mean ratings of the *-s* plural and of the best irregular plural forms of Roots are presented in Figure 1. Overall, the ratings were better for the best irregular. Irregular forms were judged as better in the Rhyme condition than in the Nonrhyme condition (4.3 vs. 3.9), whereas *-s* affixed forms were judged as worse in the Rhyme condition than in the NonRhyme condition (3.3 vs. 3.6). This interaction was significant by subjects $F(1,39) = 20.08$, $p < 0.001$, and by items $F(1,22) = 4.63$, $p < 0.05$. For Non-Rhymes, the difference between the ratings of the Regular and Irregular is not significant.

The decline in the response of the irregular items can be explained as a standard generalization gradient in associative generalization. The improvement of *-s* across in this same comparison, in contrast, suggests that it is produced as a default (lack of similarity to irregulars is not a sufficient condition for generalization of a regular affix in a pattern associator; see Prasada and Pinker, 1992, for a demonstration). Though *-s* was not rated better than the best irregular form on average, it was rated better in 31% of the subjects' ratings of the Non-Rhymes, and equal to the best irregular in an additional 24%.

Mean ratings of the plurals of Names are presented in Figure 2. Regular (*-s*) plurals were rated as better than the best Irregular plural (mean 4.2 versus 3.0; the difference is significant by subjects, $F(1,39) = 39.89$, $p < .001$, and by items, $F(1,22) = 26.11$, $p < .001$). This is exactly the opposite of how Roots were rated. Just as strikingly, *-s* was preferred, and irregular plurals dispreferred, to the exact same extent among Rhymes and Non-Rhymes, as predicted by the Rule hypothesis. Specifically, subjects gave identical mean ratings for the Regular plural forms of Rhymes and Non-Rhymes (mean 4.2), and gave very close ratings to their most preferred Irregular plural form of Rhymes and Non-Rhymes (3.1 versus 2.9, a difference which is not significant by subjects $F(1,39) = 1.39$, NS, or by items $F(1,22) < 1$). The contrast between the similarity-sensitivity of Roots and nonsensitivity of Names can be tested in the three way interaction between Rhyme, Root, and Regularity (Root versus Name); this interaction is significant, by subjects, $F(1,39) = 5.70$, $p < .05$, though not by items, $F(1,22) < 1$.

Mean ratings of the -s plural and of the best irregular plural form of Borrowings are presented in Figure 3. As in the case of Roots, the best Irregular plural form was judged as better for Rhymes than for non-rhymes (4.0 versus 3.7), while the regular plural forms were judged better for Non-Rhymes than for Rhymes (3.9 versus 3.4). This interaction is significant by subjects, $F(1,39) = 10.67$, $p < .002$, and nearly significant by items $F(1,22) = 3.68$, $p < .07$.

Note, too, that in comparison with Roots, Borrowed nouns triggered higher mean ratings for Regular plural forms (3.6 versus 3.5), and lower ratings for the best Irregular plural form (3.8 versus 4.1). This is reflected in a significant interaction between Root (Root vs Borrowing) and Regularity, $F(1,39) = 17.10$, $p < .001$ by subjects, $F(1,22) =$

Figure 1:

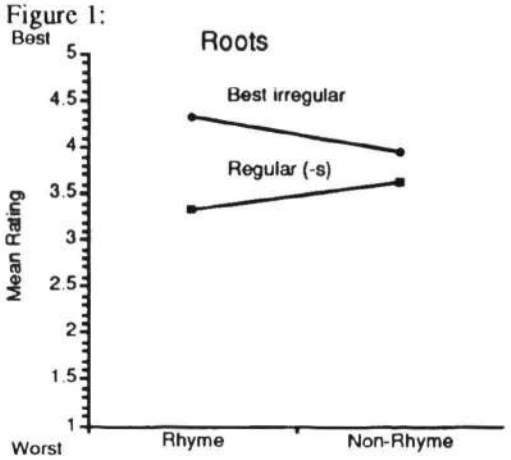


Figure 2:

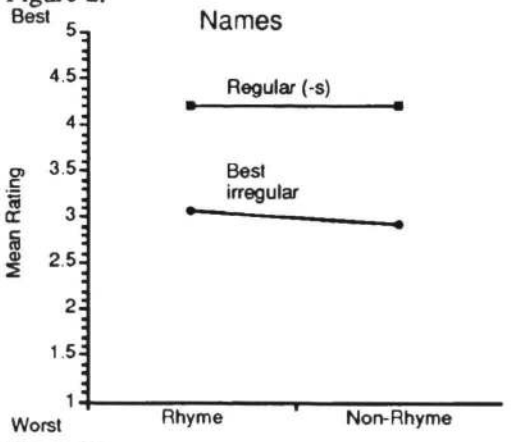
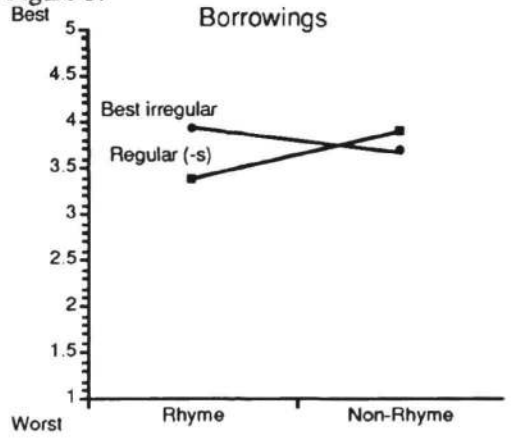


Figure 3:



8.25, $p < .01$, by items. As predicted, Rhyme had similar effects in the two conditions.

In sum, German speakers generalize the *-s* plural and the irregular plural forms in qualitatively different ways. If a novel noun is learned as a root, or as a borrowing easily assimilable to roots, its plural can be formed by analogy to the plural forms of similar existing irregular nouns. The affix *-s* is used elsewhere: for the more unusual-sounding roots, for unassimilated borrowings, and for names with both usual and unusual sounds. The heterogeneity and rarity of these circumstances argue that the plural *-s* affix applies not as an association separately acquired for each of these combinations of circumstances, but whenever the combination allowing memory-based generalization (similar root in head position) does not apply; that is, elsewhere, as the last resort, emergency, or default.

In a second experiment not reported here, we found similar effects for the German *-t* participle suffix, which applies to less than half of German verbs; this finding further establishes the independence of defaultness from frequency.

The fact that *-s* serves as a default even though it is rare argues against the hypothesis that default application of an affix is an epiphenomenon of its applying to a large number of words. Instead, defaultness appears to be a consequence of the affixation process accessing a mental symbol for a grammatical category, and hence applying indiscriminately to any word that such a symbol refers to unless specifically blocked.

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