The morphological complexity of simplex nouns[1]

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Abstract

This paper reports experimental results concerning the processing of morphologically simplex nouns. It appears that the way in which these nouns are processed is influenced not only by their own frequency of use, but also by two other frequency measures. First, the token frequency of the corresponding plural inflection plays a role. Second, the type count of the number of compounds and derived words in which a given simplex noun appears as a constituent also affects our experimental measures. We offer an explanation of these results in terms of the semantic differences between noun pluralization as inherent inflection on the one hand, and derivation and compounding on the other.

Introduction

What could be of less interest to a morphologist than unquestionably monomorphemic nouns such as *bean* and *limb*? And what could be more surprising than to find that the relative positions of *bean* and *limb* in the network of morphological relations in the mental lexicon influence the way these nouns are processed in visual word recognition? Recent experiments with Dutch monomorphemic nouns revealed that the numbers of complex words containing these monomorphemic nouns as a constituent influence their recognition (Schreuder and Baayen 1997).

In these experiments, three variables were manipulated, while keeping constant a range of other variables known to affect visual processing. The first variable investigated was the summed frequency of the singular and plural form, henceforth the stem frequency. Schreuder and Baayen (1997) compared nouns with a high stem frequency (Fstem) with nouns with a low stem frequency, while keeping the frequency of the singular form (Fsg) constant, as shown in (1). (These numbers are based on the

Linguistics 35 (1997), 861–877

0024–3949/97/0035–0861

CELEX counts for a corpus of 42 million words.) This amounts to contrasting nouns matched for the frequency of the singular form with respect to the frequency of their plural (Fpl).

(1)

		Fsg	Fpl	Fstem
akker	'field'	214	404	618
gif	'poison'	213	0	213

Two different tasks (visual lexical decision and subjective frequency rating) revealed the same pattern: nouns with a high stem frequency are processed faster and rated higher than nouns with a low stem frequency, despite being matched for the frequency of the singular form. Since the plural is an inflectional variant of the singular, this result is not too surprising from a linguistic point of view.

Given that the processing of a singular noun is influenced by the summed frequency of the singular and plural forms, the question arises whether a similar cumulation of frequency takes place for other complex words in which a given noun appears as a constituent. We therefore investigated a second variable, the summed token frequencies of all derived words and compounds in which a given noun stem occurs as a constituent. We will refer to this cumulated token frequency count as the (morphological) family frequency (Nf).

(2)

		Fstem	Nf
schuit	'barge'	208	39
fluweel	'velvet'	207	457

In (2), for example, the nouns *schuit* and *fluweel* are matched for stem frequency, but they differ with respect to their family frequency. When such nouns are investigated experimentally, it appears that family frequency has no effect at all on response latencies in visual lexical decision nor on subjective frequency ratings.

However, a third variable was found to play a substantial role, namely what we have called the (morphological) family size (Vf), the number of different derived words and compounds containing a given noun as a constituent.

(3)

		Fstem	Vf
smart	'sorrow'	362	3
rente	'interest'	385	23

In (3), *smart* occurs in few other derived words and compounds, while *rente* has a large family size. Words with a large family size elicit shorter response latencies in visual lexical decision as well as higher subjective frequency ratings, while being matched for all other relevant factors.

What we have found for Dutch, in sum, is a cumulative token-frequency effect for inflection and a type-frequency effect for derivation and compounding on the processing of monomorphemic nouns. These results raise two questions. First, do these results generalize to a related language such as English? Second, why is it that the linguistic distinction between inflection and derivation appears as a distinction between sensitivity for type and token frequencies in lexical processing?

In what follows, we first present three experiments in which we manipulate stem frequency, family frequency, and family size for English monomorphemic nouns. As the results of Schreuder and Baayen (1997) show that subjective frequency ratings are strongly correlated with response latencies in an on-line task such as visual lexical decision and reveal exactly the same pattern of results with similar power, we have opted for using subjective frequency ratings in this study. As we shall see, our replication experiments reveal the very same pattern for English as observed for Dutch. Following the presentation of the experiments, we will offer suggestions as to why inflection and derivation might differ in their respective sensitivity to token and type frequencies.

Experiments 1–3

Method

Participants. Three groups of native speakers of English, students and employees at the University of New Hampshire, Durham, participated in the rating experiments: 15 subjects in experiments 1 and 3, and 16 in experiment 2. Each participant performed only one of the three ratings.

Materials. The materials used in the experiments are listed in Appendices A–C. The frequencies reported in these appendices are based on the frequency counts in the CELEX lexical database (Baayen et al. 1993), counts calculated for a corpus of 18 million words. For experiment 1, we contrasted nouns with a high stem frequency with nouns with a low stem frequency, while keeping the frequency of the singular constant. The two sets were matched for family frequency, family size, length in letters, and geometric mean bigram frequency. In experiment 2, we compared nouns with a high family frequency with nouns with a low family frequency, while keeping all other potentially relevant variables matched. In experiment 3, our aim was to contrast nouns with a high family size with nouns with a low family size. The two sets of nouns were matched for the frequency of the stem, length, and bigram frequency. We have also matched these two sets as far as possible for family frequency. However, a small difference in family frequency is still present. As will become clear below, this small difference does not affect our results. Finally, only nouns without conversion alternants were included in the experiments. In this way we ensured that stimuli would only be interpreted as nouns and not as verbs.

Procedure. Participants were asked to complete a questionaire consisting of the words followed by a seven-point scale, on which they had to indicate their estimate of the relative frequency of occurrence of these words in English.

Results and discussion

The results of these experiments are summarized in Table 1. Our participants tended to assign high ratings to all our experimental words, which, after all, are all well-known words of English. Nevertheless, interesting and significant differences emerge from these ratings.

As predicted, experiment 1 reveals that nouns with a high stem frequency are rated as more frequent (6.38) than nouns with a low stem frequency (5.77), despite the fact that they are matched for the frequency of the singular form. This difference is statistically reliable in the predicted direction (analysis by subjects: $t_{(14)} = 11.97$, $p < 0.001$; analysis by items: $t_{(50)} = 2.52$, $p < 0.01$; all tests of significance reported in this paper are one-tailed tests).

Experiment 2 was designed to bring to light a possible effect of family frequency. Our hypothesis was that no effect of family frequency should

Table 1. *Mean subjective frequency ratings for monomorphemic singulars with high and low stem frequency (experiment 1), with high and low family frequency (experiment 2), and with a high or low family size (experiment 3)*

	Frequency manipulation	Rating
Experiment 1	High stem frequency	6.38
	Low stem frequency	5.77
Experiment 2	High family frequency	5.96
	Low family frequency	5.87
Experiment 3	High family size	6.08
	Low family size	5.50

be observed. Experiment 2 confirmed this hypothesis. Nouns with a high family frequency received a mean rating of 5.96, and nouns with a low family frequency a mean rating of 5.87. The difference between the two means is not significant (analysis by subjects: $t_{(15)} = 1.39, p > 0.09$; analysis by items: $t_{(34)} = 0.29$, $p > 0.30$).

In experiment 3, we varied the family size. Nouns with a large family size received a mean rating of 6.08, nouns with a small family size received a mean rating of 5.50. The difference between the two means is significant in the predicted direction (analysis by subjects: $t_{(14)} = 6.74$, $p < 0.001$; analysis by items: $t_{(40)} = 1.87$, $p < 0.04$). Recall that it was not possible to fully match the two sets of nouns with respect to family frequency. Experiment 2 shows that family frequency has no role play. To make sure that this holds true also for experiment 3, we calculated for the items the correlation between family size and mean rating on the one hand, and the correlation between family frequency and mean rating on the other hand. The correlation between family size and mean rating was 0.25 and significant in the predicted direction ($t_{(40)} = 1.69$, $p < 0.05$). By contrast, there was no correlation ($r = 0.001$) between family frequency and mean rating ($t_{(40)} = 0.008$, $p > 0.9$). Again, we find that family size is the relevant factor.

Discussion

Our results show that for English, as in Dutch, the subjective frequency estimates for monomorphemic nouns are influenced by the token frequency of the plural inflectional variant, and by a type-frequency effect, namely, the morphological family size: the number of derived words and compounds in which a noun appears as a constituent. In contrast to the morphological family size, the morphological family frequency, the summed token frequencies of the morphological family members, does not play any role at all. Apparently, token frequencies cumulate in the domain of inflection, but not in the domain of derivation and compounding.

This leaves us with two questions. First, how can we understand the effect of family size? Second, why does the frequency of the plural influence the way in which the corresponding singular is perceived, while family frequency appears to be completely irrelevant? We will address these questions in turn.

First consider the question how the effect of family size might be understood. Schreuder and Baayen (1997) show that the effect of family size takes place following perceptual identification. This effect occurs at a relatively late stage of lexical processing. It is probably an effect of semantic activation spreading among the family members. It is well known that lexical decision is sensitive to the amount of activation in the semantic lexicon (see, e.g., Grainger and Jacobs 1996), and apparently subjective frequency ratings are also partly affected by the extent to which a simplex word is anchored in the semantic network by means of its morphological relatives. When a word with a high family size is recognized, it activates a large number of morphologically related words. This high degree of activation helps subjects to decide that the experimental item is indeed a word of the language. Likewise, a high degree of activation in the mental lexicon causes a word to feel more familiar when rating words for subjective frequency.

Next consider the question of why plural token frequencies cumulate with singular frequencies, while the token frequencies of derived words and compounds do not cumulate with the frequency of the singular base noun. This experimental dissociation ties in nicely with the traditional distinction between inflection on the one hand and word formation (derivation and compounding) on the other. Using the terminology of Aronoff (1994), who defines a lexeme as "a (potential or actual) member of a major lexical category, having both form and meaning but being neither, and existing outside of any particular syntactic context" (1994: 11), word formation creates new lexemes, whereas inflectional morphology adapts existing lexemes to the requirements of syntax. This suggests that cumulative token-frequency effects are restricted to the domain of the lexeme. No cumulation would then take place between different lexemes.

This explanation is in need of further refinement, for two reasons. First, there are linguistic and psycholinguistic arguments for assuming that noun pluralization involves lexeme formation (see, e.g., Beard 1982, 1995; Booij 1993, 1996; Baayen et al. 1996; Baayen et al. 1997). Second, an explanation that restricts cumulative frequency effects to the domain of the lexeme leaves unspecified why token frequency cumulates from the plural to the singular but not from the singular to the plural. Let's consider these two points in more detail.

What are the reasons to suppose that noun plurals might have their own lexeme representations independently of the lexeme representations for noun singulars? Kuryłowicz (1964) distinguished between inflectional categories with a primarily syntactic function, such as case or person marking, and inflectional categories with a primarily semantic or autonomous function. Booij (1993, 1996) labeled these categories as contextual versus inherent inflection. He argues that noun pluralization belongs to the category of inherent inflection, as it is in many ways similar to derivation. For instance, noun pluralization, unlike contextual inflection, feeds word formation (e.g., in Dutch, *heldendom*, heroes-ism, 'heroism'). Noun plurals often reveal idiosyncrasies of the kind typically found in the domain of derivation. Many singulars do not have a plural counterpart, just as many words do not have a derivative in every possible category. Often, the meaning of such singulars is incompatible with pluralization. This indicates that pluralization of a noun involves changing its meaning in a way that does not take place for case or person inflection. Similarly, there are plural nouns that lack a singular, just as derived words may be formally complex without having a synchronic base word (see Booij 1996: 3–5 for extensive discussion). Other evidence for the possible lexeme status of noun plurals can be found in Tiersma (1982), Beard (1982, 1995), and Dimmendaal (1987). Tiersma shows that high-frequency noun plurals can serve as attractors for language change. Beard presents a rich collection of observations supporting the derivational nature of noun pluralization and points out, for instance, that affixes marking pluralization are often borrowed from other languages along with derivational affixes, while borrowing of contextual inflectional endings such as case marking hardly ever takes place. Finally, Dimmendaal (1987) discusses examples of plural concepts that are lexicalized as monomorphemic nouns, requiring a singulative affix in order to express singular number. In cross-linguistic comparisons, one often finds that a given concept is expressed by means of a monomorphemic word in one language and by a complex word in another; compare, for instance, English *speed* with Dutch *snelheid*, 'fast-ness' (see Baayen and Neijt 1997 for detailed discussion). Likewise, high-frequency plural concepts are expressed in monomorphemic form in some Nilo-Saharan languages, whereas in more familiar languages such as English complex forms are always used. Such differences in the choice of the basic form are atypical and extremely rare for contextual inflections such as person and case marking.

Experimental evidence supporting the hypothesis that noun plurals have their own representations in the mental lexicon is discussed in Baayen et al. (1996, 1997), Sereno and Jongman (1997), and Taft (1979). They observe that the processing times of high-frequency noun plurals are largely determined by the token frequency of the plural form itself and not by the frequency of the stem. If noun plurals do not have their own lexical representations, then they must be recognized on the basis of the stem and the rule for pluralization. No effect of plural token frequency on the processing of the plural form should then be observed. This is not what these authors find. In English, Dutch, and Italian, the frequency of the plural noun is an important determinant of processing times of these plural nouns themselves. This shows that, independent of their full regularity, noun plurals have their own lexical representations, independent of their singular forms. Considered together with the linguistic evidence, we conclude that plurals are independent lexemes in their own right.[2] By contrast, no surface frequency effects are observed for verb plurals in Dutch. Apparently, these plural forms are processed by rule, without the aid of their own listed form representations. Thus, for contextual inflection, only the summed frequency of the base and its (contextual) inflectional variants appears to determine the processing times of their plural verb forms (see Baayen et al. 1997 for details).

Assuming, as we do, that noun plurals (in contrast to verb plurals) are themselves lexemes, it is no longer possible to explain the cumulation of plural token frequencies and the absence of a family-frequency effect by claiming that the lexeme is the domain within which token frequencies cumulate. Given that noun plurals are lexemes, token frequency must be able to cumulate across lexemes. The question then is why this happens for noun plurals but not for derived words and compounds. To our mind, the crucial difference is that, even though plurals may be independent lexemes in their own right, the change in meaning effected by pluralization is qualitatively different from the change in meaning effected by standard word (lexeme) formation. Regular pluralization affects the meaning of the semantically unmarked singular noun by adding information on number, without changing the meaning of the noun itself. By contrast, derivation and compounding generally apply semantic operations on the constituents to yield new meanings that differ qualitatively from the meanings of the base words. We can understand our experimental results when we assume that cumulation of token frequency takes place across lexemes if and only if these lexemes differ minimally in their meaning. This, we would argue, is what is typical for the domain of inflection, contextual and inherent inflection alike.

Another way of describing our findings is to make use of the notions *meaning-invariant morphology*, *meaning-adding morphology*, and *meaning-changing morphology*. Contextual inflection is meaning-invariant and hence presents the prototypical domain for the cumulation of token frequencies of inflectional variants with their base form. Inherent inflection can be viewed as adding meaning without changing the conceptual meaning of the base word. Other word-formation rules that fall into this category, in addition to noun pluralization, are, for instance, diminutive formation and comparative formation. Given the high degree of semantic similarity between the base word and its inherent inflected form, our hypothesis is that the token frequencies of diminutives and comparatives will likewise cumulate with the token frequencies of their base words, even though the diminutive suffix in a language such as Dutch appears to be a morphological head and hence should be classified as derivational rather than inflectional. Clearly, further empirical research is required here. Finally, derivation and compounding are typically meaning-changing operations. For instance, a compound such as *armchair* is much more specific in meaning than its head noun *chair*: the concept CHAIR has been changed into another concept, its hyponym ARMCHAIR. Our data suggest that, apparently, such changes in conceptual structure block the cumulation of token frequencies of complex words to their base words.

What remains to be explained is the unidirectionality of the plural token-frequency effect. Recall that while the frequency of the plural cumulates with that of the singular, no such cumulation takes place from the singular to the plural. This experimentally observed asymmetry coincides with a difference in general markedness. The frequency count of the marked plural is not affected by the frequency count of the unmarked singular. Conversely, the frequency count of the unmarked singular noun is determined by the summed frequencies of both the marked and the unmarked forms. It seems possible to argue that there is a kind of part–whole relation between the meaning of the singular and the plural noun. The plural noun adds to the meaning of the singular but does not change it. Whenever a plural form is encountered, its semantics fully support the lexical meaning of the singular. Conversely, when a singular is encountered, the full meaning of the plural is not supported. After all, the singular is the unmarked form. If this tentative semantic explanation is correct, the consequences for lexical processing are that token frequency cumulates only for semantically highly similar lexemes in a part–whole relationship (from the whole to the parts) along the direction of markedness (from marked to unmarked).

Summing up, what we have tried to show in this paper is that the way in which the human processing system handles unquestionably monomorphemic words may shed light on the issue of the classification of noun pluralization as inflectional or derivational. As we have seen, there are various linguistic and psycholinguistic arguments for assuming that noun plurals be lexemes in their own right. From this point of view, noun plurals, instantiating inherent inflection in the sense of Booij (1993, 1996), would seem to be more derivational than inflectional in nature. By itself, Booij's argument might be taken one step further. One could argue that noun pluralization is in fact derivational. However, the cumulation of the token frequencies of the plural form to the frequency count of their singulars is typical for inflection and does not occur for derived words and compounds. Derived words and compounds only affect lexical processing of their base words via the family-size type count. Our present findings show that with respect to cumulative token-frequency effects noun pluralization firmly sides with inflection, even though, like derivation, it may lead to lexeme formation. Paradoxically, this conclusion hinges on a study of the processing of monomorphemic singular nouns, which, from the processing perspective, emerge as "morphologically complex".

Received 3 February 1997
Revised version received
2 June 1997

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Appendix A. Experiment 1

Table A. *Words used in experiment 1 with a high stem frequency*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
bean	68	320	388	15	45	13.52	6.60
berry	44	142	186	14	336	12.89	6.60
biscuit	88	189	277	5	3	12.39	6.00
camel	146	303	449	2	6	12.80	6.60
carrot	45	99	144	1	1	12.90	6.60
fossil	79	130	209	4	46	12.69	5.93
gene	113	227	340	0	0	13.29	5.60
germ	49	109	158	4	3	12.53	6.60
gland	41	79	120	8	36	12.91	5.87
grape	37	142	179	4	58	12.64	6.73
heel	200	324	524	7	9	13.33	6.20
herb	87	182	269	5	75	12.39	5.73
insect	148	290	438	3	78	13.22	6.67
jewel	50	113	163	6	249	11.70	6.40
limb	137	299	436	2	6	11.80	5.87
lip	304	1097	1401	7	149	11.99	6.87
mile	620	2455	3075	6	108	13.19	6.67
minute	1321	3752	5073	9	51	13.01	6.93
molecule	85	210	295	1	54	12.75	5.40
month	1611	4052	5663	9	250	13.35	6.80
muscle	566	1015	1581	7	232	12.51	6.73
potato	206	433	639	5	0	13.01	6.73
shoe	249	1168	1417	15	115	12.84	6.87
symptom	109	326	435	3	31	11.77	6.07
twig	44	113	157	2	4	12.64	6.07
weapon	431	1425	1856	2	45	13.00	6.73
Mean	264.54	730.54	995.08	5.62	76.54	12.73	6.38

Key: Fsg: frequency of the singular.
Fpl: frequency of the plural.
Fstem: summed frequency of singular and plural.
Vf: family size.
Nf: family frequency.
Big: geometric mean bigram frequency.
Rating: subjective frequency rating on a 7-point scale.

Table B. *Words used in experiment 1 with a low stem frequency*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
beak	87	33	120	0	0	12.58	6.20
bliss	146	0	146	3	56	13.05	5.13
chrome	45	0	45	4	49	12.97	4.93
cove	37	13	50	0	0	13.25	4.80
crag	41	18	59	3	26	12.46	2.20
denim	50	0	50	1	14	12.72	6.00
east	578	0	578	38	811	13.37	6.80
garlic	115	0	115	0	0	12.11	6.27
lane	635	111	746	2	4	13.46	6.47
magnet	45	7	52	13	231	12.52	6.40
nephew	136	25	161	1	0	12.20	6.73
ocean	436	90	526	5	18	13.17	6.73
plaid	49	8	57	1	0	12.78	5.93
porcelain	108	0	108	0	0	12.82	5.60
pouch	67	18	85	1	0	12.68	5.80
protocol	85	15	100	0	0	12.63	3.80
purpose	1651	704	2355	10	201	12.36	6.40
ramp	78	19	97	5	56	12.12	6.27
robin	207	16	223	2	0	12.63	6.47
skull	305	65	370	2	21	11.53	6.60
spine	204	38	242	6	90	13.14	6.00
surgeon	146	58	204	8	302	12.51	6.47
tomb	248	89	337	3	62	12.42	5.67
verb	42	16	58	20	377	11.67	6.53
wine	1313	108	1421	11	8	13.71	6.60
zeal	86	0	86	4	36	11.46	3.33
Mean	266.92	55.81	322.73	5.50	90.85	12.63	5.77

Key: Fsg: frequency of the singular.
Fpl: frequency of the plural.
Fstem: summed frequency of singular and plural.
Vf: family size.
Nf: family frequency.
Big: geometric mean bigram frequency.
Rating: subjective frequency rating on a 7-point scale.

Appendix B. Experiment 2

Table C. *Words used in experiment 2 with a high family frequency*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
bath	796	39	835	20	985	13.28	7.00
calculus	48	1	49	12	1035	12.12	4.38
cigar	233	81	314	6	1283	12.61	6.69
drama	415	37	452	6	977	12.47	5.44
empire	195	71	266	9	852	12.70	5.38
fame	175	0	175	7	1488	13.02	6.19
fortune	514	162	676	8	2162	13.05	6.12
guilt	653	0	653	6	971	12.02	6.38
intellect	125	11	136	3	1141	13.23	5.25
luck	814	0	814	10	1073	11.80	6.62
noon	290	0	290	8	2259	13.14	6.94
origin	423	356	779	5	2243	13.13	5.19
quart	56	7	63	17	1407	12.12	5.94
stairs	789	0	789	8	1090	13.02	7.00
symbol	420	231	651	7	666	11.58	5.94
terror	491	57	548	9	1121	13.37	6.44
text	507	180	687	5	942	12.84	5.31
virtue	412	251	663	4	927	12.20	5.19
Mean	408.67	82.44	491.11	8.33	1256.78	12.65	5.97

Key: Fsg: frequency of the singular.
Fpl: frequency of the plural.
Fstem: summed frequency of singular and plural.
Vf: family size.
Nf: family frequency.
Big: geometric mean bigram frequency.
Rating: subjective frequency rating on a 7-point scale.

Table D. *Words used in experiment 2 with a low family frequency*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
acorn	10	19	29	1	0	13.18	6.06
apple	315	231	546	9	57	12.94	7.00
bungalow	107	31	138	1	0	12.52	3.69
candle	140	154	294	6	75	13.14	6.94
cloth	810	65	875	20	337	12.89	6.62
coal	746	53	799	20	157	12.64	5.94
fellow	593	196	789	10	131	12.54	4.94
heaven	585	219	804	6	96	13.45	6.75
heir	121	53	174	9	220	13.16	4.69
horror	535	148	683	5	296	13.07	6.56
lamp	381	248	629	19	105	12.10	6.88
magnet	45	7	52	13	231	12.52	6.12
mistress	275	45	320	6	92	13.15	5.38
opera	420	36	456	9	31	13.08	5.75
prophet	178	101	279	5	169	12.74	5.50
tribe	416	275	691	7	276	13.09	5.62
verb	42	16	58	20	377	11.67	6.06
volume	531	127	658	3	43	12.02	5.44
Mean	347.22	112.44	459.67	9.39	149.61	12.77	5.89

Key:
Fsg: frequency of the singular.
Fpl: frequency of the plural.
Fstem: summed frequency of singular and plural.
Vf: family size.
Nf: family frequency.
Big: geometric mean bigram frequency.
Rating: subjective frequency rating on a 7-point scale.

Appendix C. Experiment 3

Table E. *Words used in experiment 3 with a high family size*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
acid	277	107	384	24	50	13.10	5.87
basket	320	108	428	12	81	12.54	6.67
bean	68	320	388	15	45	13.52	6.93
berry	44	142	186	14	336	12.89	6.73
corn	429	5	434	18	113	13.10	6.87
folk	184	97	281	17	104	12.16	5.33
magnet	45	7	52	13	231	12.52	6.27
maid	227	82	309	16	191	12.99	6.33
nerve	257	68	325	16	1329	13.07	5.73
pearl	102	103	205	11	35	12.69	6.67
pole	196	179	375	27	216	13.12	6.40
prude	10	1	11	12	284	12.52	4.80
pudding	198	83	281	11	1	12.29	6.40
quart	56	7	63	17	1407	12.12	5.87
sauce	272	48	320	12	230	12.71	6.60
sword	237	68	305	11	22	12.58	6.33
tube	264	164	428	15	37	13.02	6.33
verb	42	16	58	20	377	11.67	6.20
vice	144	47	191	11	374	12.74	4.40
ware	19	9	28	17	432	13.80	4.40
wool	384	0	384	13	195	12.70	6.53
Mean	179.76	79.10	258.86	15.33	290.00	12.75	6.08

Key:
Fsg: frequency of the singular.
Fpl: frequency of the plural.
Fstem: summed frequency of singular and plural.
Vf: family size.
Nf: family frequency.
Big: geometric mean bigram frequency.
Rating: subjective frequency rating on a 7-point scale.

Table F. *Words used in experiment 3 with a low family size*

Word	Fsg	Fpl	Fstem	*Vf*	*Nf*	Big	Rating
acorn	10	19	29	1	0	13.18	6.20
bard	9	3	12	2	1	12.86	3.07
blade	205	188	393	3	29	13.05	6.27
bullet	229	197	426	3	24	12.95	6.60
circus	257	21	278	0	0	12.34	6.73
cliff	264	174	438	1	6	12.34	6.40
corpse	186	124	310	0	0	12.64	5.80
crag	41	18	59	3	26	12.46	2.67
diary	323	64	387	1	3	12.69	6.27
grove	144	48	192	0	0	12.80	4.73
gulf	265	11	276	1	113	11.90	5.33
jungle	254	48	302	2	9	12.27	6.40
ledge	148	35	183	0	0	12.74	5.80
limb	137	299	436	2	6	11.80	5.47
ratio	285	53	338	0	0	13.10	4.87
realm	177	28	205	0	0	12.53	4.20
sinus	18	34	52	3	32	13.04	5.53
skull	305	65	370	2	21	11.53	6.33
sleeve	169	151	320	3	30	12.92	6.67
sofa	361	37	398	0	0	12.98	6.47
stag	32	32	64	1	0	12.93	3.67
Mean	181.86	78.52	260.38	1.33	14.29	12.62	5.50

Key:
- Fsg: frequency of the singular.
- Fpl: frequency of the plural.
- Fstem: summed frequency of singular and plural.
- *Vf*: family size.
- *Nf*: family frequency.
- Big: geometric mean bigram frequency.
- Rating: subjective frequency rating on a 7-point scale.

Notes

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2. Note that participation as basic form in an inflectional paradigm is not a necessary condition for being a lexeme: English adjectives, for instance, are not inflected, while being lexemes. Similarly, noun plurals, which are also not inflected themselves, can be lexemes.

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