Imageability and distributional typicality measures of nouns and verbs in contemporary English

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Dissociations between noun and verb processing are not uncommon after brain injury; yet, precise psycholinguistic comparisons of nouns and verbs are hampered by the underrepresentation of verbs in published semantic word norms and by the absence of contemporary estimates for part-of-speech usage. We report herein imageability ratings and rating response times (RTs) for 1,197 words previously categorized as pure nouns, pure verbs, or words of balanced noun-verb usage on the basis of the Francis and Kučera (1982) norms. Nouns and verbs differed in rated imageability, and there was a stronger correspondence between imageability rating and RT for nouns than for verbs. For all word types, the image-rating-RT function implied that subjects employed an image generation process to assign ratings. We also report a new measure of noun-verb *typicality* that used the Hyperspace Analog to Language (HAL; Lund & Burgess, 1996) context vectors (derived from a large sample of Usenet text) to compute the mean context distance between each word and all of the *pure* nouns and *pure* verbs. For a subset of the items, the resulting HAL noun-verb difference score was compared with part-of-speech usage in a representative sample of the Usenet corpus. It is concluded that this score can be used to estimate the extent to which a given word occurs in typical noun or verb sentence contexts in informal contemporary English discourse. The item statistics given in Appendix B will enable experimenters to select representative examples of nouns and verbs or to compare typical with atypical nouns (or verbs), while holding constant or covarying rated imageability.

Word recognition is one of the most frequently studied phenomena in cognitive science. We now have available a rich empirical and theoretical base that has fostered inquiry into fundamental mechanisms of lexical access and retrieval (Forster, 1994; Seidenberg & McClelland, 1989; Stone & Van Orden, 1993). However, our knowledge of such mechanisms is heavily skewed toward the representation and processing of nouns, since most experiments either utilize nouns exclusively or select items without regard to part of speech.

Neuropsychological investigations, in contrast, document a powerful influence of part of speech on the processing of single words. Dissociations in the comprehension and production of open class (nouns, verbs, adjectives) and closed class (articles, auxiliaries, prepositions) items in aphasic patients are well known (Caplan, 1987). More recently, patients with selective deficits in verb retrieval, with sparing of nouns, have been the focus of intense investigation (Caramazza & Hillis, 1991; Daniele, Guistoli, Silveri, Colosimo, & Gainotti, 1994); the reverse dissociation (greater impairment of noun than of verb

processing) has also been reported (Daniele et al., 1994; Zingeser & Berndt, 1990). Neuroimaging (Warburton et al., 1996) and electrophysiological (Koenig & Lehmann, 1996; Molfese, Burger-Judisch, Gill, Golinkoff, & Hirsch-Pasek, 1996) studies also support the idea of a neural dissociation between noun and verb processing mechanisms. Such data strongly imply that grammatical class is an important factor in the comprehension and production of individual words and highlight the need for targeted investigation of noun versus verb processing in neurologically intact individuals.

However, precise experimental contrasts of nouns and verbs are hampered by two methodological constraints on stimulus selection. First, although the noun-verb distinction is primarily a grammatical one, nouns and verbs, even if matched for frequency of occurrence and length, are likely to differ on semantic dimensions, such as imageability, that are known to influence lexical processing (Balota, Ferraro, & Connor, 1991). A second methodological challenge for noun-verb experiments arises from the fluid nature of grammatical class assignment in English. Whereas some words are used exclusively as nouns or verbs, others (e.g., *sleep*) can represent either class, even without the addition of a derivational affix. Thus, this categorical contrast might be better conceptualized as a *nouniness* or *verbiness* continuum, which demands a measure that accurately reflects the extent to which a word is used in noun and verb contexts. In this report, we present (1) imageability ratings and rating response times (RTs) for a large set of words that includes a high proportion of

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verbs and (2) two new, continuous measures of noun-verb distributional typicality that reflect statistical regularities present in contemporary discourse contexts. We begin by briefly discussing earlier work that is relevant to each measure.

Imageability Ratings

In order to be certain that noun-verb processing differences reflect grammatical (rather than partially correlated semantic) influences, it is necessary to match words for imageability (and/or other semantic dimensions). Unfortunately, verbs are notably underrepresented in most published semantic word norms (Paivio, Yuille, & Madigan, 1968; Toglia & Battig, 1978). Imageability ratings have been reported for the Toronto Word Pool, which includes verbs, adjectives, and adverbs, in addition to nouns (Friendly, Franklin, Hoffman, & Rubin, 1982). However, since single-syllable words were not included in this corpus, no ratings are available for many of the most common verbs in English (e.g., *see, think, sit, eat, grow*, etc.). To address this problem, we report here imageability ratings for a large sample of nouns and verbs.

We also report the mean RTs for each word rating, in order to provide an additional index of ease of image generation. To our knowledge, there are no prior reports of RT measures for normative word-rating tasks. Word ratings are considered to be metalinguistic *off-line* tasks, and little is known about the *on-line* processes individuals use to assign such ratings. In the case of imageability ratings, it is presumed that the ratings reflect ease of mental image generation. If this is so, words receiving high imagery ratings should yield the fastest RTs. Furthermore, those receiving the lowest imagery ratings should produce the slowest responses, reflecting a difficult and time-consuming attempt to generate an image for an unimageable concept. Thus, RTs should decrease in a roughly linear manner as imageability ratings increase.

However, it is also possible that such ratings can be derived without an actual image generation attempt. Perhaps each word's semantic features are initially examined for the frequency of sensory-motor attributes. If many such attributes are found, a rapid high imagery rating could be given, whereas a low imagery rating could be quickly assigned if few or no such attributes are detected. But if a moderate number of sensory-motor attributes are found, a more time-consuming additional process would be undertaken, either to examine the nature of the features themselves or, perhaps, to attempt to generate an image. This account is consistent with feature comparison models that were developed to account for RT data in semantic verification tasks (Smith, Shoben, & Rips, 1974). If imagery ratings reflect a similar feature-based process, a curvilinear relation between ratings and RTs should be observed (with slowest responses for the intermediate ratings). Contrasting the RT-rating relationship for nouns and verbs will additionally suggest whether there are form class differences in how imageability decisions are made.

Noun-Verb Usage Metrics

To date, frequency data have been used to determine the extent to which words have predominant noun or verb usages. The Francis and Kučera (1982) norms, which tally frequency by part of speech (on the basis of human judgments of the word's role in published sentence contexts), have been used for this purpose (e.g., Berndt, Mitchum, Haendiges, & Sandson, 1997; Zingeser & Berndt, 1990). Although useful, these norms are now rather dated, and the corpus on which they are based is relatively small and may underrepresent lower frequency items (see Burgess & Livesay, 1998). Furthermore, since only formal published texts (i.e., books, periodicals, newspapers) were sampled, the Francis and Kučera data will not reflect the greater flexibility in part-of-speech usage that occurs in more informal language contexts. Thus, it is likely that these conservative norms underestimate the extent to which many words can be used interchangeably as nouns and verbs in contemporary discourse, thereby limiting their utility as an index of psycholinguistic experience.

Friendly et al. (1982) took a different approach to estimating the frequency of grammatical class usage. Psychology undergraduates ($N = 120$) were given a list of words and, for each, were instructed to "mentally generate a sentence containing that item" and then to record the part of speech that the stimulus item represented in their sentence. Friendly et al. reported the mean percentage of noun usage for each word as derived from these data. Although this measure can reflect informal usages, there are several problems with this approach. First, data were only collected for words having dictionary definitions for more than one part of speech. Thus, there is no way to determine whether words that lexicographers have determined are unambiguous nouns or verbs are in fact used unambiguously in current discourse. Second, since the participants did not record the sentences they generated, there was no way to check the accuracy of their part-of-speech judgments. Indeed, it is possible that some participants may not have actually generated sentences for all the items but, rather, may have made part-of-speech judgments based on viewing the word in isolation. Such judgments might then reflect students' ideas of what the part of speech is *supposed to be*, rather than how they actually use the word themselves. Third, even if the participants' judgments accurately reflected the sentences they generated, the resulting estimate is based on only 120 occurrences for each word, and it is unknown how this relates to the part-of-speech distribution actually encountered in the individual's language experience. Finally, because only the percentage of noun usage is reported, one cannot determine the frequency of verbs (or other parts of speech) generated in this sample.

In sum, although the Friendly et al. (1982) sentence generation task represents an innovative attempt to gather part-of-speech data without relying on the analysis of formal texts, it also highlights the difficulties of acquiring a representative sample of less formalized language and the

limitations of relying on human decisions for each token in the sample. Ideally, to index noun-verb usage, one would like to have available a very large language sample that includes informal (i.e., conversational) exchanges, with part-of-speech usages estimated without requiring time-consuming judgments. In this report, we utilize the Hyperspace Analog to Language (HAL) model (see Burgess, 1998) to computationally derive noun and verb context distances. As will be described in more detail below, this measure allows us to identify words that resemble nouns more than verbs in their distributional contexts (and vice versa). The noun-verb distance difference (NVDD) scores we report herein can be used to estimate the extent to which a word is used in noun versus verb contexts without relying on human judgments. Furthermore, because the HAL context vectors were derived from the Usenet corpus (which includes over 300 million word occurrences gathered from Usenet newgroups), this measure will reflect more contemporary conversational exchanges (Burgess, 1998; Lund & Burgess, 1996).

Imageability ratings, RTs, and HAL NVDD scores were collected for 1,197 three- to six-letter words. The words were those that would be considered to be pure nouns, pure verbs, or balanced noun-verbs on the basis of the Francis and Kučera (1982) norms, since these represent word classes most likely to be used in psycholinguistic investigations. We examined the relation between imageability ratings and RTs and the suitability of the HAL measures for assessing the degree to which a word occurs in noun versus verb contexts. The normative data reported here should prove useful for future psycho- and neurolinguistic investigations of noun-verb processing differences.

METHOD

Imageability Ratings

Participants. The participants were 89 native English-speaking University of California, Riverside students (49 female; mean age = 20.7 years). Each received payment (\$5/h) or course credit for participating. Twenty-two of the participants were tested in more than one session (21 received two sessions, 1 received three sessions), receiving a different stimulus list on each test day. An average of 8 days elapsed between test sessions.

Materials. All 1,197 stimulus words (three, four, five, or six letters in length) were taken from Francis and Kučera (1982). Pure verbs ($n = 427$) had verb frequencies of two or greater but no listings for any other part of speech. The resulting set of verbs represented nearly 50% of the pure verbs of the target length given in Francis and Kučera (verbs that the authors deemed obscure or unlikely to be known to the average college student were excluded). A set of 555 pure nouns was also selected, including words having noun frequencies of two or greater but no listings for any other part of speech. Since the Francis and Kučera norms contained over 3,200 such nouns, the authors selected a subset to span a range of frequencies and intuitive imageabilities. Finally, 215 balanced noun-verbs were selected. These represented a nearly exhaustive list of words having similar frequencies for noun and verb usages (but none for any other part of speech). In this study, we used the Francis and Kučera frequencies that were summed over all the inflected forms of a given word. For each word, separate log frequencies were calculated for noun and for verb use; items with noun-verb log fre-

quency differences of ± 0.20 or less were considered to be relatively balanced in noun-verb usage (mean noun-verb difference of selected items = 0.005).

Four experimental lists were created, each consisting of a unique set of 300 items (134–142 nouns, 105–113 verbs, 53–55 balanced words). Although it was our intention to gather data for 1,200 unique items, an error in stimulus list construction led to the elimination of three items from the final sample. A practice list consisting of another 10 items was also constructed.

Apparatus and Procedure. Power Macintosh 7500/100 computers (AppleVision 1710 Display) were used for stimulus presentation and recording of responses. The participants used the numeric keypad on the computer's keyboard to register their imageability ratings. The Psyscope software package was used to control experimental events (Cohen, MacWhinney, Flatt, & Provost, 1993).

The participants were seated in individual testing rooms, approximately 57 cm from the computer display. They then received oral instructions from the experimenter and read a briefer set of instructions on the computer screen (the latter is provided in Appendix A). Imageability instructions were very similar to those employed by Toggia and Battig (1978), using a 7-point scale (1 = *not at all imageable*; 7 = *highly imageable*). The instructions emphasized the importance of using the entire range of ratings. The participants were also informed that they should try to create a mental image of the word, but not to spend a lot of time thinking about their response, since their "first impressions" were of greatest interest. They were told to register their rating with the numeric keypad and to press the keypad Enter key after typing their rating. The participants rested their fingers over the keypad in whatever position they felt was most comfortable.

The rating scale appeared at the top of the computer screen for each trial (see Appendix A). The stimulus word appeared in lower-case letters (Geneva Bold 18) in the center of the screen and remained visible until the participant responded. The message "Rating = ____" also appeared four lines below the stimulus word; when a number was typed on the keypad, it appeared just after this message. RT was calculated as the time from the onset of the stimulus word until the Enter key was pressed. The screen was cleared once the Enter key was pressed, and the next trial was initiated after a 500-msec interval.

Each session began with the set of 10 practice trials, followed by three blocks of 100 trials each. Short rest breaks were given after each trial block.

Each participant viewed one experimental list per session. Order of word presentation was independently randomized for each participant. Each of the four experimental lists was seen by 28 participants (14 females, 14 males).

HAL Measures

Before describing our method for determining noun and verb context distances, a brief review of how words are represented in the HAL model is in order (for more detailed accounts, see Burgess, 1998; Burgess, Livesay, & Lund, 1998; Lund & Burgess, 1996). The HAL model employs the Usenet corpus to derive a matrix of word co-occurrence values via a 10-word window that moves across the text, so that lexical co-occurrences are weighted by the distances between words within the window. Using the 70,000 most frequently occurring items in the corpus, the model constructs a 70×70 K co-occurrence matrix to represent co-occurrence (i.e., context) vectors for each of the 70,000 items. These context vectors can be thought of as the coordinates of points in high-dimensional space, where each word is represented by a single point. Words that occur in similar contexts will have similar vector representations and, thus, will occupy nearby locations in high-dimensional space. Burgess and colleagues have demonstrated that the distance between such word representations (henceforth referred to as the *con-*

text distance) encodes both semantic and grammatical category information (Burgess & Lund, 1997).

In particular, the HAL co-occurrence vectors are quite sensitive to grammatical class. Multidimensional scaling of vector representations produces clusters of items that segregate by part of speech, reflecting the fact that words from the same grammatical category tend to occur in similar sentential contexts (Burgess, 1998; Burgess & Lund, 1997). Interestingly, Burgess and Lund found that words that could be used as both nouns and verbs tended to occupy locations between the noun and the verb clusters. But although context distances in the HAL model clearly represent grammatical class information, the model cannot explicitly tag words for part of speech. This led us to devise a similarity-based measure of noun and verb classification that made use of grammatical class information encoded in HAL's context distances.

The set of 555 pure nouns and 427 pure verbs, as classified by the Francis and Kučera norms were used to derive noun and verb context distances as follows. First, we computed the context distances between each of our 1,197 words and each of the Francis and Kučera pure nouns and pure verbs. Next, a HAL noun distance score was created for each word by averaging the distances between that word and all of the pure nouns. Verb distance scores were computed by averaging distances between each word and all of the pure verbs. This resulted in HAL noun distance and verb distance scores for each item that should reflect how contextually similar that word is to a relatively unambiguous set of nouns and verbs, respectively. However, because context distances encode a variety of information (including semantic dimensions and word frequency; see Lund & Burgess, 1998), one cannot directly compare noun (or verb) distances across two different words. Hence we constructed a NVDD score (the difference between a word's noun and verb distances) to index the extent to which a given word was more typical in its contextual distribution to nouns or verbs. This difference score should *subtract out* other information about the word that is carried in the context vectors, leaving an estimate of noun versus verb use that can be compared across different words. On this measure, words that mainly occur in contexts that typify nouns will have a negative difference score, whereas words that mainly occur in contexts that typify verbs will have a positive difference score. We contend that this difference score indexes the distributional typicality of a word's use as a noun or a verb.

An *inflected* difference score was also computed as follows. First, all the possible inflected forms (both regular and irregular) were generated for each of the 1,197 words. Next, noun and verb distances were calculated for each form as described above. That is, the distance between each form and each of the uninflected nouns and verbs was computed. Because some inflected forms are ambiguous in noun-verb classification (e.g., *building*), we computed inflected-to-uninflected distances, rather than inflected-to-inflected distances. These distances were each weighted by the Usenet frequency for each form and then averaged across all forms of the word (inflected and uninflected). For example, the inflected verb (or noun) distances for *daze* would be the average of the frequency-weighted verb (or noun) distances computed for the forms *daze*, *dazed*, *dazing*, and *dazes*. Thus, the final inflected difference scores

should indicate the extent to which a word, *across all its possible inflected forms*, typifies the contextual distribution of nouns or verbs.

To validate and further explore the HAL noun-verb measure, representative contexts from the Usenet corpus were sampled for a subset of 50 uninflected words. These words were selected to span the range of uninflected noun-verb difference scores for all three Francis-Kučera word classes, including both words for which the HAL measure agreed with the Francis-Kučera classification, and words for which these two indices disagreed. The sampling procedure for each word was as follows. First, all instances of the target word were identified in the Usenet corpus, and the context was delineated. The context for each instance was operationally defined as any text between two terminal punctuation marks (e.g., “.” “!” “?”) that included the target word. The computer then sampled every *N*th context, where *N* was defined as the total number of contexts divided by 100. The first author coded each instance of the target word for part of speech. If the target word occurred more than once in a given context, only the first occurrence was coded. Any unusual uses for the target word (e.g., abbreviations, idioms) were noted.

A similar procedure was used to sample inflected contexts for 28 words. Here, all the contexts containing a given word or any of its inflected variants were identified, and the procedure described above was employed to select a representative sample of contexts that would encompass inflected as well as uninflected forms of a given word. These contexts were coded to provide an assessment of the inflected noun-verb difference measure.

Finally, frequencies for all 1,197 items were estimated from the Usenet corpus. Frequencies were summed across all inflected forms for each word, to better correspond to the summed Francis-Kučera frequencies employed to classify words as nouns, verbs, or balanced forms.

RESULTS AND DISCUSSION

The mean imageability rating and rating RT for each word are listed in Appendix B, along with the log summed Usenet frequency and the HAL context distance measures. Words with missing noun and verb distance values in Appendix B are not represented in the current HAL matrix. The means for each of our primary measures are given by Francis-Kučera word class in Table 1. The correlations among these measures are provided in Table 2.

Imageability Ratings

Comparison with previous norms. A subset of our words (216 nouns, 80 verbs, 79 balanced) were also listed in the Toglia and Battig (1978) norms. There was good correspondence in imageability ratings between the norms ($r = .88$) for these overlapping items, which was stronger for the Francis-Kučera nouns ($r = .88$) and balanced forms ($r = .88$) than for the verbs ($r = .75$).

Table 1
Means (and Standard Deviations) of Imageability Ratings, Rating Reaction Times (RTs),
Usenet Summed Log Frequency, and HAL Noun-Verb Distance Difference Scores,
According to Word Class as Determined by the Francis and Kučera (1982) Norms

Francis and Kučera Word Class	Imageability Rating		Rating RT		Usenet Log Freq		N-V Diff		Inflected N-V Diff	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Pure noun	5.30	1.46	2,305	526	3.77	0.73	-100	36	-90	34
Balanced noun-verb	5.11	1.57	2,423	462	3.80	0.74	-37	57	-34	44
Pure verb	3.96	1.74	2,686	412	3.71	0.85	105	59	33	50

Table 2
Correlation Matrix for Word Measures

	Image Rating	Image RT	FK Log Freq	Usenet Log Freq	HAL Noun Distance	HAL Verb Distance	NVDD	HAL Infl Noun Distance	HAL Infl Verb Distance	Inflected NVDD
Image Rating	1.00									
Image RT	-.68	1.00								
FK Log Frequency	-.02	-.02	1.00							
Usenet Log Freq	.06	.03	.81	1.00						
HAL Noun Distance	-.36	.20	-.28	-.33	1.00					
HAL Verb Distance	-.20	-.20	-.39	-.39	.34	1.00				
NVDD	-.48	.38	.11	.07	.54	-.61	1.00			
HAL Inflected Noun Distance	-.33	.17	-.36	-.42	.92	.39	.42	1.00		
HAL Inflected Verb Distance	.09	-.13	-.43	-.45	.47	.91	-.42	.60	1.00	
Inflected NVDD	-.47	.38	.09	.05	.48	-.59	.93	.43	-.47	1.00

Note—All correlations in bold type are significant at .01 or better. RT, response time; FK, Francis–Kučera; NVDD, noun–verb distance difference.

Likewise, there was an overall correlation of .92 between our imageability ratings and those reported in the Toronto norms of Friendly et al. (1982) for 192 overlapping items (87 nouns, 87 verbs, 18 balanced). The correlations were stronger for nouns ($r = .94$) and balanced forms ($r = .92$) than for verbs ($r = .71$).

Thus, there is a good correspondence between the present imageability ratings and previously published norms, despite substantial differences in norming procedures (e.g., computerized vs. paper-and-pencil tasks) and populations. Words that are frequently used as nouns (pure

nouns and balanced forms) show better agreement across norms than do the pure verbs. This may indicate greater variability in how verb, as compared with noun, concepts are imaged, consistent with the standard deviations, as reported in Table 1.

Ratings by frequency and Francis–Kučera grammatical class. As is noted in Table 2, there was no correlation of imageability rating and word frequency. This indicates that the participants' imageability ratings were not influenced in any regular way by differential familiarity with the stimulus words.

Figure 1. Proportion of imageability ratings given for nouns, balanced forms, and verbs (according to Francis & Kučera, 1982, classification).

In general, nouns and balanced words were rated as more imageable than verbs. Figure 1 displays the distribution of imageability ratings for each Francis–Kučera word class. It is clear that the participants tended to reserve their highest imageability ratings for words with noun usages and that most nouns were rated as moderately to highly imageable. In contrast, pure verbs elicited much lower imageability ratings, but verb ratings were somewhat more evenly spread out over the entire range, as compared with noun ratings. The distribution of imageability ratings for the balanced forms was intermediate between these two patterns.

Imageability response times. There was no correlation between word frequency and imagery rating RTs (see Table 2). Since word frequency is a reliable predictor of response speed across a range of word recognition tasks (Balota & Chumbley, 1984; Monsell, Doyle, & Haggard, 1989), the absence of a correlation here is consistent with the idea that the RTs index the speed of postrecognition processes involved in assessing imageability, rather than word recognition latencies. This interpretation is supported by the overall negative correlation of these two measures ($r = -.68$): In general, the fastest imageability ratings were given to words rated most highly imageable. However, this association was much stronger for the pure nouns ($r = -.75$) and balanced forms ($r = -.66$) than for the pure verbs ($r = -.37$). The scatter plots for each Francis–Kučera word class (see Figure 2) indicate that, especially for nouns and balanced forms, RTs increase as imagery ratings decrease up to the approximate midpoint of the rating scale and, thereafter, level off. Regression analyses with models for linear, quadratic, and cubic relations (Cohen & Cohen, 1983) verified this departure from a linear trend. There was a significant linear trend for all Francis–Kučera word types [nouns, $F(1,554) = 791.8, p < .0001, r^2 = .59$; balanced, $F(1,213) = 177.5, p < .0001, r^2 = .45$; verbs, $F(1,425) = 70.6, p < .0001, r^2 = .14$]. The quadratic trend was also significant for all three word classes [nouns, $F(2,553) = 567.4, p < .0001, r^2 = .67$; balanced, $F(2,212) = 107.2, p < .0001, r^2 = .50$; verbs, $F(2,424) = 47.3, p < .001, r^2 = .18$]. The cubic trend was not reliable for any word type.

These data are consistent with reliance on an image generation process, but one with an internally imposed response deadline. That is, within a certain time period, participants may attempt to generate an image and select an appropriate imageability rating as soon as an image becomes available. This would produce an image rating that corresponds to the ease and speed with which an image can be generated. However, the RT leveling for low image ratings implies that, if after some time (~3 sec?), no image has been generated, no further image processing is attempted, and a low rating (1–3) is given. The data for the pure verbs, although qualitatively similar to those for nouns and balanced forms, show a much less consistent relation between image rating and RT (low r^2 values for both linear and quadratic trends). This may indicate a less

consistent imaging process for verbal than for nominal concepts.

It should be noted, however, that our RT measures (amount of time to type the rating and hit the Enter key) were rather insensitive. It is likely that this increased both the mean and the variability of RTs. A better method for future studies would be to have participants speak aloud their ratings and to record vocal response latencies.

HAL Noun–Verb Measures

Our consideration of the HAL findings will be organized around four issues: (1) similarities and differences in noun–verb classification between Francis and Kučera (1982) and HAL; (2) comparison of HAL noun–verb difference scores to human coding of part-of-speech usages for a representative sampling of Usenet contexts; (3) comparison of the uninflected and the inflected noun–verb difference indices; and (4) the relation of the HAL noun–verb difference measures to imageability and frequency.

Noun–verb classification: Francis–Kučera versus HAL. As is indicated in Figures 3 and 4, both the uninflected and the inflected HAL NVDD measures produced a good separation of the word types as determined by the Francis and Kučera (1982) norms, thereby providing some validation of the HAL measures. The Francis–Kučera pure nouns tended to have negative difference scores and the pure verbs tended to have positive difference scores, whereas balanced words had a more intermediate distribution (although somewhat more noun- than verblike).

However, this global consistency in classification is tempered by a nontrivial number of items for which the two measures fail to agree. Although, by definition, all *pure* forms had no usages for other parts of speech in the Francis–Kučera corpus, our noun–verb index suggests

Table 3
Examples of Words Classified Consistently (Bold) and Inconsistently by Francis and Kučera (1982) and the HAL Noun–Verb Difference Measure

Francis–Kučera Classification	HAL Noun–Verb Classification		
	Verb Typical	Noun and Verb Atypical	Noun Typical
Pure verb	defend	holler	daze
	delve	munch	ebb
	devote	pour	mar
	refute	revere	nag
	prove	shrink	wed
	spend	swap	zip
Balanced noun–verb	change	cure	crease
	gain	favor	lounge
	pout	punt	ring
	taunt	rhyme	shield
	trust	slouch	slug
	work	taint	tower
Pure noun	access	bout	comet
		idiot	river
		liar	sea
		niece	skull
		snail	sword
		wit	vessel

Figure 2. Scatter plots of imageability rating response time by mean imageability rating for nouns, balanced forms, and verbs (according to Francis & Kučera, 1982, classification).

that some of these forms are much more nounlike (or verblike) than others. And it would appear to be better (from the perspective of the HAL model) to view a number of the putatively balanced words as rather typical nouns or verbs. Table 3 provides some examples of words classified consistently and inconsistently by both schemes. It

should be noted, however, that because the HAL noun-verb difference score is a continuous measure, there is no point on the scale that can be identified as a categorical boundary between word classes.

There are a number of factors that could contribute to these discrepancies. (1) The Francis-Kučera classifica-

Figure 3. Proportion of noun–verb distance difference (NVDD) scores for words classified by Francis and Kučera (1982) as nouns, balanced forms, and verbs.

tion was based on direct counts of part-of-speech usages by human judges, whereas the HAL measures are based on computed similarity across context distances. We will consider the possibility that our difference score measures something other than (or in addition to) simple frequency of part-of-speech use. (2) The Francis–Kučera corpus was compiled from works published in 1961, 34 years prior to the assembly of the Usenet corpus (Burgess & Livesay, 1998), and thus, some of the differences may reflect historical or generational changes in language use. (3) The Francis–Kučera corpus is based on formal texts, whereas the Usenet corpus includes much more informal and conversational exchanges. Thus, stylistic differences in language use would also be expected to contribute to the differing results. However, before evaluating such possibilities, we need to examine the extent to which the HAL difference measures reflect actual part-of-speech usages within the Usenet corpus.

What does the HAL noun–verb difference index?

Recall that our difference score measures the extent to which a word is more similar to a noun or a verb in the linguistic contexts in which it occurs. Words that nearly always occur in contexts that typify nouns should have

large negative difference scores, whereas words that regularly occur in contexts that typify verbs should have large positive difference scores. Words with difference scores closer to zero are not likely to be typical of either nouns or verbs in the contexts in which they occur. If we are correct that this measure is an index of noun–verb distributional typicality, it should not *always* correspond to a simple count of the part-of-speech occurrences in the corpus (although we would expect a reasonably good correspondence among these measures). For example, one could imagine two words that are nearly always used as nouns, as based on a linguistic analysis of their sentence contexts, but which differ in the HAL measure because one occurs predominantly in contexts that typify other nouns, whereas the other occurs only in contexts that are very atypical of other nouns. If our noun–verb difference is best viewed as a typicality measure, this could account for some of the varying noun–verb classifications between HAL and Francis and Kučera (1982).

To determine the extent to which the difference score corresponds to noun versus verb usages in the Usenet corpus, consider the part-of-speech coding judgments for our sample of 50 words. As was described earlier, these

Figure 4. Proportion of inflected noun-verb distance difference (NVDD) scores for words classified by Francis and Kučera (1982) as nouns, balanced forms, and verbs.

words were selected to span a range of noun-verb difference scores and to include multiple examples of words from the three Francis-Kučera classes. Approximately half of the sample words had difference scores that "agreed with" the Francis-Kučera classification (e.g., *sword*, *punish*), whereas the others were chosen because their difference scores did not neatly correspond to the Francis-Kučera classification (e.g., *zip*, *crease*). Appendix C contains the part-of-speech data as classified by the first author for all 50 sample words and a description of the coding procedure.

Five categories (noun, adjective, preposition, adverb, verb) were needed to capture all the part-of-speech occurrences in the sample contexts, and the percentage of occurrence within each category for each sample word is given in Appendix C (3% of the sample contexts did not provide sufficient information to code part of speech, indicated by "?"). In general, words with large negative difference scores were mainly used as nouns in the Usenet corpus, and those with large positive difference scores were mainly used as verbs. To better compare the percentage of noun versus verb usage to HAL's noun-verb difference measure, for each sample word, the percent-

age of usages classified as nouns was subtracted from the percentage classified as verbs (hence, negative differences will correspond to predominant noun uses). The correlation of the latter measure with the HAL noun-verb difference was +.90, indicating that over 80% of the variance in the difference scores could be accounted for by the extent to which the word was used as a noun or a verb in the Usenet corpus. This is an impressive correspondence, considering that approximately half of the sample words were chosen so as to be "oddities" from the perspective of the Francis and Kučera norms. And further inspection of Appendix C provides numerous examples of words for which the difference score, although discrepant from the Francis-Kučera classification, is an accurate reflection of noun versus verb usage in the Usenet corpus. For example, several words that were considered balanced on the basis of the Francis and Kučera norms were, in fact, predominantly used as nouns (e.g., *crease*, *arch*, *slug*) or verbs (e.g., *work*, *gain*, *change*) in the Usenet corpus and had corresponding typical noun or typical verb difference scores. Some of the more extreme examples of discrepant classifications appear to reflect stylistic or historical differences in part-of-speech usage

(e.g., *daze*, *access*, *swap*) across the two corpora. In other cases, discrepancies could be traced to three-letter words that were used much more frequently as abbreviations for words of another part of speech [e.g., *wed(nesday)*, *mar(ch)*] or entire phrases (*cod* vs. *c.o.d.*; note that, to be considered an instance of *cod*, the abbreviation “c.o.d.” had to have been written as “cod” or “COD” in the corpus, since terminal punctuation marks signaled the end of a sentence context).

However, the HAL difference score did not always mirror the proportion of noun–verb occurrences in the corpus, and a consideration of the most extreme example among the sample words can illuminate why this sometimes occurred. The word *extent* is a pure noun according to the Francis–Kučera count and, indeed, is used as a noun in 99% of the sample Usenet contexts; yet, the noun–verb difference score (+18) would appear to indicate that it does not occur in contexts typical of nouns or of verbs. In fact, over three quarters of this word’s noun usages in the Usenet sample occurred within the expression to *X extent* (e.g., *to a large extent*, *to some extent*, *to the extent that*, and so on). Note that, although *extent* functions as a noun within such phrases, it is never followed by a verb, and the phrase itself is generally used parenthetically. Because the majority of the occurrences of the word *extent* were within this single idiomatic expression, it is not *typical* of nouns in its contextual distribution. Hence, it is unlikely to be close to most nouns or verbs in high-dimensional context space, and the noun–verb difference score appears to accurately reflect this fact.

Other words in the context sample also sometimes occurred within idiomatic or otherwise syntactically restricted expressions. The majority (89%) of the noun usages of *slouch* occurred within the expression *X is no slouch*. Similarly, although *idiot* was only used as a noun, the expression *X is an idiot* accounted for 25% of its occurrences, and it was used parenthetically as an insult (e.g., *idiot*, *the fans made the ballplayers rich*) in another 15% of the contexts. The word *care* is used in the corpus as a verb nearly as often as it is used as a noun, but 30% of its noun uses occurred as *take care (of)*. In each of these cases, the HAL difference score is much less noun-like than one would expect on the basis of a simple count of noun versus verb occurrences (see Appendix C). Since nouns that occur in an unusually restricted set of contexts will be less similar to most other nouns in their syntactic distribution, they are in this sense atypical nouns, and the noun–verb difference score seems to reflect this.

What about words that are neither nouns nor verbs? According to our analysis, such words should not appear in typical noun or verb contexts, and thus, difference scores close to zero would be expected. Although it was our intent to investigate only words with exclusive noun and/or verb uses, Appendix C contains two counterexamples. In only 12% of the contexts was *bout* used as a noun (e.g., *his bout with chicken pox*); fully 86% of the occurrences were reduced forms of the word *about* (e.g., *tell me bout*

it; *bout time they started this newsgroup*) and, hence, prepositions or adverbs. Likewise, although *erect* was originally coded as a pure verb, it had an adjective frequency of 8 (verb frequency = 26) in Francis and Kučera (1982) that was overlooked when selecting our original set of pure verbs; yet, it only appeared as a verb in 9% of the sample Usenet contexts. Nearly all other occurrences represented adjective uses. The difference scores for *bout* (−9) and *erect* (+3) indicate that (from the perspective of the HAL model) such forms are not typical in their contextual distributions to either nouns or verbs. An exhaustive rechecking of the Francis and Kučera norms for all 1,197 stimulus words uncovered three other words with some adjective uses (*ski*, *absent*, *worth*)—the latter two items having predominant adjective uses and atypical difference scores (see Appendix B).

On the basis of the previous analysis, it can be inferred that a noun–verb difference score near zero should not be used as the sole criterion to identify words that are balanced in their use as nouns and verbs. Although Table 3 and Appendix C provide some examples of words with near-zero difference scores and approximately equal proportions of noun and verb uses (*hush*, *punt*), this is not always the case. As we have seen, noun–verb difference scores close to zero are more indicative of words that are neither typical nouns nor typical verbs.

In sum, an examination of the relation between the noun–verb difference score and judgments of part-of-speech use in the Usenet corpus suggests a close correspondence. Words with very restricted syntactic distributions, even if exclusively used as a single part of speech, will nevertheless be contextually dissimilar to other words from that class, and the noun–verb difference is sensitive to this, as well as to actual part-of-speech usage. Thus, some discrepancies between the Francis–Kučera and the HAL noun–verb estimates may be traceable to the sensitivity of the latter to the typicality of a word’s contextual distribution. In other cases, it was clear that disparities were attributable to generational and/or stylistic differences between the two corpora. The more informal style of discourse characteristic of the Usenet corpus does appear to engender more flexibility in part-of-speech usage, and access to such contemporary information is a valuable resource.

Inflected noun–verb differences. As might be expected, overall, there was a strong correlation ($r = .93$) between uninflected and inflected difference scores. This association was stronger for Francis–Kučera nouns ($r = .94$) and balanced words ($r = .95$) than for verbs ($r = .68$). As is indicated by the means in Table 1 and by a comparison across Figures 3 and 4, there is greater overlap in the Francis–Kučera noun and verb distributions when inflected forms are included. This is primarily due to a shift away from high typical verb scores for inflected verbs. In contrast, the distributions for nouns and balanced forms are not altered when inflected forms are included.

A consideration of English inflectional morphology suggests why words with verb usages may become more

ambiguous in grammatical class when inflected forms are included. The primary noun inflections, plural and possessive, will only rarely produce noun–verb ambiguities when added to a noun (e.g., *oceans* and *ocean's* are just as nounlike as *ocean*). However, some verb inflections—most notably, the progressive and the past tense—will produce forms that can also be used as nouns or adjectives (e.g., *Everyone remembered the drowning; the drowned rat*). Because the HAL model does not explicitly tag words for part of speech, all the contexts in which the inflected verb forms (*drowning*, *drowns*, *drowned*, as well as *drown*) occur will be included in the computation of noun and verb distances for such words. Thus, it is most likely that the less verblike inflected difference scores accurately reflect the wider contextual distribution of verbally inflected than of nominally inflected forms. Yet, despite this, the inflected index still provides a good separation of Francis–Kučera nouns and verbs, with balanced words showing an intermediate distribution (see Figure 4).

Appendix D contains the part of speech classification for the 28 words for which inflected contexts were sampled and a description of the coding procedure. Approximately half of the sample words were selected so as to have inflected difference scores that were discrepant with the Francis–Kučera classification. For each word, contexts were sampled (as described previously) for each inflected form of the word (the uninflected form was included as well). The percentages listed in Appendix D reflect the part-of-speech usages when averaged across all forms of the word. Six categories (noun, adjective, adjective/verb, noun–verb, interjection, verb) were needed to capture all the part-of-speech occurrences in the sample contexts.

Not surprisingly, when inflected forms are included, adjective usages for verbs and balanced forms are frequently noted. As was done for the uninflected difference measure, the percentage of noun uses for the sample words was subtracted from the percentage of verb uses and correlated with the inflected difference scores ($r = +.70$). An inspection of Appendix D indicates that several Francis–Kučera verbs (*elapse*, *tatter*, *bind*) had adjective usages exceeding 25%, usually coupled with relatively low noun usages, but negative inflected difference scores (indicating greater distributional similarity to nouns than to verbs). This suggested that verbs used as adjectives (e.g., *tattered dress*) occurred in contexts more similar to those of nouns than to those of verbs (noun–noun combinations are not infrequent—e.g., *house dress*). Indeed, when the proportion of adjective and noun usages was combined and subtracted from the proportion of verb usages, the correlation with inflected difference scores increased to .79.

As was found for uninflected contexts, words with restricted sentential distributions tended to have atypical inflected difference scores, despite a very high proportion of use as a single part of speech. For example, *apathy* and *deceit* are nearly always used as nouns but have

inflected difference scores (−27 and −14, respectively), indicating low noun typicality. However, unlike typical nouns, in the majority of the sample contexts, these words had no preceding modifiers (e.g., *against a tide of apathy*; *deceit and outright disinformation*). Because nouns generally take a variety of preceding modifiers, those that occur with few or no modifiers will not share as many contexts with other nouns and, in that sense, are not typical nouns.

In sum, the inflected noun–verb difference provides a reasonable measure of the extent to which a word, across all its inflected forms, is used primarily as a noun or a verb. As with the uninflected measure, this is best considered as an index of distributional typicality, rather than as an estimate of the actual part-of-speech usage in the corpus. The greater part-of-speech variability for inflected forms is appropriately reflected in the greater overlap of the Francis–Kučera word classes for the inflected, as compared with the uninflected, noun–verb difference (compare Figures 3 and 4). The inflected measure would be preferable whenever an experimenter is interested in the distributional behavior of a word that takes into account inflected, as well as uninflected, occurrences.

Relation of noun–verb difference to imageability and word frequency. As is indicated in Table 2, inflected and uninflected difference scores were negatively correlated with imageability ratings and positively correlated with imageability RTs. Thus, in general, more nounlike words had higher and faster imageability ratings than more verblike forms, similar to the pattern previously shown for the Francis–Kučera word classification (see Figure 1).

The HAL noun–verb indices, however, were not correlated with Usenet or Francis–Kučera frequency. Thus, although the noun and verb distances were negatively associated with frequency, relying on the difference score as our measure of noun–verb typicality effectively eliminates the known association of HAL's context vectors with word frequency (in general, less frequent words will have greater interword context distances than will higher frequency words). Lund and Burgess (1998) provide evidence that the techniques employed here (calculating difference scores between context distances across two sets of *anchoring* words—words that have little in common with each other except for the variable of interest) allow one to isolate a particular aspect of lexical knowledge from the highly distributed and overlapping context vectors in the HAL model. The absence of an association of frequency and the noun–verb difference supports their claim.

Finally, although word frequency measures were not the focus of our investigation, the correlation of Francis–Kučera and Usenet frequencies may be of some interest. There was a strong overall association of these two measures ($r = .81$), which was somewhat greater for Francis–Kučera balanced words ($r = .84$) or verbs ($r = .86$) than for nouns ($r = .76$). Burgess and Livesay (1998) previously reported a very high correlation between these

two frequency estimates for nouns, but only for those of very high frequency ($r = .96$); the two indices were very poorly correlated for moderate- and low-frequency nouns ($r_s < .15$). Because our sample included words of varying frequency and word class, the correlations reported here are of greater generality. Nevertheless, the r^2 value (.66) for the two measures may indicate that the Francis–Kučera norms are less sensitive indices of the frequency of word occurrences in contemporary informal discourse.

GENERAL DISCUSSION

In this report, we have presented several measures that can be used to assess both semantic and grammatical characteristics of individual nouns and verbs: imageability ratings, RTs, and two measures of distributional typicality. In general, words with noun usages were more readily imaged than verbs, as indexed by image ratings and RTs, and the RT distributions indicated that off-line image ratings reflect reliance on an image generation process, but one with an internally imposed response deadline. The uninflected and inflected measures of noun–verb distributional typicality produced a good separation between words previously categorized as pure nouns or pure verbs (Francis & Kučera, 1982) and also reflected the part-of-speech distribution in the Usenet corpus. We will now discuss the utility and limitations of these measures and suggest avenues for future research.

Investigators of word recognition traditionally have relied on normative word judgments about salient word characteristics (imageability, concreteness, familiarity, etc.) to select items for experimentation. Certainly, words that vary along the rated dimensions are often processed differently in various experimental contexts, implying that the information participants access for word-rating tasks also influences processing in other contexts. However, the word judgments themselves are often taken at face value, without attempting to discern how participants arrive at such decisions. The imageability RT data reported here suggest that words with equivalent mean ratings need not indicate that the words were imaged with equivalent consistency. The scatter for the imageability–RT distributions suggested that the imagery process for verbal concepts is considerably less consistent than that for nominal concepts. Since the process participants use to determine imageability for verbs is less well understood, it would be unwise to assume that nouns and verbs “matched” for rated imageability are necessarily equivalent. Whether or not high- versus low-imagery verbs exhibit the same behavior in psycholinguistic experiments as high- versus low-imagery nouns is an unsettled empirical question. The ratings reported here will be useful in undertaking such needed experimental investigations.

The grammatical categories of noun and verb represent rather idealized concepts that have proven invaluable for linguistic theory and scholarship. Nevertheless, it is essential to determine the extent to which a word is

employed as a noun or a verb in contemporary language use. One approach to gathering such statistics requires human categorization of part-of-speech usage in a large corpus of contemporary text. The Francis and Kučera (1982) norms represent the most comprehensive attempt to do so. However, because this approach is extremely time consuming, only limited-sized corpora can be coded, and such norms are unlikely to be updated frequently. Thus, despite the massive effort needed to acquire such information, only a snapshot of a restricted set of texts at a limited point in time will result.

In this report, we presented a different approach. The HAL noun–verb indices described here provide a measure of distributional typicality—the extent to which a word is used in sentence contexts that typify nouns or verbs. The context vectors provided by the HAL model, which have been demonstrated to encode grammatical class information (Burgess & Lund, 1997), were used to determine the mean context distance between an item and a large class of nouns and verbs. The difference between a word’s noun and verb distances allows us to identify words that are closer to nouns than to verbs in high-dimensional context space (and vice versa). Because there is no human coding of sentence contexts, these measures can be derived rather quickly from even massive corpora, limited only by available computational resources. The presently implemented model utilizes a 70×70 K matrix (Burgess, 1998; Burgess & Lund, 1997), but larger matrices could be derived to represent a greater number of words. Although this computational approach provides benefits in speed and breadth of word codings, it is important to acknowledge some potential costs as well. The HAL model does not “interpret” text, and lexical items are treated exactly as they appear in the text stream. Hence, abbreviations, misspellings, and reduced word forms are not tagged and will be coded as instances of whatever word they resemble (i.e., there is no distinction between *bout* as an abstract noun and *bout* as a reduced form of *about*). However, it is arguable whether this is problematic. If an experimenter wishes to select words with predominant noun uses, strings with high-frequency non-noun uses in a person’s language experience should be avoided, even if they represent abbreviations or slang. Hence a noun–verb difference score that appears aberrant may provide a “reality check” that a given form is frequently used in nonstandard ways.

Similarly, the qualitative characteristics of Usenet text should also be kept in mind. Whereas the Francis–Kučera corpus is based entirely on formal texts, the Internet exchanges that make up the Usenet corpus are extremely informal and may overrepresent the language use of subcultures that frequent the Internet. If an experimenter is interested in how a word is used in formal published texts, the noun–verb measures reported here would not be appropriate. However, the HAL methodology could be employed with any text corpus to create a new matrix that will reflect the distributional regularities of that corpus. Since new usages will appear in informal language con-

texts long before they are accepted as standard English, this important component of an individual's psycholinguistic experience will be reflected in our noun-verb measures. Furthermore, if a word has a very large (positive or negative) difference score, it is very likely to occur nearly exclusively in typical verb or noun contexts, even when used informally.

But perhaps the most fundamental difference between the two approaches is their varying sensitivity to the typicality of a word's contextual distribution as a noun or a verb. Simple frequency counts, such as those reported by Francis and Kučera (1982), index only the number of times a word occurs as each part of speech. As we have seen, the HAL measures also reflect frequency of noun versus verb usages but, in addition, index the extent to which a word's contextual distribution is typical of nouns and verbs in the corpus. If a word occurs only in a very restricted set of sentence contexts, even if used exclusively as a single part of speech, its contextual distribution will be dissimilar to most other words of that grammatical class. Hence, it will have rather low distributional typicality, despite its high frequency as a single part of speech. Thus, it is not appropriate to view the noun-verb difference measures as distributional frequency counts per se. Whether or not this is advantageous depends on how the experimenter wishes to operationalize part-of-speech usage. But it is worth pointing out that human categorization across many different domains is characterized by graded membership—not all members of a category are equally good exemplars, and the best exemplars are those that are similar to many other category members (Komatsu, 1992; Lakoff, 1987; Rosch & Mervis, 1975). If grammatical categories are also structured according to a typicality gradient (Lakoff, 1987; Ross, 1973), HAL's noun-verb difference may provide a means to assess a word's noun-verb distributional typicality, while circumventing the need to gather normative typicality judgments.

We conclude that the noun-verb difference scores reported here provide a useful index of noun-verb distributional typicality in contemporary discourse. Since the HAL context distance measures reflect the statistical regularities present in the input corpus, additional research will be needed to assess just how distributional typicality might influence the performance of psycholinguistic tasks. For example, if participants are sensitive to the typicality of a word's occurrence in noun versus verb contexts, lexical and sentence acceptability decisions should be faster for typical than for atypical forms. In other domains, HAL's context distances have been successful at predicting human RTs in a variety of linguistic tasks (Burgess, 1998). But until this has been shown for noun-verb distances, it is best to consider them as an index of the structure inherent in the linguistic input (i.e., informal contemporary discourse). At the very least, the item statistics reported here will enable experimenters to select representative examples of nouns and verbs, while holding constant or covarying rated imageability. Such

information will facilitate further experimental inquiry into the neuro- and psycholinguistic bases of noun versus verb processing.

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Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log Frequency
absent	V*	4.57	1.91	2,566	1,628	573	570	3	573	570	3	3.48
absorb	V	4.18	1.85	2,732	1,598	610	487	123	598	562	36	3.86
accept	V	3.70	2.02	2,809	1,931	629	456	173	613	513	100	4.98
access	N	3.07	1.61	3,022	1,688	590	529	61	594	538	56	5.27
accord	B	2.57	2.32	3,232	1,531	494	610	−116	505	544	−39	4.84
accost	V	2.61	1.40	2,706	1,548				757	728	29	2.30
accuse	V	4.04	1.95	2,800	1,962	639	472	167	582	546	36	4.20
acquit	V	3.23	1.95	2,653	1,644				719	689	30	2.85
act	B	4.79	1.93	2,526	1,299	487	503	−16	494	512	−18	5.05
action	N	3.86	2.10	3,075	1,478	459	557	−98	481	559	−78	5.03
adapt	V	3.21	1.69	2,799	2,874	647	481	166	619	540	79	3.87
add	V	5.43	1.67	2,197	1,216	577	449	128	563	490	73	5.33
adhere	V	2.82	1.72	2,341	1,263	672	513	159	713	625	88	3.54
adjust	V	3.74	1.87	2,327	963	602	444	158	577	493	84	4.20
admire	V	4.36	1.73	2,982	2,225	646	523	123	648	568	80	3.73
admit	V	3.75	1.71	2,982	1,632	653	500	153	628	518	110	4.61
adopt	V	4.79	1.79	2,456	1,103	627	464	163	578	528	50	4.24

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
adore	V	4.96	1.79	2,455	928	659	578	81	678	618	60	3.21
adorn	V	2.86	1.88	2,583	3,249				645	718	-73	2.58
affair	N	4.64	1.91	2,182	966	529	663	-134	571	673	-102	4.25
affirm	V	2.86	1.92	2,563	1,055	655	510	145	697	665	32	3.35
afford	V	4.00	2.04	2,267	1,013	701	593	108	698	598	100	4.30
agent	N	5.07	1.68	2,384	1,584	477	562	-85	505	578	-73	4.58
agree	V	3.43	1.97	2,682	1,450	666	563	103	642	558	84	5.12
ail	V	2.48	1.58	2,194	1,167	678	718	-40	679	684	-5	2.72
aim	B	4.36	1.97	2,621	1,083	485	509	-24	520	554	-34	4.30
alarm	B	6.29	1.24	2,572	1,250	481	563	-82	532	586	-54	3.96
album	N	6.14	1.60	1,827	613	505	620	-115	515	621	-106	4.72
alcove	N	3.71	2.16	2,540	1,197	651	766	-115	651	766	-115	2.42
align	V	3.70	1.68	2,918	1,352	591	487	104	592	565	27	3.57
allege	V	2.39	1.40	2,237	1,047	715	670	45	544	612	-68	3.96
alley	N	6.07	1.61	1,873	928	519	643	-124	534	653	-119	3.51
allot	V	2.36	1.45	2,227	1,565	735	684	51	686	684	2	2.98
allow	V	2.43	1.48	2,724	1,701	589	470	119	578	533	45	5.26
allude	V	2.93	1.90	2,429	1,190	693	597	96	652	633	19	3.20
alter	V	4.57	2.08	2,299	1,220	552	471	81	557	524	33	4.20
amass	V	2.71	1.76	2,958	2,433	713	612	101	693	646	47	2.72
amaze	V	4.54	1.67	3,212	2,530	768	626	142	589	623	-34	4.51
amble	V	2.04	1.37	3,087	1,587							1.74
ambush	B	5.52	1.48	2,182	760	701	824	-123	711	816	-105	3.33
amend	V	2.96	1.67	3,143	1,830	621	542	79	700	708	-8	3.83
amuse	V	4.68	1.98	2,818	1,918	657	495	162	639	602	37	3.94
anchor	B	6.75	0.52	1,839	879	475	545	-70	505	569	-64	3.62
angel	N	6.79	0.57	1,555	453	634	745	-111	592	702	-110	4.41
annoy	V	4.57	1.71	2,908	3,104	709	584	125	618	576	42	4.35
answer	B	4.61	2.02	2,266	856	550	497	53	557	519	38	5.25
apathy	N	2.36	1.95	2,545	1,410	551	578	-27	551	578	-27	3.01
appall	V	3.50	1.84	3,461	2,160				645	648	-3	3.30
appear	V	3.64	2.00	3,216	2,418	576	493	83	555	546	9	5.06
append	V	2.04	1.48	2,255	1,004	601	533	68	606	587	19	3.72
apply	V	2.57	1.67	2,486	1,114	601	471	130	576	517	59	4.73
arch	B	6.39	1.20	1,952	630	515	652	-137	573	673	-100	3.75
area	N	4.00	2.00	3,300	1,768	521	644	-123	541	647	-106	5.34
arena	N	6.36	1.13	2,221	2,059	536	685	-149	551	693	-142	4.08
argue	V	4.46	1.64	2,988	1,548	663	482	181	641	522	119	4.58
arise	V	3.96	1.99	2,842	1,456	636	581	55	628	640	-12	4.10
aroma	N	5.18	1.91	3,084	3,447	537	619	-82	537	619	-82	2.90
arouse	V	4.79	2.02	2,473	1,767	706	573	133	661	615	46	3.44
arrive	V	4.11	1.66	2,637	1,054	610	496	114	594	562	32	4.48
arrow	N	6.68	0.98	1,543	514	524	640	-116	514	627	-113	4.01
arson	N	4.11	1.93	2,868	1,509	675	743	-68	675	743	-68	2.88
art	N	5.71	1.30	2,631	1,772	460	582	-122	470	596	-126	4.93
artery	N	5.79	1.45	2,656	1,599	596	722	-126	615	704	-89	2.96
artist	N	6.39	1.13	1,648	513	471	590	-119	496	591	-95	4.54
ascend	V	3.93	2.14	2,287	1,007	583	543	40	593	597	-4	3.34
ash	N	6.32	1.42	1,847	806	500	607	-107	624	691	-67	3.93
ask	V	3.39	1.83	2,778	1,692	602	459	143	582	500	82	5.50
aspect	N	1.21	0.42	2,501	1,172	514	616	-102	551	624	-73	4.58
aspire	V	3.36	2.18	2,683	1,342	684	548	136	630	583	47	3.20
assert	V	2.43	1.57	2,657	1,742	623	453	170	609	532	77	3.90
assess	V	2.68	1.87	2,982	1,602	649	511	138	661	602	59	3.70
asset	N	3.75	1.90	2,737	1,151	543	602	-59	540	602	-62	4.06
assign	V	3.50	1.86	1,946	850	624	476	148	572	539	33	4.29
assume	V	2.54	1.62	3,069	2,015	600	483	117	571	510	61	4.93
assure	V	2.82	1.61	3,294	2,711	649	527	122	639	558	81	4.15
atlas	N	6.36	0.91	2,240	1,777	503	611	-108	503	611	-108	3.73
atom	N	5.54	1.71	2,350	1,262	517	664	-147	532	650	-118	3.76
attach	V	4.43	1.62	3,041	1,440	598	464	134	531	533	-2	4.47
attack	B	5.64	1.66	2,153	879	468	487	-19	491	502	-11	4.90
attain	V	3.29	1.94	2,505	1,421	679	518	161	671	588	83	3.67

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		M	SD	M	SD	NDist	VDist	NVDD	NDist	VDist	NVDD	
attend	V	3.41	1.58	3,330	2,514	641	475	166	609	531	78	4.40
aunt	N	6.50	1.00	2,170	1,080	567	578	-11	594	605	-11	3.54
auto	N	5.96	1.88	2,156	1,593	477	564	-87	484	568	-84	4.22
autumn	N	6.14	1.11	2,464	1,334	609	752	-143	609	752	-143	3.50
avenge	V	2.43	1.32	3,094	1,319	711	606	105	682	662	20	2.67
avenue	N	5.54	1.79	2,412	1,391	759	840	-81	751	829	-78	4.33
avert	V	2.54	1.53	2,741	1,448	728	693	35	726	695	31	3.18
avoid	V	4.04	2.13	2,120	1,066	600	453	147	597	477	120	4.76
await	V	3.89	1.55	2,366	812	630	534	96	624	615	9	3.83
awaken	V	5.57	1.67	2,055	1,068	617	514	103	610	637	-27	3.62
awe	B	4.29	1.82	2,604	1,277	509	586	-77	529	595	-66	3.47
awning	N	5.11	2.01	2,466	916							1.18
bacon	N	6.89	0.31	1,555	885	514	598	-84	514	598	-84	3.50
badge	N	6.43	1.20	1,777	917	499	594	-95	522	603	-81	3.48
barf	V	3.75	1.73	3,335	2,254	583	605	-22	645	636	9	3.21
ballad	N	4.52	2.10	2,412	1,358	505	671	-166	528	664	-136	3.20
ballet	N	6.50	1.11	2,070	1,068	473	584	-111	473	584	-111	3.22
ban	B	3.71	2.31	2,718	1,361	511	504	7	549	541	8	4.36
banana	N	6.81	0.96	1,558	541	496	590	-94	505	582	-77	3.63
banish	V	3.54	1.79	2,553	1,210	686	545	141	660	649	11	3.12
banner	N	6.32	1.39	1,808	728	504	609	-105	521	612	-91	3.59
barley	N	4.96	2.25	2,189	1,354	550	633	-83	550	633	-83	3.08
barn	N	6.93	0.38	1,278	333	506	639	-133	522	648	-126	3.46
basin	N	4.93	2.07	2,039	924	597	740	-143	606	742	-136	3.38
basis	N	1.64	0.95	2,191	953	601	682	-81	601	682	-81	4.68
baste	V	4.29	1.88	2,797	2,480				768	836	-68	2.72
batch	N	4.00	2.09	3,111	1,893	503	572	-69	517	580	-63	4.07
bath	N	6.48	1.16	1,696	918	475	598	-123	490	600	-110	3.83
bathe	V	5.57	1.73	2,806	1,291	679	512	167	614	593	21	3.43
baton	N	5.75	1.71	2,067	947	708	823	-115	708	823	-115	3.23
bauble	N	3.11	2.18	2,539	1,464							1.71
bawl	V	3.50	1.95	3,193	1,100							2.38
beast	N	6.46	0.88	1,908	861	537	704	-167	568	723	-155	4.30
beauty	N	5.36	1.68	3,185	3,028	445	560	-115	456	569	-113	4.13
beckon	V	3.75	2.05	2,309	1,098				756	825	-69	2.68
become	V	2.75	1.62	2,266	1,224	578	448	130	563	506	57	5.16
bee	N	6.96	0.19	1,294	357	464	569	-105	590	694	-104	3.95
beet	N	5.46	2.01	2,780	2,978	603	650	-47	620	672	-52	2.76
beg	V	5.54	1.62	2,094	965	608	506	102	602	546	56	4.00
begin	V	3.54	1.73	3,386	1,936	585	504	81	565	568	-3	5.08
behave	V	3.86	1.84	2,747	2,618	652	476	176	629	521	108	3.99
belief	N	3.64	1.75	2,743	2,108	490	548	-58	537	560	-23	4.53
bell	N	6.71	0.81	1,635	699	470	606	-136	477	604	-127	4.45
belly	N	6.18	1.44	1,836	1,275	555	639	-84	564	645	-81	3.80
belong	V	2.79	1.83	2,617	1,180	656	562	94	625	581	44	4.44
berate	V	1.96	1.53	2,542	2,229	743	569	174	710	613	97	2.56
betray	V	3.79	1.89	3,151	2,534	674	511	163	634	595	39	3.47
beware	V	4.39	2.04	2,275	905	564	578	-14	564	578	-14	3.75
bib	N	5.93	1.76	1,796	800	596	712	-116	596	712	-116	2.89
bicker	V	4.21	2.02	2,422	1,812	728	649	79	596	607	-11	3.03
bind	V	3.71	1.74	2,867	1,265	570	581	-11	539	583	-44	4.46
blade	N	6.67	0.68	1,638	730	446	602	-156	465	601	-136	4.16
bleed	V	6.39	0.99	2,198	1,700	565	474	91	542	538	4	3.91
blend	B	5.54	1.57	2,547	1,889	531	560	-29	553	583	-30	3.75
bless	V	4.41	1.85	3,356	2,470	633	606	27	595	648	-53	4.22
blight	B	2.21	1.57	3,013	1,740	861	944	-83	861	944	-83	3.29
bliss	N	3.21	1.71	2,967	3,177	517	583	-66	517	583	-66	3.35
blob	N	5.61	1.59	2,597	1,017	536	661	-125	560	660	-100	3.20
bloom	B	5.82	1.39	2,341	1,051	572	652	-80	569	643	-74	3.71
blot	B	5.14	1.51	3,301	4,695	566	622	-56	656	698	-42	2.94
blouse	N	6.54	1.04	1,787	1,126	658	741	-83	664	741	-77	3.28
blurt	V	4.25	1.90	2,571	1,992	795	644	151	757	690	67	2.71
bolt	B	6.00	1.47	2,582	1,934	482	621	-139	495	608	-113	4.06

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
bone	N	6.46	1.17	1,916	1,203	661	792	-131	596	718	-122	4.37
bonus	N	4.21	1.83	2,684	1,650	520	613	-93	536	616	-80	4.23
boost	B	4.04	2.06	3,126	1,634	566	514	52	586	557	29	3.80
booth	N	6.14	1.15	2,013	859	484	606	-122	504	618	-114	3.73
booty	N	5.54	1.88	2,780	1,324	599	665	-66	621	674	-53	2.75
borrow	V	4.82	1.83	2,298	1,072	651	484	167	593	528	65	4.02
bound	B	4.00	1.66	2,105	853	520	532	-12	538	559	-21	4.23
bounty	N	3.57	1.77	3,383	2,889	502	630	-128	525	643	-118	3.28
bout	N	3.21	1.79	2,252	1,209	583	592	-9	583	595	-12	3.79
breath	N	5.89	1.47	2,440	1,773	541	593	-52	546	596	-50	4.18
brew	B	4.96	1.29	2,311	979	490	525	-35	512	565	-53	3.89
bride	N	6.89	0.31	1,798	719	489	620	-131	506	626	-120	3.67
bring	V	2.68	1.54	2,696	1,449	566	404	162	546	473	73	5.09
brood	B	3.36	2.18	2,272	1,740	570	572	-2	584	599	-15	3.03
broth	N	4.96	2.15	2,569	1,436	589	680	-91	589	680	-91	2.89
brow	N	5.26	1.79	2,314	938	591	677	-86	607	688	-81	2.99
bruise	B	6.29	1.01	2,044	925	625	614	11	615	618	-3	3.35
brush	B	6.68	0.55	2,101	680	501	520	-19	541	556	-15	3.99
bucket	N	6.68	0.67	1,803	894	505	638	-133	509	628	-119	3.61
buckle	B	6.43	1.03	1,886	1,062	531	584	-53	577	623	-46	3.42
bug	B	6.57	0.79	1,572	698	513	578	-65	520	571	-51	4.72
bugle	N	5.54	1.75	2,360	882	577	672	-95	596	672	-76	2.73
bulb	N	6.32	1.02	2,072	1,245	559	653	-94	545	625	-80	3.73
bulge	B	5.07	2.00	2,164	1,069	568	673	-105	589	670	-81	3.31
bullet	N	6.89	0.32	1,797	617	452	582	-130	460	567	-107	4.12
bury	V	5.21	1.77	2,551	1,226	590	471	119	555	541	14	3.47
bustle	B	3.57	2.18	2,071	1,070				690	805	-115	2.58
butler	N	6.43	1.17	1,874	1,055	571	651	-80	571	651	-80	3.56
buzz	B	5.14	1.96	2,552	1,161	475	557	-82	507	578	-71	3.71
cab	N	6.61	0.99	1,813	1,016	466	587	-121	478	594	-116	3.60
cadet	N	5.33	1.86	2,286	1,153	521	603	-82	524	606	-82	3.32
camel	N	6.75	0.70	1,454	370	683	808	-125	674	789	-115	3.61
campus	N	6.43	1.03	1,830	691	519	632	-113	538	645	-107	4.18
cancel	V	3.93	1.86	2,839	1,709	588	472	116	603	565	38	4.76
cancer	N	4.86	2.12	2,470	1,077	499	570	-71	506	575	-69	4.28
canyon	N	6.57	0.69	1,798	1,227	497	640	-143	508	646	-138	3.66
cape	N	6.04	1.50	2,315	1,767	507	644	-137	510	645	-135	3.75
care	B	4.64	2.26	2,217	1,172	587	503	84	591	517	74	5.09
carrot	N	6.68	0.82	1,662	818	491	616	-125	535	628	-93	3.44
carry	V	5.32	1.79	2,060	796	580	426	154	549	487	62	4.71
carve	V	5.54	1.43	2,874	1,761	629	501	128	570	572	-2	3.50
casino	N	6.68	0.86	1,746	941	532	634	-102	584	675	-91	3.86
cast	B	5.32	1.83	2,558	1,021	467	491	-24	471	506	-35	4.52
cater	V	4.89	1.73	2,648	1,823	670	537	133	649	616	33	3.52
cattle	N	6.75	0.52	1,666	576	492	575	-83	492	575	-83	3.58
cavern	N	5.86	1.88	2,254	1,298	559	695	-136	740	868	-128	3.43
cavity	N	6.07	1.36	2,585	1,374	552	696	-144	565	681	-116	3.17
cavort	V	2.07	1.63	2,571	1,287							2.04
cease	V	3.48	1.72	2,737	1,300	596	491	105	614	556	58	3.85
cell	N	5.71	1.46	2,236	874	455	588	-133	589	673	-84	4.65
cereal	N	6.61	0.92	1,907	1,619	504	578	-74	535	607	-72	3.59
chalk	B	6.61	1.23	1,523	779	498	532	-34	498	532	-34	3.22
change	B	3.54	1.95	3,268	1,738	538	432	106	531	475	56	5.47
chase	B	5.64	1.62	1,945	785	479	524	-45	506	539	-33	4.14
chef	N	6.54	0.88	2,365	2,064	499	610	-111	523	622	-99	3.24
chess	N	6.68	0.72	1,947	710	481	576	-95	481	576	-95	4.05
chest	N	6.64	0.68	1,873	808	574	660	-86	576	660	-84	4.13
chew	V	5.89	1.03	2,220	892	596	457	139	589	523	66	3.77
child	N	6.61	1.20	1,972	2,167	464	541	-77	494	534	-40	5.24
chime	B	5.75	1.55	2,875	1,971	596	631	-35	597	648	-51	3.29
chive	N	4.96	2.05	2,886	1,462							2.03
choir	N	6.39	1.40	2,265	1,387	489	611	-122	503	619	-116	3.37
choke	V	5.89	1.31	2,102	813	489	507	-18	538	554	-16	3.76

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log Frequency
choose	V	3.67	1.69	3,758	2,017	596	447	149	579	486	93	4.95
chore	N	5.14	1.90	2,461	1,502	656	703	-47	659	690	-31	3.18
church	N	6.67	0.88	1,511	598	471	583	-112	480	587	-107	4.75
cider	N	5.61	1.57	2,002	884	556	604	-48	556	604	-48	2.82
cigar	N	6.86	0.45	1,689	1,116	588	668	-80	587	660	-73	3.23
cinema	N	6.36	1.50	1,761	801	494	639	-145	509	649	-140	3.55
circus	N	6.81	0.48	1,711	1,048	476	636	-160	494	643	-149	3.56
cite	V	2.93	1.82	3,635	2,591	592	499	93	567	557	10	4.25
city	N	6.57	1.20	1,620	1,148	494	651	-157	501	648	-147	5.08
claim	B	3.18	1.52	3,114	1,693	567	486	81	549	509	40	5.08
clan	N	4.71	2.21	2,241	1,033	451	581	-130	469	591	-122	3.73
clang	B	4.82	1.93	2,333	1,354	783	798	-15	783	798	-15	2.44
clause	N	2.79	1.57	2,991	1,007	527	636	-109	537	639	-102	3.89
claw	B	6.21	1.23	2,159	1,374	525	617	-92	561	630	-69	3.73
clay	N	6.14	1.15	1,857	1,005	670	787	-117	670	787	-117	4.03
clench	V	4.63	1.84	2,357	1,708	689	600	89	695	701	-6	3.11
client	N	4.61	2.02	2,480	1,425	523	603	-80	564	613	-49	5.02
cliff	N	6.75	0.59	1,629	989	474	593	-119	501	614	-113	3.82
cling	V	4.75	1.55	2,483	1,297	634	494	140	635	580	55	3.45
clinic	N	5.86	1.33	2,084	947	505	628	-123	521	620	-99	3.82
clot	B	5.14	1.58	2,234	1,220	626	690	-64	675	718	-43	2.82
cloth	N	6.44	0.97	2,064	1,316	778	860	-82	773	853	-80	4.06
clothe	V	5.63	1.84	2,477	1,109	694	616	78	525	562	-37	4.41
coax	V	2.54	1.57	2,961	1,500	503	565	-62	539	591	-52	3.40
cocoa	N	5.96	1.43	2,288	1,857	557	667	-110	557	667	-110	3.16
cod	N	4.18	2.37	2,718	1,385	679	661	18	688	670	18	4.07
coddle	V	2.57	1.83	2,209	1,063							1.84
coffin	N	6.64	1.06	2,353	2,128	669	820	-151	669	811	-142	3.59
colony	N	5.21	1.60	2,888	2,011	469	619	-150	494	621	-127	3.87
column	N	6.07	1.12	2,141	985	476	623	-147	486	619	-133	4.35
comb	B	6.75	0.44	1,883	746	585	623	-38	635	665	-30	3.47
come	V	3.57	1.91	2,936	1,520	554	438	116	541	500	41	5.72
comedy	N	4.79	1.95	2,677	1,687	462	582	-120	471	586	-115	3.87
comet	N	6.68	0.86	2,211	1,307	513	686	-173	528	685	-157	3.65
comma	N	5.50	1.82	2,713	1,324	538	626	-88	563	632	-69	3.38
compel	V	2.79	1.85	2,347	1,800	679	580	99	630	600	30	3.87
comply	V	3.43	1.79	2,726	1,772	691	525	166	682	567	115	3.66
concur	V	2.46	1.45	2,875	1,608	696	644	52	708	698	10	3.26
confer	V	2.29	1.46	3,282	2,397	650	580	70	667	649	18	3.15
convey	V	2.52	1.42	2,815	1,438	640	512	128	643	571	72	3.66
cookie	N	6.93	0.26	1,382	470	465	590	-125	484	568	-84	3.74
cope	V	2.46	1.32	2,934	1,663	646	492	154	626	516	110	3.70
corn	N	6.79	0.79	1,720	1,568	467	572	-105	467	572	-105	3.70
corpse	N	6.50	0.84	1,815	720	495	619	-124	516	621	-105	3.52
county	N	4.63	1.94	2,375	856	515	642	-127	522	647	-125	4.42
coupon	N	6.57	1.14	1,796	986	583	686	-103	583	650	-67	3.66
cousin	N	5.89	1.81	2,458	1,664	552	612	-60	571	616	-45	3.83
coward	N	5.07	1.86	2,667	1,793	621	632	-11	616	631	-15	3.36
crab	N	6.89	0.31	1,732	1,734	486	619	-133	516	620	-104	3.14
craft	N	4.79	1.73	2,203	908	455	560	-105	509	591	-82	4.02
cram	V	4.46	1.99	2,846	1,289	687	629	58	661	634	27	3.34
crave	V	4.61	1.95	2,750	1,917	682	589	93	635	604	31	3.23
crease	B	5.18	1.72	2,580	1,611	617	761	-144	707	800	-93	3.56
create	V	3.18	1.96	3,486	1,904	596	435	161	562	499	63	5.22
creek	N	5.96	1.64	1,995	968	580	699	-119	583	702	-119	3.94
crime	N	5.75	1.48	2,199	2,071	470	561	-91	494	569	-75	4.67
crisis	N	4.89	1.83	2,309	947	478	614	-136	486	617	-131	4.16
critic	N	4.64	1.91	2,766	1,726	504	597	-93	512	566	-54	3.90
croak	B	5.32	1.74	2,263	991	734	659	75	734	659	75	2.27
crunch	B	5.50	1.45	2,288	1,048	499	557	-58	555	598	-43	3.42
crutch	N	5.43	1.97	1,881	810	621	694	-73	635	690	-55	2.95
cult	N	4.39	2.15	2,710	1,366	464	585	-121	482	593	-111	4.12
cure	B	4.46	1.95	2,934	1,704	504	503	1	531	527	4	4.11

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
dabble	V	3.54	1.97	2,142	934	727	584	143	783	719	64	2.65
daisy	N	6.79	0.57	1,754	972	508	575	-67	536	606	-70	3.21
dance	B	6.57	0.92	1,714	555	456	519	-63	480	547	-67	4.64
danger	N	4.00	2.31	2,756	1,531	512	593	-81	524	600	-76	4.19
dash	B	5.07	1.86	3,185	1,727	460	551	-91	498	570	-72	3.70
day	N	5.11	2.10	3,309	2,936	484	597	-113	512	617	-105	5.60
daze	V	4.61	1.55	2,975	1,828	614	726	-112	587	664	-77	3.12
deal	B	4.86	2.09	2,486	1,590	560	507	53	559	525	34	5.11
death	N	6.14	1.35	2,239	1,232	459	540	-81	467	547	-80	4.93
debt	N	4.57	1.93	2,315	1,213	518	598	-80	546	615	-69	4.22
decay	B	4.93	1.70	2,384	1,164	565	587	-22	578	613	-35	3.69
deceit	N	2.36	1.57	2,877	1,740	684	698	-14	684	698	-14	2.96
decide	V	2.46	1.53	2,822	1,312	625	460	165	594	516	78	4.99
deduce	V	3.11	1.85	2,565	1,469	709	560	149	701	597	104	3.15
deduct	V	3.26	1.93	2,524	1,167	705	554	151	702	607	95	3.27
defeat	B	4.54	1.93	2,980	2,342	542	466	76	549	519	30	4.17
defend	V	4.50	1.60	3,191	2,547	649	458	191	609	488	121	4.40
defer	V	1.96	1.69	2,666	1,291	693	523	170	648	573	75	3.18
define	V	3.04	1.62	2,691	1,287	598	459	139	570	531	39	4.78
defy	V	2.82	1.76	3,094	1,789	651	526	125	654	592	62	3.31
delude	V	2.82	1.61	3,174	6,388	731	578	153	678	619	59	3.21
delve	V	2.07	1.65	2,457	1,443	737	547	190	745	623	122	3.03
demand	B	4.19	1.88	2,352	1,309	507	498	9	517	516	1	4.64
demon	N	6.21	1.23	1,994	830	538	689	-151	529	652	-123	4.10
denote	V	2.46	1.50	2,648	1,426	647	584	63	661	696	-35	3.50
deny	V	3.39	1.89	2,446	953	634	452	182	601	511	90	4.48
depart	V	4.26	1.85	2,907	2,069	568	491	77	575	575	0	3.57
depend	V	3.14	1.72	3,273	2,955	595	514	81	579	572	7	4.84
depict	V	2.04	1.23	3,036	1,377	640	554	86	620	658	-38	3.59
depth	N	3.57	1.50	3,041	1,262	493	580	-87	505	589	-84	4.18
derive	V	2.75	1.71	2,597	1,267	631	478	153	578	594	-16	4.21
design	B	5.29	1.49	2,159	936	532	597	-65	540	595	-55	5.24
desire	B	4.68	1.98	2,201	1,090	519	522	-3	554	562	-8	4.69
desk	N	6.71	0.85	1,796	1,108	540	650	-110	544	651	-107	4.16
detach	V	4.54	1.77	2,363	948	626	556	70	580	577	3	3.25
detain	V	3.61	1.79	2,645	1,440	781	665	116	684	663	21	3.36
detect	V	3.71	1.78	2,773	1,456	624	483	141	614	549	65	4.25
detest	V	4.14	1.90	2,657	1,847	700	614	86	700	614	86	2.67
device	N	4.25	1.90	2,428	1,248	479	591	-112	498	584	-86	4.87
devise	V	2.96	1.60	2,923	1,662	656	501	155	636	596	40	3.47
devote	V	3.04	1.76	3,182	2,163	672	489	183	590	618	-28	4.08
devour	V	5.14	1.58	2,705	1,476	694	562	132	875	913	-38	3.44
dew	N	5.96	1.37	1,876	698	512	613	-101	512	613	-101	3.12
diary	N	6.46	0.96	1,893	700	480	616	-136	511	635	-124	3.55
differ	V	3.57	2.06	3,515	3,194	608	516	92	593	557	36	4.11
dilate	V	3.36	2.04	3,526	2,137				702	692	10	2.70
dine	V	5.21	0.96	2,984	1,725	652	610	42	538	613	-75	3.53
dinner	N	6.68	0.77	1,877	1,153	537	548	-11	541	552	-11	4.14
dip	B	6.21	1.20	2,282	1,132	474	516	-42	508	542	-34	3.87
dirt	N	6.61	0.99	1,941	1,683	455	541	-86	455	541	-86	3.88
distil	V	3.14	1.76	3,504	2,736				584	592	-8	3.01
divert	V	3.56	1.95	2,174	955	665	537	128	665	600	65	3.36
donate	V	3.46	1.71	3,023	1,709	681	505	176	648	563	85	3.79
donor	N	4.79	1.50	2,315	926	545	637	-92	572	642	-70	3.44
door	N	6.86	0.36	1,560	554	528	628	-100	521	618	-97	4.82
dough	N	6.39	1.07	2,364	1,655	511	600	-89	511	600	-89	3.53
doze	V	5.00	1.41	2,717	1,353	635	649	-14	673	672	1	2.76
dragon	N	6.64	0.73	1,460	676	599	732	-133	584	714	-130	4.55
drain	B	6.14	1.04	2,122	928	707	787	-80	680	748	-68	4.27
drama	N	4.57	1.85	2,648	1,550	473	595	-122	492	608	-116	3.72
dress	B	6.67	1.00	1,743	560	493	520	-27	518	540	-22	4.39
drift	B	5.29	1.44	2,401	1,256	532	572	-40	563	591	-28	3.76
drill	B	5.89	1.31	1,778	612	492	570	-78	509	571	-62	3.99

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log	Frequency
drink	B	6.75	0.59	1,629	669	529	450	79	534	499	35	4.66	
droop	V	4.75	1.84	2,350	1,442	690	678	12	690	678	12	2.07	
drown	V	5.89	1.40	2,506	1,372	649	527	122	629	648	-19	3.72	
duct	N	4.39	2.11	3,133	2,166	523	601	-78	548	622	-74	3.17	
duet	N	5.44	1.50	2,486	1,439	509	615	-106	538	635	-97	3.12	
dune	N	4.14	2.09	2,373	1,017	518	639	-121	534	657	-123	3.43	
dusk	N	5.86	1.56	2,440	1,235	586	661	-75	586	661	-75	2.90	
duty	N	4.00	1.76	2,468	1,488	553	605	-52	569	622	-53	4.38	
dwarf	B	6.46	1.20	1,793	902	513	639	-126	531	646	-115	3.83	
dwelt	V	4.04	2.05	2,181	962	655	513	142	641	592	49	3.45	
eagle	N	6.86	0.59	1,780	1,152	460	593	-133	481	613	-132	4.00	
earn	V	3.93	1.92	2,736	1,600	647	498	149	614	541	73	4.38	
ease	B	2.50	1.45	2,693	1,165	532	513	19	550	534	16	4.06	
easel	N	5.46	1.95	2,297	1,395	634	724	-90	634	724	-90	2.35	
eat	V	6.36	0.87	1,912	704	601	427	174	579	476	103	4.83	
ebb	V	1.75	1.43	2,398	2,064	587	675	-88	635	706	-71	2.85	
echo	B	5.18	1.68	2,816	1,293	750	802	-52	729	780	-51	4.52	
edit	V	4.57	1.97	2,397	888	570	477	93	550	521	29	4.66	
eject	V	5.89	1.45	2,040	843	599	518	81	609	573	36	3.44	
elapse	V	2.93	2.06	2,761	1,373				619	705	-86	3.05	
elude	V	2.89	1.47	2,683	1,585	710	586	124	704	679	25	3.01	
embark	V	3.64	2.09	2,405	1,335	753	594	159	721	652	69	3.09	
emerge	V	4.19	1.64	3,055	1,736	604	520	84	582	622	-40	4.06	
emit	V	3.50	1.97	2,185	877	628	539	89	626	628	-2	3.51	
empire	N	5.07	1.90	2,710	2,156	506	659	-153	566	704	-138	4.37	
enable	V	2.93	1.78	2,944	1,727	601	489	112	609	568	41	4.45	
enact	V	2.68	1.70	2,920	1,890	695	590	105	689	673	16	3.59	
endure	V	3.43	1.91	2,825	1,681	674	506	168	684	633	51	3.62	
energy	N	4.00	1.81	3,248	2,168	489	588	-99	492	588	-96	4.78	
engage	V	4.11	1.85	2,312	952	610	443	167	592	519	73	4.27	
engine	N	6.56	0.85	1,843	785	459	603	-144	466	598	-132	4.70	
engulf	V	4.57	1.83	2,859	2,051	742	650	92	689	692	-3	2.78	
enjoy	V	4.07	2.05	3,022	1,621	603	470	133	609	504	105	4.85	
enlist	V	3.50	1.88	2,197	1,499	722	555	167	612	572	40	3.19	
enroll	V	4.11	1.71	3,152	5,377	739	603	136	692	624	68	3.51	
enter	V	4.36	1.97	2,639	1,554	569	458	111	564	504	60	4.81	
enzyme	N	4.00	2.13	2,575	1,974	584	673	-89	587	660	-73	3.40	
equip	V	3.50	1.58	2,509	1,299	662	618	44	579	591	-12	3.90	
era	N	3.39	1.62	2,651	1,555	516	657	-141	516	657	-141	4.18	
erase	V	5.93	1.33	2,436	1,726	625	478	147	629	533	96	3.79	
erect	Va	4.89	1.66	2,485	1,010	598	595	3	609	617	-8	3.55	
erode	V	4.54	1.99	2,476	1,029	720	596	124	706	689	17	3.04	
err	V	2.30	1.32	3,106	2,406	621	572	49	640	597	43	3.62	
errand	N	3.18	1.81	3,463	1,430	606	680	-74	664	680	-16	2.77	
erupt	V	5.79	1.57	2,361	2,055	640	584	56	645	682	-37	3.19	
estate	N	5.29	1.78	2,780	2,190	557	650	-93	561	652	-91	4.01	
evade	V	3.56	1.91	3,365	3,668	683	530	153	684	592	92	3.19	
event	N	4.04	2.15	2,756	1,607	482	609	-127	491	592	-101	4.92	
evict	V	4.21	2.11	2,522	841	811	714	97	803	726	77	2.64	
evolve	V	3.86	1.99	2,143	753	648	502	146	600	567	33	4.05	
exalt	V	2.18	1.39	2,769	1,720				631	648	-17	2.99	
exceed	V	3.21	1.85	2,992	1,586	643	551	92	632	613	19	4.03	
excel	V	4.43	2.08	2,193	895	567	588	-21	576	594	-18	4.12	
excite	V	4.96	1.86	2,490	1,732	659	519	140	599	584	15	4.38	
exert	V	2.61	1.47	2,744	1,229	647	513	134	643	589	54	3.32	
exhale	V	5.43	1.85	2,432	1,326	618	604	14	618	604	14	2.75	
exist	V	3.04	1.84	2,930	1,490	655	575	80	611	585	26	5.07	
expand	V	4.43	1.97	2,649	1,277	627	483	144	587	542	45	4.47	
expel	V	3.59	1.62	3,138	3,324	704	594	110	641	628	13	3.37	
expire	V	3.74	1.97	3,278	1,395	621	547	74	617	616	1	3.89	
extend	V	3.89	1.87	3,714	3,316	613	457	156	529	533	-4	4.55	
extent	N	2.54	1.88	2,997	1,679	590	572	18	590	573	17	4.18	
fabric	N	5.89	1.26	2,344	1,218	477	584	-107	490	589	-99	3.87	

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log Frequency
facet	N	4.29	2.26	2,338	1,389	638	687	-49	662	707	-45	3.32
fact	N	3.46	2.15	2,845	1,730	502	568	-66	505	565	-60	5.34
fad	N	3.85	1.92	2,722	1,116	577	664	-87	588	663	-75	3.13
fail	V	3.04	1.62	3,309	1,411	582	459	123	554	526	28	4.82
fairy	N	6.18	1.47	2,125	1,103	473	589	-116	496	600	-104	3.45
faith	N	2.68	1.74	3,609	2,167	519	577	-58	524	581	-57	4.48
falcon	N	6.21	1.55	1,574	772	574	715	-141	574	712	-138	3.96
falter	V	2.04	1.10	2,701	1,172	714	626	88	714	626	88	2.28
fame	N	4.89	2.04	2,489	1,284	545	622	-77	545	622	-77	3.78
family	N	6.43	1.07	1,711	495	447	556	-109	468	562	-94	5.03
famine	N	4.89	1.95	2,797	2,230	541	625	-84	586	659	-73	3.10
fasten	V	5.18	1.54	2,770	1,421	665	549	116	634	612	22	3.13
fate	N	3.21	2.41	2,857	1,600	476	583	-107	483	587	-104	3.96
favor	B	4.00	1.56	2,652	1,731	573	574	-1	573	575	-2	4.39
feat	N	3.04	1.93	2,689	1,533	575	668	-93	592	667	-75	3.31
fender	N	5.89	1.71	2,479	1,380	494	601	-107	509	612	-103	3.48
fern	N	6.14	1.53	1,545	429	595	689	-94	603	693	-90	2.89
fervor	N	2.50	1.71	2,536	1,311	611	679	-68	611	679	-68	2.64
fetch	V	5.82	1.72	2,022	818	576	486	90	599	546	53	3.69
fever	N	5.50	1.71	2,090	884	549	659	-110	549	659	-110	3.62
fiber	N	4.18	2.16	2,898	1,403	504	596	-92	514	603	-89	3.90
fig	N	5.14	2.03	2,005	903	504	622	-118	517	624	-107	3.43
file	B	6.33	1.04	1,981	1,242	505	596	-91	516	581	-65	5.71
filter	B	5.46	1.50	2,044	1,067	468	540	-72	487	548	-61	4.48
fish	B	6.89	0.42	1,629	807	435	534	-99	455	540	-85	4.62
flare	B	5.68	1.61	2,546	1,756	792	884	-92	746	831	-85	3.77
flash	B	6.57	0.79	2,118	1,564	480	602	-122	490	597	-107	4.37
flask	N	5.29	2.09	1,687	537	608	754	-146	608	754	-146	2.91
flaunt	V	4.64	1.83	2,394	1,594	708	551	157	698	590	108	2.72
flea	N	6.21	1.29	1,670	606	496	579	-83	534	580	-46	3.79
flee	V	5.11	1.73	2,492	1,780	633	513	120	618	610	8	3.70
flight	N	5.61	1.42	2,398	1,309	441	578	-137	458	581	-123	4.55
flow	B	5.25	1.48	3,109	2,145	493	544	-51	507	562	-55	4.45
flu	N	4.79	1.66	2,761	1,312	540	637	-97	540	637	-97	3.18
focus	B	3.75	1.97	3,207	1,965	484	476	8	511	517	-6	4.64
foe	N	4.39	2.01	2,284	1,286	512	600	-88	548	622	-74	3.33
follow	V	5.04	1.67	2,520	1,545	574	429	145	573	601	-28	5.55
folly	N	2.07	1.36	3,245	2,126	562	632	-70	579	652	-73	3.19
forbid	V	2.93	1.65	2,921	1,493	600	526	74	574	597	-23	4.04
forget	V	4.36	1.85	2,136	832	604	507	97	614	542	72	4.89
found	V	4.07	1.65	2,606	1,362	574	529	45	576	538	38	5.33
fraud	N	4.29	1.96	2,510	1,924	522	578	-56	530	584	-54	3.91
frenzy	N	4.00	2.13	2,553	1,135	555	706	-151	555	706	-151	3.32
fright	N	5.50	1.43	2,701	1,295	580	655	-75	580	655	-75	2.78
frog	N	6.89	0.42	1,667	1,060	476	601	-125	495	601	-106	3.67
frolic	B	4.25	2.17	2,302	932	743	703	40	743	703	40	2.24
fury	N	4.64	2.26	2,523	1,171	599	723	-124	603	723	-120	3.60
fuse	B	5.11	1.99	2,937	2,317	503	563	-60	530	588	-58	3.55
fusion	N	3.93	2.14	2,775	1,549	501	656	-155	501	656	-155	3.94
gadget	N	4.96	1.77	3,495	3,244	497	600	-103	520	600	-80	3.40
gaiety	N	3.14	2.19	2,301	869							1.83
gain	B	3.18	1.98	3,069	1,892	547	442	105	544	490	54	4.63
galley	N	4.21	2.04	2,350	979	569	699	-130	569	699	-130	2.67
gallon	N	6.14	1.27	2,516	1,332	611	732	-121	600	704	-104	3.75
gallop	B	6.18	1.06	2,106	8,76	594	682	-88	616	700	-84	2.63
garlic	N	6.68	0.82	1,838	1,075	546	660	-114	546	660	-114	3.62
gasp	B	4.54	1.95	2,181	882	541	543	-2	639	639	0	3.78
gather	V	4.18	1.72	3,119	1,731	580	454	126	535	549	-14	4.34
gem	N	6.54	0.69	1,897	1,213	492	594	-102	516	618	-102	3.73
genius	N	4.75	1.80	3,106	3,089	491	589	-98	501	593	-92	3.85
germ	N	4.70	1.96	2,193	796	549	664	-115	569	652	-83	3.03
get	V	3.46	1.95	2,515	1,175	614	439	175	600	476	124	6.19
gift	N	6.68	0.55	2,337	3,178	495	582	-87	514	577	-63	4.23

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
giggle	B	6.11	1.19	2,199	1,417	597	562	35	648	628	20	3.66
glance	B	5.61	1.62	2,687	3,061	598	624	-26	633	645	-12	3.82
gland	N	4.50	1.88	3,647	3,027	588	686	-98	591	678	-87	3.14
glaze	B	5.11	1.66	2,315	1,227	556	608	-52	596	642	-46	3.05
glide	V	5.39	1.29	3,126	2,356	534	555	-21	557	586	-29	3.37
gloat	V	3.96	1.93	2,618	1,131	695	549	146	659	588	71	2.76
gloom	N	4.89	1.93	3,493	7,502	769	856	-87	769	856	-87	3.50
gloss	B	4.68	2.04	3,261	2,534	563	559	4	593	582	11	3.09
glow	B	5.96	1.26	2,384	1,550	482	564	-82	512	593	-81	3.71
glut	B	2.04	1.35	3,444	2,591	594	662	-68	594	662	-68	2.79
gnaw	V	4.57	1.87	2,228	885	722	605	117	737	698	39	2.73
goal	N	3.68	2.34	3,212	1,967	501	578	-77	513	575	-62	4.61
goat	N	6.64	1.19	1,631	756	557	661	-104	555	645	-90	3.59
gobble	V	4.96	1.88	2,020	869	699	611	88	699	611	88	2.53
gouge	V	4.32	2.07	2,461	1,670	658	595	63	683	651	32	2.85
govern	V	4.64	1.93	2,743	2,310	653	580	73	604	639	-35	3.85
gram	N	3.52	2.05	2,823	1,569	527	645	-118	595	686	-91	3.66
grape	N	6.21	1.64	1,484	500	505	602	-97	505	599	-94	3.47
gravy	N	6.59	1.31	1,665	891	520	603	-83	520	603	-83	2.97
graze	V	4.68	1.91	2,009	713	675	579	96	595	609	-14	3.19
greed	N	4.43	2.01	2,812	1,575	563	660	-97	563	660	-97	3.63
greet	V	5.11	1.89	2,294	781	674	521	153	588	582	6	3.66
grief	N	4.36	1.81	2,719	1,672	539	574	-35	539	574	-35	3.59
grieve	V	4.75	2.01	2,227	1,165	656	560	96	636	584	52	2.99
grind	V	5.04	1.79	2,194	1,393	539	476	63	486	571	-85	4.73
grip	B	5.07	1.68	2,611	1,260	490	572	-82	521	576	-55	4.06
groom	B	5.79	1.60	1,972	904	527	555	-28	588	611	-23	3.61
grove	N	5.71	1.05	3,119	1,783	608	722	-114	608	716	-108	3.66
grovel	V	4.22	2.22	2,176	1,199	656	534	122	656	534	122	2.74
grow	V	5.11	1.83	2,161	939	588	430	158	541	532	9	4.87
growl	B	5.89	1.71	1,867	1,093	597	595	2	644	646	-2	3.25
growth	N	3.79	2.08	2,891	1,700	519	607	-88	520	608	-88	4.57
guilt	N	4.04	2.12	2,798	1,789	521	532	-11	521	532	-11	3.70
guitar	N	6.86	0.36	1,701	659	445	559	-114	460	564	-104	4.47
gulf	N	5.04	1.88	2,945	2,084	541	676	-135	541	676	-135	3.81
gulp	B	5.54	1.55	2,363	1,153	598	605	-7	643	638	5	2.98
guzzle	V	4.43	1.87	2,557	1,387							1.98
habit	N	2.68	1.66	2,884	1,696	526	581	-55	551	583	-32	4.04
hammer	B	6.96	0.19	1,798	1,455	457	570	-113	481	576	-95	3.94
hang	V	5.54	1.55	1,875	983	544	436	108	537	506	31	4.65
happen	V	1.96	1.67	2,863	1,735	676	535	141	652	581	71	5.28
harass	V	5.11	1.76	2,534	1,673	753	634	119	693	634	59	3.80
harp	B	6.39	1.37	2,019	1,054	494	554	-60	536	581	-45	3.35
haste	N	3.75	1.88	2,456	1,524	613	628	-15	613	628	-15	2.89
hasten	V	3.21	1.97	2,438	1,151	677	563	114	677	563	114	2.73
haven	N	3.59	1.82	2,882	939	624	750	-126	629	748	-119	3.77
heal	V	4.07	1.88	2,937	1,686	580	488	92	545	575	-30	4.20
health	N	4.96	2.05	2,149	948	493	567	-74	493	567	-74	4.78
hear	V	4.93	2.09	2,733	1,426	663	493	170	645	559	86	5.41
heart	N	6.86	0.45	1,422	564	461	573	-112	476	577	-101	4.74
hearth	N	3.96	2.15	2,498	1,730	625	728	-103	625	728	-103	2.62
heaven	N	6.39	1.31	2,307	1,641	529	551	-22	563	599	-36	4.31
height	N	5.04	2.01	2,472	1,282	462	578	-116	483	585	-102	4.21
heir	N	3.39	1.99	3,043	1,407	554	670	-116	574	651	-77	3.34
hem	B	5.00	1.68	2,656	1,359	599	664	-65	599	664	-65	3.25
hen	N	6.54	0.96	1,743	1,014	538	586	-48	552	601	-49	3.22
hero	N	5.54	1.40	2,433	1,404	575	706	-131	557	679	-122	4.40
hill	N	6.64	0.68	1,741	668	519	657	-138	520	657	-137	4.63
hinder	V	3.30	1.79	2,769	1,952	704	560	144	696	622	74	3.23
hint	B	4.30	1.90	2,104	767	524	558	-34	558	571	-13	4.34
hire	V	3.39	1.73	2,735	1,346	637	489	148	592	526	66	4.40
hitch	B	4.78	1.89	2,614	1,099	570	646	-76	612	676	-64	3.28
hobby	N	4.04	2.05	2,611	1,462	492	599	-107	511	602	-91	4.00

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
holler	V	5.04	2.12	2,389	795	681	683	-2	683	681	2	2.73
honor	B	3.36	2.04	3,211	2,115	484	507	-23	520	541	-21	4.23
hoot	B	4.32	2.13	3,426	1,982	693	697	-4	693	697	-4	2.98
hope	B	3.68	2.13	2,603	1,199	563	530	33	568	538	30	5.26
horror	N	5.04	1.79	2,727	1,658	495	626	-131	530	659	-129	4.21
hour	N	5.07	2.21	2,321	1,653	563	653	-90	563	639	-76	5.09
howl	B	6.21	1.20	1,763	993	783	873	-90	762	852	-90	3.92
hub	N	3.04	1.79	2,575	1,069	491	610	-119	527	623	-96	3.85
hue	N	2.93	2.29	2,312	1,072	518	631	-113	547	659	-112	3.20
hum	B	5.36	2.06	1,978	961	488	534	-46	527	562	-35	3.62
hunk	N	5.43	1.77	1,846	743	590	637	-47	603	645	-42	3.05
hurl	V	5.79	1.52	2,484	1,722	642	519	123	640	589	51	3.16
hush	B	4.43	1.85	2,236	1,059	569	572	-3	599	613	-14	2.88
hustle	V	4.14	2.14	2,850	2,269	573	548	25	584	571	13	2.95
hymn	N	5.39	1.64	2,337	1,061	840	927	-87	785	873	-88	3.46
idea	N	4.86	2.14	2,146	1,044	557	599	-42	558	586	-28	5.31
idiot	N	5.68	1.61	2,111	964	594	588	6	580	581	-1	4.26
ignite	V	5.57	1.29	2,825	2,919	657	525	132	645	588	57	3.13
ignore	V	3.25	1.78	2,749	1,149	593	438	155	590	490	100	4.73
impair	V	3.29	1.70	2,521	1,517	800	670	130	607	616	-9	3.38
impale	V	2.75	2.24	3,041	1,957				689	708	-19	2.82
impart	V	2.29	1.51	2,381	1,057	709	555	154	685	629	56	3.04
impede	V	2.93	1.86	2,469	1,469	724	588	136	728	636	92	2.93
imply	V	1.75	1.29	2,518	1,409	665	525	140	613	572	41	4.44
impose	V	3.39	2.01	2,753	1,457	653	488	165	600	559	41	4.12
incite	V	2.96	1.69	2,416	1,291	711	566	145	741	674	67	3.04
incur	V	2.25	1.35	1,989	711	763	689	74	705	671	34	3.50
indict	V	2.82	1.79	3,139	1,427				700	697	3	3.18
induce	V	3.14	1.88	2,367	1,839	662	514	148	586	582	4	3.73
infect	V	4.39	1.75	2,889	1,514	626	512	114	586	586	0	3.83
infer	V	2.43	1.60	2,098	1,106	699	529	170	694	570	124	3.40
infest	V	3.93	1.88	3,361	2,434				606	611	-5	2.86
inform	V	4.04	2.01	2,595	1,286	602	456	146	597	510	87	4.44
ingest	V	4.04	1.91	2,516	1,312	720	560	160	688	609	79	3.19
inject	V	5.71	1.36	2,360	1,245	622	473	149	593	566	27	3.51
injure	V	4.82	1.83	3,575	3,043	702	550	152	602	595	7	3.89
injury	N	5.07	1.94	2,807	1,515	516	551	-35	529	561	-32	4.12
insect	N	6.57	0.79	1,505	611	618	732	-114	596	662	-66	3.69
insist	V	4.14	1.90	2,251	1,129	630	502	128	600	537	63	4.23
insure	V	2.96	1.77	3,092	1,860	654	556	98	665	601	64	3.91
intend	V	2.04	1.10	2,574	1,298	676	580	96	606	588	18	4.68
intent	N	3.11	1.59	2,625	1,847	517	569	-52	527	576	-49	4.14
invade	V	4.64	1.68	2,611	1,271	665	520	145	612	578	34	3.76
invent	V	3.11	1.95	3,109	1,635	658	495	163	613	564	49	4.04
invert	V	3.32	1.91	2,945	1,708	592	568	24	555	610	-55	3.43
invest	V	3.93	1.90	2,612	1,760	651	481	170	621	524	97	4.19
ion	N	3.61	2.18	3,181	2,176	530	629	-99	551	637	-86	3.63
irony	N	1.79	1.10	2,796	1,683	518	574	-56	530	586	-56	3.51
item	N	4.93	2.16	3,048	3,124	517	604	-87	529	592	-63	4.93
join	V	4.75	1.73	2,564	1,469	605	462	143	592	493	99	4.81
jolt	B	4.85	1.73	2,522	1,673	600	655	-55	618	664	-46	2.99
joy	N	5.61	1.91	1,761	786	485	558	-73	491	562	-71	4.10
juggle	V	6.25	1.21	2,155	1,004	641	560	81	561	560	1	3.42
jumble	B	4.18	2.06	2,422	1,311	645	718	-73	643	700	-57	2.75
jungle	N	6.89	0.31	1,471	623	498	662	-164	508	667	-159	3.77
keg	N	6.32	1.02	2,183	1,174	522	632	-110	530	622	-92	3.21
kelp	N	5.61	2.04	2,388	1,572	979	1069	-90	979	1069	-90	3.28
kettle	N	6.54	0.88	1,767	859	547	673	-126	547	673	-126	3.18
kidnap	V	5.14	1.94	2,287	772	612	546	66	578	605	-27	3.49
kit	N	4.93	1.76	2,520	1,065	489	624	-135	499	617	-118	4.51
knack	N	2.48	1.63	2,798	1,264	639	687	-48	639	687	-48	2.80
kneel	V	6.14	1.15	2,103	961	692	562	130	668	639	29	3.33
knob	N	6.57	1.07	1,790	840	513	624	-111	531	629	-98	3.50

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
label	B	5.57	1.75	2,384	1,357	472	568	-96	497	567	-70	4.60
lack	B	1.93	1.12	2,976	1,640	479	531	-52	504	542	-38	4.72
lad	N	5.14	1.78	2,579	2,769	538	614	-76	543	620	-77	3.47
lake	N	6.82	0.55	2,281	3,855	500	655	-155	507	656	-149	4.40
lamp	N	6.74	0.53	1,741	986	595	754	-159	579	724	-145	3.92
lane	N	5.43	1.83	2,490	1,745	560	677	-117	561	672	-111	4.21
lapel	N	4.75	2.27	2,188	1,060	630	743	-113	630	743	-113	2.38
lapse	B	3.29	1.92	2,854	1,437	682	751	-69	683	730	-47	3.33
lasso	B	6.33	1.49	1,796	720	695	725	-30	695	725	-30	2.26
lather	B	4.82	2.07	2,273	824	645	716	-71	645	716	-71	2.58
law	N	4.36	2.09	2,721	1,522	481	580	-99	491	572	-81	5.24
lawn	N	6.57	0.84	1,696	854	526	629	-103	537	634	-97	3.49
lawyer	N	6.36	1.03	2,069	1,044	544	578	-34	530	565	-35	4.38
leak	B	5.75	1.38	2,582	1,388	611	679	-68	588	635	-47	4.01
learn	V	3.93	2.11	2,765	1,428	619	439	180	582	485	97	5.14
lease	B	3.57	2.08	3,435	2,153	538	587	-49	580	619	-39	3.86
ledge	N	5.82	1.36	2,059	860	640	701	-61	640	703	-63	3.29
leg	N	6.79	0.63	1,544	543	510	640	-130	570	649	-79	4.65
legend	N	4.43	1.81	2,708	1,098	554	705	-151	672	795	-123	4.52
lend	V	3.75	1.69	2,633	1,165	628	468	160	605	553	52	3.83
length	N	4.18	2.09	3,515	2,169	625	718	-93	622	709	-87	4.73
lesson	N	4.43	1.77	2,323	1,214	510	565	-55	513	549	-36	4.18
lever	N	5.79	1.57	3,013	2,239	498	606	-108	514	610	-96	3.47
liar	N	4.82	2.06	2,810	1,584	663	672	-9	658	661	-3	3.89
lick	V	6.43	1.17	1,894	752	646	530	116	653	605	48	4.05
lid	N	6.36	1.13	1,965	1,091	518	626	-108	529	631	-102	3.53
life	N	4.71	2.14	2,702	1,470	487	562	-75	498	564	-66	5.42
limb	N	6.14	1.27	1,797	784	638	691	-53	598	658	-60	3.59
linger	V	3.25	1.71	2,720	1,256	656	550	106	629	622	7	3.24
link	B	4.61	1.77	2,757	1,327	490	549	-59	517	564	-47	4.90
lint	N	5.96	1.72	2,082	1,133	628	668	-40	628	668	-40	3.00
lion	N	6.93	0.26	1,447	573	509	647	-138	537	664	-127	4.13
listen	V	4.93	2.11	2,200	1,405	597	440	157	587	483	104	4.78
liter	N	5.79	1.42	2,740	1,411	589	730	-141	615	743	-128	3.33
litter	B	5.82	1.33	2,775	1,317	476	569	-93	518	596	-78	3.63
lizard	N	6.89	0.42	1,513	629	601	681	-80	592	670	-78	3.85
locate	V	2.93	1.49	3,378	1,777	688	535	153	612	608	4	4.71
loosen	V	4.63	1.42	3,561	2,005	606	487	119	615	553	62	3.36
lose	V	3.96	1.77	4,186	3,866	636	459	177	552	501	51	5.14
loss	N	4.21	1.75	2,852	1,667	458	552	-94	472	552	-80	4.56
lotion	N	6.54	1.04	1,790	1,006	559	666	-107	586	679	-93	3.11
lounge	B	5.25	2.08	2,511	1,197	494	634	-140	505	641	-136	3.40
love	B	6.25	1.43	2,480	1,784	536	502	34	543	512	31	5.31
lull	B	3.36	2.06	2,590	1,400	673	712	-39	690	699	-9	2.81
lung	N	6.50	0.96	1,793	1,178	994	1013	-19	926	955	-29	4.21
lurk	V	4.18	2.02	2,365	1,316	623	535	88	632	593	39	3.80
luxury	N	5.14	1.99	2,459	1,419	490	558	-68	508	569	-61	3.59
magnet	N	6.64	0.68	2,048	2,019	488	597	-109	505	604	-99	3.51
malt	B	5.93	1.33	2,363	1,572	510	614	-104	523	620	-97	3.32
manage	V	2.93	1.80	3,547	2,680	634	476	158	589	528	61	4.72
mane	N	5.82	1.91	2,041	969	538	647	-109	654	715	-61	2.98
manner	N	2.11	1.45	2,470	900	619	687	-68	612	673	-61	4.40
manor	N	4.78	1.80	2,590	1,101	610	742	-132	610	742	-132	3.21
mantel	N	6.04	1.37	2,233	988	621	702	-81	621	702	-81	2.31
mar	V	2.43	1.50	2,384	1,261	742	827	-85	699	787	-88	4.69
marrow	N	3.29	2.02	2,724	1,491	529	626	-97	529	626	-97	3.02
marry	V	6.30	0.95	2,003	1,008	672	506	166	599	541	58	4.56
marsh	N	5.39	1.57	2,340	1,347	831	959	-128	828	956	-128	3.73
marvel	B	3.07	1.66	2,954	1,630	740	826	-86	739	824	-85	4.32
math	N	5.14	2.07	2,673	1,380	471	540	-69	477	546	-69	4.30
meal	N	6.54	0.79	2,267	1,258	511	600	-89	529	594	-65	4.02
meat	N	6.68	0.72	1,601	575	455	513	-58	462	519	-57	4.19
meddle	V	2.29	1.24	3,128	1,254	751	645	106	769	736	33	3.19

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log Frequency
melody	N	4.43	1.89	3,219	1,368	466	581	-115	491	591	-100	3.57
melt	V	5.71	1.49	2,357	1,553	558	475	83	559	587	-28	3.89
member	N	3.61	2.13	2,932	1,261	541	611	-70	527	589	-62	5.16
memo	N	5.61	1.66	2,664	1,837	513	630	-117	532	635	-103	3.59
mend	V	4.64	1.57	2,873	1,591	701	561	140	712	620	92	2.75
menu	N	6.67	0.78	3,018	7,852	546	644	-98	543	632	-89	4.54
mercy	N	2.71	1.96	3,366	1,661	577	628	-51	580	630	-50	3.79
merger	N	2.64	1.28	3,068	1,633	501	620	-119	551	658	-107	3.34
mesh	B	3.68	1.83	3,241	2,526	473	558	-85	498	570	-72	3.35
meteor	N	6.25	1.48	2,354	1,981	657	791	-134	656	771	-115	3.18
method	N	2.44	1.63	2,802	1,881	486	576	-90	506	579	-73	4.92
mile	N	4.64	2.15	3,097	1,965	561	680	-119	532	631	-99	4.66
mince	V	4.14	1.78	2,780	1,480	668	626	42	754	789	-35	3.06
mingle	V	4.11	1.69	3,066	1,557	690	558	132	671	646	25	2.94
misery	N	5.36	1.87	2,723	2,312	553	593	-40	594	630	-36	3.50
mitten	N	6.39	1.29	2,402	1,442	751	868	-117	697	758	-61	2.61
modify	V	2.79	1.50	3,211	1,776	631	459	172	558	533	25	4.64
molest	V	4.54	1.79	2,998	1,632	742	626	116	724	665	59	3.14
moment	N	3.18	2.16	3,104	2,250	538	642	-104	540	639	-99	4.71
monk	N	6.14	1.46	2,044	1,079	544	691	-147	536	663	-127	3.78
mood	N	4.68	1.98	2,961	2,053	520	612	-92	530	613	-83	3.91
morale	N	3.00	1.72	2,685	1,262	700	812	-112	700	812	-112	3.49
morsel	N	4.25	1.69	2,771	1,458	681	709	-28	681	709	-28	2.21
moss	N	5.89	1.42	1,812	880	608	724	-116	608	724	-116	3.57
motel	N	6.64	0.68	1,553	597	492	618	-126	516	633	-117	3.37
moth	N	6.68	0.55	1,961	1,452	560	663	-103	563	650	-87	2.96
mourn	V	5.57	1.77	2,121	1,330	679	547	132	623	668	-45	3.42
movie	N	6.86	0.45	1,581	732	460	596	-136	474	588	-114	4.96
mud	N	6.82	0.55	1,574	656	451	567	-116	475	571	-96	4.15
muffle	V	4.64	1.79	2,361	1,026				624	674	-50	2.90
munch	V	6.04	1.10	2,333	1,971	588	588	0	629	647	-18	3.28
museum	N	6.82	0.55	1,535	624	492	643	-151	511	647	-136	4.09
mutter	V	4.75	1.65	2,484	1,589	690	616	74	673	653	20	3.25
myth	N	4.18	1.94	2,731	1,747	510	627	-117	521	623	-102	4.07
nab	V	3.54	2.28	2,464	1,472	650	588	62	675	615	60	2.67
nag	V	5.25	1.80	2,258	1,375	538	610	-72	561	609	-48	3.21
napkin	N	6.46	1.26	1,746	947	638	722	-84	658	714	-56	2.85
nation	N	5.89	1.57	2,095	1,120	509	621	-112	541	649	-108	4.75
nature	N	5.61	1.50	2,379	1,010	501	601	-100	507	606	-99	4.73
nectar	N	5.32	1.28	2,704	1,076	564	657	-93	564	657	-93	2.71
neon	N	5.85	1.61	2,383	1,032	492	618	-126	492	618	-126	3.56
nerve	N	4.46	1.95	2,881	1,696	501	575	-74	528	590	-62	3.82
nestle	V	4.25	1.94	2,535	1,516	705	734	-29	680	715	-35	2.86
news	N	5.96	1.23	1,983	814	478	555	-77	478	555	-77	5.17
nickel	N	6.68	0.90	1,730	805	492	573	-81	507	583	-76	3.34
niece	N	5.82	1.83	2,322	1,287	622	626	-4	639	641	-2	2.93
night	N	6.57	0.96	1,733	1,029	499	604	-105	505	609	-104	5.05
nip	B	4.00	2.05	2,485	1,188	638	572	66	668	640	28	3.19
noon	N	4.21	2.42	2,798	1,656	624	679	-55	624	679	-55	3.69
note	B	6.33	0.78	2,115	976	524	571	-47	529	577	-48	5.30
notify	V	3.11	1.79	3,179	2,539	699	560	139	703	632	71	4.03
notion	N	1.46	0.74	2,901	1,679	514	566	-52	539	570	-31	4.13
noun	N	3.64	2.48	3,288	1,939	567	653	-86	586	654	-68	3.35
nozzle	N	5.46	1.69	2,335	954	596	709	-113	604	706	-102	2.95
nurse	B	6.79	0.50	1,792	1,044	520	495	25	529	541	-12	4.25
oasis	N	5.59	1.65	2,073	1,125	708	811	-103	708	811	-103	3.61
oath	N	4.89	1.89	2,079	980	598	663	-65	603	661	-58	3.60
obey	V	4.21	2.10	2,968	1,843	681	504	177	680	545	135	3.80
obtain	V	4.46	2.03	2,381	1,702	661	512	149	656	580	76	4.71
occupy	V	4.14	1.76	3,058	1,687	637	512	125	574	584	-10	3.93
occur	V	3.11	1.99	2,733	1,854	637	547	90	605	597	8	4.75
ocean	N	6.96	0.19	1,521	559	483	629	-146	500	640	-140	4.11
odor	N	4.96	1.91	3,106	1,631	539	608	-69	557	619	-62	3.23

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
offend	V	3.86	1.78	2,642	1,034	731	549	182	675	591	84	4.09
office	N	6.71	0.53	1,789	1,401	508	613	-105	522	623	-101	5.01
omelet	N	6.64	0.73	1,526	610							1.48
omit	V	2.89	1.85	3,198	1,511	645	519	126	625	586	39	3.70
onion	N	6.82	0.55	1,261	306	586	698	-112	584	685	-101	3.66
opera	N	6.32	0.94	1,911	636	454	592	-138	466	595	-129	3.89
oppose	V	3.14	1.76	2,789	1,428	634	487	147	579	569	10	4.49
ordeal	N	1.86	1.38	3,114	1,619	627	678	-51	627	678	-51	3.05
ore	N	5.25	1.96	2,580	1,203	537	641	-104	577	676	-99	3.26
organ	N	6.36	1.10	2,364	1,371	465	576	-111	486	587	-101	4.36
orphan	B	5.25	1.84	2,299	725	568	624	-56	591	635	-44	3.26
ounce	N	4.04	1.82	2,931	1,313	592	660	-68	609	677	-68	3.56
outlet	N	5.89	1.71	2,011	690	526	621	-95	549	619	-70	3.80
oven	N	6.82	0.48	1,476	978	518	662	-144	525	658	-133	3.65
owe	V	4.04	1.84	2,505	951	641	543	98	623	575	48	3.96
owl	N	6.86	0.59	1,289	414	509	608	-99	526	620	-94	3.67
pacify	V	3.75	1.97	2,439	1,207	750	665	85	750	665	85	2.44
packet	N	5.79	1.55	2,619	1,683	483	582	-99	499	568	-69	4.35
pact	N	3.11	1.72	2,472	1,106	555	705	-150	555	705	-150	3.14
pad	B	5.86	1.38	1,801	636	477	604	-127	531	629	-98	4.23
pail	N	5.86	1.67	1,961	1,072	581	737	-156	581	737	-156	2.70
pane	N	4.89	1.95	2,749	1,466	546	667	-121	557	672	-115	3.11
pang	N	2.50	1.86	2,714	1,260	676	755	-79	676	755	-79	2.86
pant	B	5.29	1.86	2,348	1,223	642	609	33	581	616	-35	4.08
pantry	N	6.18	1.47	1,847	1,082	625	741	-116	625	741	-116	2.33
parch	V	3.36	1.81	2,892	1,748							1.98
pardon	B	3.39	1.71	2,921	2,010	592	596	-4	605	608	-3	3.73
pare	V	2.36	1.70	3,798	3,341	757	699	58	760	718	42	3.06
parlor	N	5.14	1.86	2,795	1,147	554	674	-120	554	674	-120	2.83
paste	B	5.50	1.53	2,173	1,245	631	583	48	628	592	36	3.93
pastry	N	6.36	1.28	2,003	1,358	524	642	-118	556	662	-106	2.93
path	N	6.39	1.03	2,088	1,321	495	603	-108	498	600	-102	4.70
patio	N	6.46	0.96	1,518	594	583	697	-114	583	697	-114	2.84
pave	V	4.22	1.74	2,552	1,146	598	543	55	568	606	-38	3.41
pea	N	6.57	1.03	1,685	657	512	604	-92	552	635	-83	3.38
peace	N	4.50	2.05	3,831	3,608	473	525	-52	473	525	-52	4.61
pear	N	6.71	1.15	1,655	690	552	654	-102	581	672	-91	3.11
pecan	N	6.07	1.18	1,936	961	601	700	-99	601	700	-99	2.25
peddle	V	5.71	1.36	3,511	2,798	680	586	94	681	623	58	2.87
peep	B	5.25	1.69	2,324	1,219	615	630	-15	629	651	-22	3.06
penny	N	6.71	0.98	1,415	650	512	583	-71	535	592	-57	3.82
period	N	5.71	2.11	2,583	1,405	495	628	-133	509	628	-119	4.79
perish	V	4.21	2.01	2,714	1,350	723	651	72	712	662	50	3.18
person	N	6.43	1.20	1,819	804	487	559	-72	494	563	-69	5.30
pest	N	5.96	1.37	2,503	1,314	549	598	-49	589	617	-28	3.23
pester	V	4.54	2.12	2,243	1,269	748	583	165	785	710	75	2.77
pickle	B	6.57	1.20	2,156	1,310	514	623	-109	549	635	-86	3.28
pie	N	7.00	0.00	1,777	1,191	485	600	-115	500	607	-107	3.75
pier	N	6.50	0.88	1,788	637	536	685	-149	547	668	-121	3.32
pierce	V	6.14	1.21	2,293	1,724	522	579	-57	518	598	-80	4.15
pigeon	N	6.67	0.73	1,813	1,224	660	719	-59	615	671	-56	3.19
pile	B	5.89	1.57	2,460	1,778	498	583	-85	551	612	-61	3.92
pillow	N	6.79	0.57	1,625	1,019	570	675	-105	572	670	-98	3.49
pint	N	5.00	1.87	2,217	804	554	658	-104	565	662	-97	3.29
pitch	B	5.37	1.94	2,703	1,823	450	522	-72	477	541	-64	4.11
pizza	N	6.96	0.19	1,618	674	469	545	-76	478	551	-73	3.77
plan	B	3.46	1.75	2,490	1,498	484	496	-12	520	531	-11	5.15
planet	N	6.89	0.31	2,005	949	503	630	-127	505	624	-119	4.55
plaza	N	5.93	1.24	2,277	1,276	688	797	-109	688	797	-109	3.76
plea	N	4.30	1.75	2,597	1,201	548	578	-30	568	574	-6	3.50
plead	V	5.04	1.91	2,267	778	649	506	143	649	621	28	3.54
pledge	B	4.86	1.69	2,288	1,020	528	533	-5	577	594	-17	3.65
plod	V	2.68	1.74	3,027	1,957				640	656	-16	2.49
plow	B	5.67	1.47	1,844	883	561	522	39	611	604	7	3.19

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log Frequency
poach	V	4.18	1.96	3,178	2,268				667	685	-18	2.32
poem	N	5.71	1.70	1,818	1,017	499	596	-97	513	594	-81	3.95
poet	N	5.07	1.72	2,461	1,126	516	643	-127	531	643	-112	3.74
poise	B	3.39	1.55	3,001	1,619	788	822	-34	694	727	-33	3.14
poison	B	5.32	1.74	2,491	1,374	458	518	-60	511	560	-49	3.94
poker	N	6.64	0.62	1,708	733	507	623	-116	507	623	-116	3.66
policy	N	2.54	2.03	2,477	1,057	481	567	-86	498	572	-74	4.80
pollen	N	5.50	1.60	2,285	1,206	733	816	-83	733	816	-83	2.94
pond	N	6.57	0.84	1,749	852	496	653	-157	514	658	-144	3.62
ponder	V	3.79	1.85	2,934	1,435	664	522	142	678	613	65	3.50
poppy	N	4.75	2.27	2,244	1,060	530	650	-120	550	661	-111	3.05
porch	N	6.29	1.27	1,910	978	623	727	-104	623	727	-104	3.23
poster	N	6.48	1.28	2,050	1,355	517	599	-82	518	590	-72	4.58
pour	V	5.67	1.69	2,417	1,729	605	611	-6	595	610	-15	4.21
pout	B	4.71	2.14	2,246	840	683	594	89	687	645	42	2.75
pray	V	6.18	1.28	1,949	1,682	624	509	115	629	534	95	4.14
prayer	N	6.18	1.61	2,027	1,340	508	574	-66	523	577	-54	4.13
preach	V	5.36	1.45	2,480	1,376	667	528	139	640	572	68	3.76
prefer	V	2.61	1.42	3,238	1,879	648	572	76	639	606	33	4.89
press	B	5.25	1.90	2,760	1,347	476	564	-88	490	563	-73	4.98
priest	N	6.71	0.66	1,762	1,286	670	803	-133	638	755	-117	4.26
prince	N	6.29	1.12	2,086	1,224	446	574	-128	456	580	-124	4.09
prison	N	6.68	0.61	1,612	758	526	591	-65	534	596	-62	4.19
prop	B	4.14	1.92	2,660	1,494	460	507	-47	504	549	-45	3.74
propel	V	4.33	1.90	2,255	860	688	577	111	650	611	39	2.96
prose	N	3.18	1.96	2,626	1,431	532	596	-64	569	631	-62	3.35
prove	V	2.00	1.41	2,614	1,085	631	445	186	604	512	92	4.83
pry	V	4.32	1.85	2,481	1,097	754	617	137	729	651	78	3.31
pub	N	5.71	1.86	2,036	901	826	884	-58	823	881	-58	5.02
pulley	N	6.00	1.44	1,962	646	743	858	-115	717	824	-107	3.20
pulpit	N	4.25	2.22	2,060	939	674	796	-122	674	796	-122	2.57
pump	B	5.82	1.36	2,337	1,525	480	511	-31	509	534	-25	4.29
pun	B	3.11	1.97	3,109	1,902	522	590	-68	532	597	-65	3.67
punish	V	4.85	1.59	2,701	1,426	651	469	182	660	546	114	3.93
punt	B	5.14	1.99	2,179	884	563	563	0	585	602	-17	2.80
puppy	N	6.96	0.19	1,402	717	488	551	-63	509	559	-50	4.10
purify	V	4.25	1.84	2,320	1,781	672	570	102	630	642	-12	3.43
pursue	V	4.18	1.83	2,473	1,264	665	489	176	639	539	100	4.02
put	V	3.18	1.61	3,671	1,749	556	419	137	550	437	113	5.44
quart	N	5.11	1.87	2,058	1,255	568	674	-106	589	683	-94	3.18
query	B	2.50	1.53	2,641	1,059	531	555	-24	558	561	-3	4.22
quip	B	1.75	1.32	2,589	1,388	857	889	-32	788	814	-26	2.94
quit	V	3.64	1.93	2,877	1,369	585	463	122	590	485	105	4.29
quota	N	2.29	1.76	2,911	1,336	512	570	-58	542	575	-33	3.71
radar	N	5.39	1.59	2,267	1,054	453	556	-103	461	561	-100	3.90
rake	B	6.79	0.79	1,626	829	532	568	-36	573	592	-19	3.16
rally	B	5.07	2.02	2,043	1,065	490	594	-104	525	611	-86	3.87
ramble	V	4.75	2.03	2,188	885	684	549	135	633	604	29	3.42
ravine	N	4.68	2.29	2,320	1,313	632	786	-154	632	786	-154	2.45
razor	N	6.82	0.39	2,503	1,728	489	600	-111	508	615	-107	3.56
react	V	4.54	1.84	2,273	1,125	648	481	167	630	520	110	3.99
read	V	5.68	1.44	3,049	1,953	593	465	128	579	484	95	5.61
realm	N	3.43	2.15	1,948	940	545	684	-139	550	682	-132	4.02
reap	V	3.86	1.74	2,163	823	700	616	84	704	632	72	3.22
rebuff	B	2.61	1.47	3,049	2,354				782	766	16	2.42
recede	V	3.79	1.97	2,453	1,263				623	699	-76	2.58
recipe	N	5.11	1.99	2,495	1,251	532	603	-71	548	612	-64	4.23
recite	V	4.25	2.03	2,607	1,102	655	505	150	646	577	69	3.20
redeem	V	3.46	1.82	2,657	1,583	685	549	136	651	612	39	3.34
reduce	V	2.86	1.33	2,840	1,438	602	454	148	565	517	48	4.68
reef	N	5.04	1.79	2,140	838	522	686	-164	535	684	-149	3.55
reel	B	5.25	1.82	2,246	905	461	568	-107	504	588	-84	3.66
refer	V	3.46	1.88	2,613	998	592	480	112	597	551	46	4.86
refine	V	2.96	1.72	3,028	1,738	699	542	157	608	600	8	3.50

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
refute	V	2.14	1.48	2,784	1,845	697	509	188	690	567	123	3.61
regain	V	3.79	1.91	2,621	2,035	653	496	157	647	566	81	3.53
regime	N	3.39	2.08	3,130	1,692	549	655	-106	570	661	-91	3.82
region	N	4.79	1.71	2,398	835	528	665	-137	537	661	-124	4.54
reign	B	4.00	1.89	2,701	2,243	578	633	-55	593	649	-56	3.60
relate	V	3.07	1.54	2,477	1,332	629	492	137	565	587	-22	4.98
relax	V	5.32	1.85	2,344	1,266	616	472	144	595	528	67	4.09
relent	V	2.61	1.55	2,105	940				796	806	-10	2.51
relic	N	4.54	2.03	1,831	581	938	1016	-78	901	978	-77	3.74
relief	N	3.96	1.82	3,429	1,906	468	557	-89	468	557	-89	3.96
rely	V	3.61	2.06	2,913	1,305	641	473	168	623	523	100	4.17
remain	V	2.36	1.28	3,473	2,048	577	456	121	555	544	11	4.81
remind	V	2.61	1.57	3,155	1,547	620	464	156	607	546	61	4.32
remove	V	3.64	1.91	2,667	1,180	566	447	119	579	510	69	4.96
render	V	2.50	1.67	2,491	1,168	592	453	139	543	535	8	4.17
repair	B	5.39	1.47	2,578	1,492	503	489	14	528	515	13	4.29
repay	V	3.89	2.01	2,742	1,400	685	541	144	690	579	111	3.12
repent	V	2.93	1.59	3,453	2,836	721	560	161	721	560	161	3.17
report	B	5.18	1.81	2,882	1,799	538	581	-43	531	577	-46	5.26
rescue	B	5.89	1.42	2,500	1,704	503	557	-54	521	564	-43	4.14
resent	V	2.79	1.45	3,279	2,092	646	541	105	654	558	96	3.34
reside	V	3.54	1.69	2,489	899	646	561	85	625	616	9	3.86
resign	V	3.86	1.78	2,709	1,152	645	507	138	640	578	62	3.58
resin	N	3.07	2.21	2,640	1,313	482	589	-107	514	611	-97	3.23
resist	V	3.79	1.71	2,818	1,398	621	467	154	619	500	119	4.03
retain	V	2.75	1.65	2,899	1,534	610	470	140	620	563	57	4.07
retire	V	4.57	1.93	2,337	1,132	650	501	149	565	568	-3	3.97
reveal	V	4.21	1.87	3,339	2,147	562	462	100	547	543	4	4.38
revere	V	2.71	1.63	2,666	1,551	638	628	10	722	719	3	3.14
revert	V	2.32	1.44	2,639	2,094	643	535	108	645	588	57	3.38
review	B	3.73	1.51	3,294	2,124	483	548	-65	510	562	-52	4.83
revise	V	3.75	1.73	2,179	838	689	644	45	683	768	-85	4.46
revive	V	3.93	1.68	2,809	1,229	651	513	138	628	581	47	3.43
rhyme	B	4.79	1.79	2,736	1,897	584	585	-1	583	595	-12	3.49
rhythm	N	4.89	2.06	2,873	1,872	466	573	-107	484	585	-101	3.77
riddle	B	4.79	1.95	2,156	794	517	609	-92	557	630	-73	3.33
ridge	N	4.75	1.82	2,648	1,254	524	656	-132	626	747	-121	3.99
rigor	N	3.14	1.76	2,031	799	602	637	-35	634	665	-31	2.86
ring	B	6.79	0.79	1,762	700	500	657	-157	496	641	-145	4.74
rink	N	4.89	2.06	2,735	1,179	536	673	-137	555	681	-126	3.40
rinse	B	5.00	1.81	2,867	1,486	583	558	25	604	581	23	3.38
ripen	V	4.79	1.87	2,968	3,344							2.32
river	N	6.93	0.26	1,450	841	509	685	-176	511	679	-168	4.50
road	N	6.61	1.10	1,631	876	513	652	-139	512	642	-130	4.88
roam	V	4.18	1.63	2,931	1,179	637	510	127	624	568	56	3.34
roast	B	6.11	1.10	2,219	1,304	513	537	-24	534	571	-37	3.43
rob	V	5.71	1.51	2,305	1,717	543	585	-42	550	587	-37	4.39
robot	N	6.82	0.39	1,787	930	459	594	-135	493	606	-113	4.23
rodeo	N	6.18	0.98	2,000	781	490	581	-91	490	581	-91	3.01
role	N	2.93	1.68	3,500	1,835	490	592	-102	498	592	-94	4.59
rot	B	4.75	1.86	2,568	970	553	505	48	562	548	14	3.58
rotate	V	5.11	1.79	2,264	1,173	570	463	107	538	536	2	3.91
rouse	V	3.29	1.78	3,148	3,913	645	634	11	645	649	-4	2.99
rug	N	6.64	1.03	1,462	605	538	634	-96	575	640	-65	3.30
ruin	B	4.46	2.17	2,877	1,636	641	614	27	644	665	-21	4.24
rum	N	5.89	1.55	1,738	634	518	635	-117	518	635	-117	2.98
rumple	V	3.39	1.83	2,784	1,700							2.05
rye	N	4.82	2.11	2,670	1,563	552	683	-131	552	683	-131	3.10
safety	N	5.04	1.69	2,636	1,196	470	543	-73	470	543	-73	4.38
salad	N	6.64	1.34	1,579	504	483	586	-103	521	612	-91	3.47
salary	N	4.07	2.34	2,851	1,297	693	728	-35	688	717	-29	4.56
sale	N	4.71	2.02	2,795	1,528	685	755	-70	620	689	-69	5.18
salon	N	5.46	1.77	2,923	1,689	543	667	-124	543	667	-124	2.87
satire	N	3.21	2.04	2,294	1,108	536	597	-61	536	597	-61	3.22

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
saucer	N	6.00	1.52	2,057	876	505	641	-136	537	655	-118	3.28
save	V	3.75	2.05	2,797	1,532	564	425	139	557	462	95	5.00
scene	N	4.50	2.13	2,896	1,999	474	594	-120	482	593	-111	4.64
scent	B	5.14	1.78	3,041	2,721	486	594	-108	510	604	-94	3.48
scoff	V	3.68	1.91	2,376	1,243	683	617	66	677	646	31	2.81
scold	V	5.07	1.82	1,997	704	756	597	159	717	654	63	2.78
scoop	B	5.64	1.57	2,541	1,158	551	588	-37	576	608	-32	3.54
scorch	V	5.36	1.50	2,937	1,916				601	645	-44	2.91
scour	V	3.67	2.15	2,761	1,514				627	664	-37	2.59
scuff	B	4.46	1.79	2,407	936	899	908	-9	851	883	-32	3.03
sea	N	6.93	0.38	1,371	426	554	730	-176	553	726	-173	4.60
seal	B	6.32	1.22	1,868	1,332	456	539	-83	526	608	-82	4.30
sear	V	3.32	1.87	3,244	1,766	605	656	-51	571	647	-76	3.64
search	B	3.82	1.52	3,083	1,565	506	514	-8	529	530	-1	5.00
see	V	4.68	2.21	2,630	1,332	585	441	144	597	488	109	5.94
seek	V	4.11	1.89	2,904	1,828	569	451	118	605	574	31	4.78
seep	V	3.68	1.74	2,995	1,636	689	605	84	682	682	0	2.79
seize	V	4.21	1.87	2,577	1,406	611	514	97	613	588	25	3.73
send	V	4.64	1.97	3,660	3,075	614	521	93	605	528	77	5.67
sentry	N	2.64	2.02	2,504	1,283	872	948	-76	872	948	-76	2.98
sermon	N	5.21	1.69	2,725	1,273	530	644	-114	569	647	-78	3.13
settle	V	3.50	1.75	2,935	1,650	627	457	170	596	513	83	4.23
sever	V	4.43	2.10	2,987	1,964	571	543	28	564	593	-29	3.33
sew	V	6.22	1.01	1,994	809	589	476	113	532	536	-4	3.69
sewage	N	6.18	0.94	2,506	1,315	577	652	-75	577	652	-75	2.90
shanty	N	3.82	2.21	2,613	1,537	687	819	-132	687	819	-132	2.35
shawl	N	5.71	1.84	2,177	1,011							1.52
shelf	N	6.50	0.96	2,198	1,025	565	677	-112	582	677	-95	3.94
shield	B	5.96	1.40	2,570	1,739	673	814	-141	629	750	-121	4.34
shift	B	3.82	1.54	3,367	1,797	472	502	-30	490	520	-30	4.38
shirk	V	2.96	2.13	3,038	2,017							2.44
shock	B	5.07	1.74	3,055	2,189	461	543	-82	515	557	-42	4.29
shred	B	5.21	1.60	2,940	1,638	614	576	38	619	601	18	3.52
shriek	B	5.93	1.49	3,136	3,019	586	660	-74	655	698	-43	2.99
shrimp	N	6.79	0.50	1,538	586	558	630	-72	558	630	-72	3.30
shrink	V	5.96	1.60	2,157	930	530	536	-6	544	560	-16	3.79
shrub	N	6.04	1.55	2,280	1,481	634	729	-95	640	714	-74	2.79
shun	V	2.79	1.85	2,563	1,054	573	522	51	611	561	50	3.13
shut	V	5.07	1.78	2,407	1,154	570	459	111	571	476	95	4.36
sidle	V	2.04	1.17	4,423	5,646							0.70
sift	V	4.29	1.82	2,736	893	675	562	113	677	617	60	3.11
simmer	V	5.11	1.48	2,572	1,339	738	723	15	719	725	-6	3.15
sing	V	6.18	1.09	2,971	2,468	572	448	124	540	539	1	4.55
sit	V	6.37	1.15	2,216	2,241	591	436	155	565	535	30	4.95
sizzle	V	6.21	0.83	2,102	1,198	634	644	-10	622	677	-55	2.66
ski	Ba	6.70	0.72	1,464	493	485	564	-79	504	564	-60	4.33
skid	B	5.29	1.76	2,113	1,528	536	590	-54	553	606	-53	3.01
skill	N	2.64	1.25	3,573	1,865	545	598	-53	687	719	-32	5.00
skim	V	3.89	1.77	3,040	1,085	580	526	54	608	571	37	3.28
skip	V	5.00	1.96	2,692	1,396	577	456	121	580	487	93	4.10
skit	N	4.96	1.84	2,265	833	582	671	-89	587	673	-86	3.27
skull	N	6.82	0.61	1,484	706	576	750	-174	573	733	-160	3.93
sky	N	6.93	0.38	1,527	575	516	669	-153	521	666	-145	4.36
slang	N	3.89	2.28	2,780	1,669	529	607	-78	529	607	-78	3.29
sling	B	5.32	1.61	2,738	1,456	550	545	5	575	592	-17	3.10
slob	N	5.68	1.63	2,195	935	614	684	-70	649	698	-49	2.75
slogan	N	5.11	1.87	2,482	1,117	524	627	-103	612	696	-84	3.46
slouch	B	5.82	1.33	2,415	1,110	739	739	0	739	739	0	2.29
sludge	N	4.29	2.00	2,409	1,364	536	629	-93	536	629	-93	2.81
slug	B	6.43	1.20	1,676	651	788	941	-153	753	895	-142	3.73
smack	V	6.07	1.25	2,730	2,307	557	512	45	582	554	28	3.60
smear	B	5.29	1.38	2,035	811	550	516	34	576	565	11	3.51
smell	B	5.07	1.82	2,903	1,382	537	510	27	554	538	16	4.17
smirk	B	5.79	1.42	2,179	1,082	596	604	-8	632	634	-2	2.94

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
smoke	B	6.50	1.14	1,518	579	488	502	-14	506	510	-4	4.46
smudge	B	5.64	1.25	2,191	1,008	625	723	-98	625	723	-98	2.56
snail	N	6.68	1.02	1,786	1,327	715	722	-7	707	716	-9	4.03
snare	B	4.46	1.71	2,395	763	485	604	-119	504	614	-110	3.10
sneer	B	4.36	2.20	2,016	1,055	621	579	42	644	620	24	2.99
sniff	V	5.71	1.49	2,231	1,317	672	620	52	654	622	32	3.49
soak	V	5.32	1.66	2,236	934	578	481	97	570	547	23	3.74
soar	V	5.54	1.67	2,315	1,076	588	565	23	571	617	-46	3.44
sob	B	6.00	1.44	2,042	745	542	533	9	617	609	8	3.50
soccer	N	6.68	0.67	1,877	934	494	597	-103	494	597	-103	3.88
soda	N	6.79	0.57	1,661	650	494	588	-94	510	597	-87	3.56
sodium	N	4.37	2.10	2,979	1,917	567	624	-57	567	624	-57	3.34
sofa	N	6.71	0.66	1,685	1,091	601	706	-105	601	706	-105	3.18
solve	V	4.46	1.99	2,120	947	657	477	180	637	532	105	4.58
son	N	6.54	0.92	2,159	1,099	503	578	-75	514	585	-71	4.72
sonar	N	3.68	1.93	2,965	1,397	593	654	-61	593	654	-61	2.70
song	N	5.89	1.29	2,795	2,031	458	595	-137	472	590	-118	4.97
soothe	V	4.61	1.95	2,035	812	722	597	125	625	625	0	3.00
sorrow	N	4.89	1.75	2,320	1,347	563	587	-24	744	799	-55	3.51
soul	N	4.68	2.09	3,067	1,576	559	676	-117	558	663	-105	4.58
soup	N	6.75	0.84	1,512	709	466	573	-107	476	577	-101	3.81
source	N	2.96	1.71	3,291	1,446	590	663	-73	580	646	-66	5.37
spa	N	6.86	0.45	1,767	887	551	642	-91	551	642	-91	3.01
speak	V	5.75	1.60	2,009	957	614	455	159	577	500	77	5.06
speck	N	4.93	1.78	2,069	695	654	696	-42	663	697	-34	2.86
speech	N	4.57	2.06	3,041	1,723	512	582	-70	516	585	-69	4.59
spell	B	4.71	1.94	3,067	1,774	499	522	-23	512	539	-27	4.67
spend	V	4.57	2.01	2,490	1,033	639	453	186	591	497	94	4.99
sphere	N	6.36	1.22	2,231	1,401	740	878	-138	722	854	-132	4.14
spice	B	6.19	0.96	1,794	595	515	548	-33	547	589	-42	3.61
spike	B	5.89	1.42	2,310	853	622	714	-92	595	683	-88	3.79
spine	N	6.21	1.26	1,918	600	575	689	-114	577	687	-110	3.74
splice	B	4.41	2.21	2,742	1,151	597	572	25	631	619	12	3.15
sponge	B	6.50	1.29	1,701	554	505	621	-116	535	635	-100	3.29
spouse	N	6.32	1.25	2,315	975	549	598	-49	576	610	-34	3.78
spray	B	6.30	1.17	2,617	1,639	483	506	-23	521	539	-18	3.92
spur	B	4.48	2.23	2,725	1,552	569	574	-5	547	596	-49	3.40
spurn	V	2.36	1.57	2,480	1,160							2.30
squad	N	5.52	1.55	2,408	1,513	463	624	-161	482	626	-144	3.77
squash	B	5.89	1.45	1,951	1,137	540	553	-13	563	578	-15	3.29
squeal	B	5.71	1.49	2,457	1,708	584	576	8	650	645	5	3.16
squirm	V	4.96	1.77	2,658	1,237	701	565	136	703	652	51	3.30
stack	B	6.04	1.26	2,599	2,212	466	567	-101	484	568	-84	4.29
stair	N	6.50	1.11	2,107	1,106	573	684	-111	585	668	-83	3.81
stalk	V	4.82	1.96	2,290	1,214	557	576	-19	582	607	-25	3.38
starve	V	5.26	1.65	2,860	1,905	695	529	166	609	543	66	3.63
statue	N	6.54	1.07	1,908	803	650	799	-149	635	778	-143	3.95
status	N	2.11	1.47	3,258	1,495	500	573	-73	500	573	-73	4.64
steak	N	6.96	0.19	1,559	434	493	564	-71	515	573	-58	3.30
steal	V	4.93	1.98	3,199	2,009	596	525	71	585	554	31	4.46
steam	B	6.61	0.69	1,685	680	464	554	-90	486	569	-83	3.82
stick	B	6.67	0.88	1,767	737	512	445	67	510	470	40	4.59
stifle	V	3.68	1.96	3,273	1,857	633	537	96	645	609	36	3.21
sting	B	6.18	1.02	2,040	1,581	469	556	-87	520	583	-63	3.65
stint	N	2.14	1.53	2,589	1,732	646	703	-57	646	703	-57	2.79
story	N	5.96	1.48	2,173	929	464	583	-119	479	574	-95	5.14
stow	V	3.57	2.25	2,200	1,179	681	644	37	681	644	37	2.26
strap	B	6.04	1.32	1,983	776	492	581	-89	526	596	-70	3.87
street	N	6.71	0.66	2,364	2,329	541	673	-132	544	671	-127	4.94
stride	B	5.07	1.86	2,160	1,064	591	626	-35	625	646	-21	3.20
strive	V	3.79	1.93	2,669	1,777	654	557	97	650	592	58	3.64
studio	N	6.18	1.06	1,840	910	442	585	-143	461	595	-134	4.31
stun	V	4.71	1.96	2,195	1,151	585	631	-46	569	605	-36	3.78

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	Log	Frequency
stupor	N	3.04	1.69	3,006	1,433	707	777	-70	707	777	-70		2.41
subdue	V	3.26	1.43	3,262	2,086	899	940	-41	840	871	-31		3.32
submit	V	3.89	2.06	2,353	1,734	654	536	118	628	562	66		4.60
suburb	N	5.07	1.78	2,444	1,032	680	781	-101	641	744	-103		3.64
subway	N	6.68	0.55	1,918	1,070	509	640	-131	531	649	-118		3.35
suffer	V	4.00	2.09	2,925	1,549	614	458	156	570	513	57		4.50
suite	N	5.61	1.59	2,737	1,430	874	937	-63	866	930	-64		4.73
sunset	N	6.75	0.93	1,423	558	494	631	-137	506	639	-133		3.57
supper	N	6.18	1.25	2,106	1,442	584	609	-25	584	609	-25		3.07
supply	B	4.18	1.61	2,970	2,497	504	524	-20	519	546	-27		4.77
surge	B	4.11	1.89	2,939	2,316	679	787	-108	676	771	-95		3.73
swan	N	6.64	1.03	2,036	1,281	540	653	-113	549	662	-113		3.33
swap	V	4.43	1.95	3,247	2,133	512	510	2	526	522	4		4.22
swear	V	4.32	2.02	2,725	1,358	603	526	77	615	570	45		4.01
swipe	B	5.30	1.66	2,493	1,250	619	586	33	639	616	23		3.08
sword	N	6.93	0.38	1,451	528	510	681	-171	612	756	-144		4.42
syrup	N	6.57	0.92	1,570	704	497	603	-106	497	603	-106		3.28
system	N	2.46	1.64	3,125	2,028	468	581	-113	508	602	-94		5.83
tack	B	6.43	1.26	2,507	1,290	517	522	-5	565	562	3		3.44
tact	N	2.86	1.78	2,465	1,118	643	681	-38	643	681	-38		2.88
tag	B	5.57	1.45	2,403	1,266	562	645	-83	570	638	-68		4.45
taint	B	3.36	1.85	2,364	872	577	575	2	598	605	-7		3.18
talent	N	4.86	1.76	2,504	1,517	510	576	-66	531	589	-58		4.13
tangle	B	4.50	1.82	2,723	1,549	851	927	-76	742	813	-71		3.48
task	N	3.39	1.69	2,858	1,537	489	556	-67	519	564	-45		4.50
tatter	V	3.32	2.39	2,360	997				628	737	-109		2.64
taunt	B	4.04	1.83	2,785	1,586	642	552	90	630	598	32		3.29
tavern	N	5.68	1.68	2,445	1,195	549	691	-142	549	691	-142		2.99
tea	N	6.61	0.69	1,630	1,101	458	547	-89	469	553	-84		3.97
teach	V	5.54	1.57	2,200	1,210	602	426	176	557	499	58		4.83
teem	V	2.68	1.76	4,482	4,124				678	764	-86		2.43
teeter	V	3.25	1.96	2,497	1,309	779	824	-45	779	824	-45		2.18
tell	V	4.00	1.91	2,941	1,958	622	477	145	601	506	95		5.56
tempo	N	3.68	1.79	2,868	1,404	493	598	-105	505	606	-101		3.49
tempt	V	3.57	1.48	3,034	1,420	695	553	142	666	616	50		3.71
tenant	N	5.25	1.67	2,309	1,021	519	623	-104	541	619	-78		3.21
tend	V	3.14	1.65	2,875	2,006	585	524	61	573	539	34		4.64
tendon	N	5.39	1.87	2,271	836	580	682	-102	590	667	-77		3.07
tennis	N	6.79	0.57	1,744	1,116	476	594	-118	476	594	-118		3.81
terror	N	4.57	1.91	2,659	1,329	511	650	-139	515	651	-136		3.95
text	N	5.82	1.42	2,169	1,001	519	618	-99	520	617	-97		5.12
theme	N	2.25	1.35	2,869	1,465	454	584	-130	479	595	-116		4.28
theory	N	4.00	1.92	2,287	1,669	461	556	-95	473	557	-84		4.77
thief	N	6.29	1.21	1,948	1,245	519	619	-100	525	603	-78		3.83
thigh	N	6.36	1.31	1,955	1,146	642	725	-83	697	760	-63		3.91
thing	N	3.14	2.05	3,541	1,622	538	603	-65	541	560	-19		5.70
think	V	4.32	2.20	2,338	1,201	629	547	82	612	545	67		5.96
thorn	N	6.79	0.57	1,696	747	745	870	-125	723	842	-119		3.64
threat	N	3.61	1.93	2,901	1,690	513	597	-84	519	583	-64		4.41
thrift	N	2.71	1.41	3,268	1,480	575	651	-76	575	651	-76		2.79
thrill	B	4.68	1.94	2,600	1,315	487	557	-70	572	591	-19		3.75
thrive	V	2.43	1.35	2,853	1,268	685	545	140	669	616	53		3.47
throb	V	5.07	1.65	2,656	2,094	732	673	59	674	728	-54		3.41
thud	B	4.64	2.11	3,156	3,016	641	710	-69	641	710	-69		2.67
thug	N	5.64	1.79	1,828	800	561	611	-50	555	611	-56		3.39
tickle	V	6.29	0.94	2,148	978	608	510	98	633	601	32		3.46
tire	B	6.79	0.63	1,651	1,076	462	547	-85	573	574	-1		4.53
toad	N	6.57	1.10	2,674	5,698	545	642	-97	574	653	-79		3.33
toast	B	6.63	0.79	1,583	576	493	529	-36	521	550	-29		3.63
toil	B	3.68	1.91	2,550	1,505	668	627	41	668	627	41		2.57
tomato	N	6.86	0.59	1,701	908	514	604	-90	529	615	-86		3.64
tomb	N	6.18	1.02	2,008	1,092	692	823	-131	692	821	-129		3.82
ton	N	3.86	2.26	3,191	2,132	563	626	-63	551	592	-41		4.35

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected†			HAL Inflected‡			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
tooth	N	6.69	0.97	1,580	678	493	592	-99	525	579	-54	4.15
topic	N	2.57	1.48	3,272	1,719	536	608	-72	561	619	-58	4.80
topple	V	4.96	1.50	2,505	1,334	758	659	99	716	683	33	2.80
touch	B	5.32	1.74	2,791	1,462	531	516	15	541	528	13	4.69
tousle	V	2.71	1.86	3,093	3,843							1.04
tow	B	5.32	1.54	1,876	746	495	525	-30	526	548	-22	3.51
tower	B	6.96	0.19	1,983	1,363	615	763	-148	603	747	-144	4.44
town	N	6.64	0.62	2,155	1,660	489	629	-140	497	630	-133	4.62
trait	N	3.89	1.81	2,403	1,033	597	654	-57	579	622	-43	3.75
tray	N	6.64	1.16	1,576	688	503	638	-135	518	638	-120	3.64
tread	B	4.82	1.81	3,456	1,613	551	545	6	570	564	6	3.60
treaty	N	4.68	1.83	2,360	1,103	523	669	-146	539	663	-124	3.96
tremor	N	5.68	1.31	2,200	1,343	744	851	-107	717	807	-90	2.96
tribe	N	6.04	1.10	2,434	1,596	500	647	-147	525	653	-128	3.88
trivia	N	2.93	1.76	3,195	1,733	531	628	-97	531	628	-97	3.60
trophy	N	6.79	0.63	1,818	844	556	705	-149	573	699	-126	3.45
trout	N	6.39	0.99	1,688	701	492	591	-99	492	591	-99	3.29
truce	N	3.07	1.84	3,009	1,281	634	759	-125	634	759	-125	2.97
trudge	V	4.04	2.10	2,627	1,358							2.10
trunk	N	6.50	0.96	2,232	1,017	503	627	-124	513	620	-107	3.63
trust	B	4.25	2.24	2,409	1,445	547	459	88	560	484	76	4.56
truth	N	4.07	1.92	3,110	1,778	515	546	-31	518	548	-30	4.74
tube	N	6.15	1.17	1,831	874	450	604	-154	450	604	-154	4.16
tuck	V	4.75	1.60	2,590	1,058	574	548	26	587	579	8	3.36
tulip	N	6.32	1.42	1,713	893	660	741	-81	659	733	-74	2.90
tumor	N	5.21	1.83	2,719	1,539	521	622	-101	553	633	-80	3.39
turf	N	4.71	2.00	2,601	1,286	568	628	-60	568	628	-60	3.05
turkey	N	6.86	0.45	1,348	327	480	547	-67	494	558	-64	4.19
tyrant	N	4.39	1.91	2,203	1,492	577	647	-70	635	702	-67	3.30
ulcer	N	4.04	2.13	2,456	960	611	665	-54	627	658	-31	2.98
unify	V	4.54	1.75	2,866	2,938	677	651	26	564	631	-67	3.70
union	N	3.79	1.93	3,311	1,607	482	626	-144	491	624	-133	4.55
unit	N	3.18	1.91	3,028	1,629	458	590	-132	468	580	-112	4.84
unite	V	4.89	1.91	2,839	3,223	622	543	79	553	679	-126	4.93
unity	N	4.54	1.75	2,844	1,592	507	625	-118	507	625	-118	3.72
usage	N	2.64	1.64	2,866	2,126	504	570	-66	508	573	-65	4.20
vacate	V	4.32	1.94	3,097	3,313	775	663	112	717	700	17	2.69
valley	N	6.39	1.07	1,749	571	543	697	-154	544	697	-153	4.41
valve	N	5.18	1.87	2,437	2,414	471	599	-128	481	596	-115	3.79
van	N	6.68	0.86	1,727	814	556	656	-100	556	656	-100	4.67
vanish	V	5.18	1.85	2,446	2,814	602	537	65	591	614	-23	3.69
vanity	N	3.71	2.11	3,085	1,797	505	596	-91	505	596	-91	3.14
vary	V	3.11	1.62	2,705	1,452	590	565	25	573	589	-16	4.43
vase	N	6.54	0.96	2,680	4,586	554	656	-102	554	656	-102	2.73
veer	V	3.46	1.97	2,686	1,553	722	625	97	722	625	97	2.28
verb	N	3.54	2.03	3,411	2,211	525	624	-99	554	628	-74	3.48
vessel	N	5.59	1.37	2,357	1,286	528	698	-170	527	659	-132	3.80
vest	B	6.64	0.78	1,826	1,092	525	610	-85	584	640	-56	3.54
victim	N	5.52	1.99	1,983	1,188	482	567	-85	515	577	-62	4.39
vie	V	1.89	1.42	2,947	2,016	714	729	-15	711	731	-20	3.20
vigor	N	3.29	1.86	2,662	1,808	617	647	-30	617	647	-30	2.85
vine	N	6.07	1.44	2,476	1,704	504	647	-143	520	615	-95	3.52
virtue	N	2.89	1.87	3,154	2,553	548	608	-60	553	612	-59	3.78
virus	N	5.32	1.59	2,660	1,530	527	636	-109	569	660	-91	4.54
vision	N	5.04	1.88	2,535	1,410	455	560	-105	489	589	-100	4.41
vista	N	3.46	2.13	2,842	1,592	634	724	-90	641	727	-86	3.55
volume	N	4.86	1.74	2,866	1,541	458	580	-122	465	580	-115	4.68
vote	B	5.68	1.56	2,067	999	491	486	5	512	536	-24	5.01
vow	B	3.18	1.91	2,791	1,115	551	575	-24	593	607	-14	3.41
vowel	N	5.32	1.76	3,382	2,322	568	687	-119	586	673	-87	3.28
voyage	N	5.44	1.53	2,301	1,434	533	685	-152	554	699	-145	3.44
wade	V	4.50	1.91	2,859	1,374	602	590	12	619	608	11	3.80
wagon	N	6.75	0.80	1,654	595	623	762	-139	620	750	-130	3.63

APPENDIX B (Continued)

Word	FK Code	Image Rate		Image RT		HAL Uninflected [†]			HAL Inflected [‡]			Usenet Log Frequency
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	NDist	VDist	NVDD	NDist	VDist	NVDD	
wail	B	5.04	1.79	3,224	2,765	613	595	18	620	647	-27	3.14
waive	V	2.86	2.01	2,944	1,342	688	554	134	694	621	73	3.19
wallow	V	3.89	1.97	2,595	1,344	719	583	136	683	607	76	2.76
wander	V	4.93	1.77	2,615	1,929	609	459	150	581	543	38	3.90
wane	V	2.25	1.67	2,554	1,827	747	732	15	646	721	-75	2.69
warden	N	5.29	2.05	2,892	1,542	556	635	-79	583	649	-66	2.93
warn	V	4.07	1.80	2,505	1,035	621	466	155	693	702	-9	4.68
wart	N	6.61	0.74	2,195	1,295	621	680	-59	630	657	-27	2.82
wasp	N	6.21	1.62	1,714	730	552	664	-112	568	669	-101	3.04
waste	B	5.44	1.85	2,017	847	537	485	52	557	512	45	4.63
way	N	3.29	2.09	2,626	1,153	505	576	-71	514	580	-66	5.74
wealth	N	5.71	1.41	2,225	1,362	501	563	-62	501	563	-62	4.08
wean	V	2.46	1.53	2,379	1,298	786	609	177	713	646	67	3.35
weapon	N	6.29	1.15	1,899	689	488	618	-130	484	571	-87	4.68
wed	V	5.07	1.72	2,905	1,241	778	852	-74	776	849	-73	4.19
week	N	4.00	2.05	3,159	1,546	548	668	-120	570	678	-108	5.26
weep	V	5.57	1.71	2,112	1,982	674	570	104	669	639	30	3.31
weigh	V	4.46	2.05	2,864	1,845	590	471	119	577	540	37	3.96
wheat	N	6.50	1.04	1,828	982	513	619	-106	513	619	-106	3.61
whir	B	2.82	1.79	2,271	1,113				661	707	-46	2.37
wicker	N	3.93	2.05	2,206	1,157	673	755	-82	673	755	-82	2.58
width	N	5.04	1.62	2,419	973	496	596	-100	506	599	-93	3.91
wield	V	3.71	2.03	2,360	800	672	524	148	655	626	29	3.25
wife	N	6.68	0.77	1,888	1,205	550	571	-21	553	575	-22	4.66
wince	V	4.82	1.79	2,073	710	650	579	71	683	635	48	2.87
window	N	6.64	1.03	1,562	758	498	618	-120	533	593	-60	5.45
wit	N	3.46	1.86	1,968	820	505	505	0	529	535	-6	3.72
work	B	4.89	2.17	2,102	1,287	549	454	95	544	490	54	5.90
world	N	6.79	0.42	1,704	786	505	631	-126	508	633	-125	5.50
worth	Na	2.21	1.75	3,011	1,767	602	582	20	602	582	20	4.91
wrath	N	4.39	2.33	2,146	975	703	825	-122	703	825	-122	3.75
wreath	N	6.21	1.40	2,055	873	618	739	-121	618	739	-121	2.46
wring	V	4.18	1.85	3,093	1,788	682	591	91	682	591	91	2.55
write	V	5.61	1.73	1,927	808	595	448	147	870	894	-24	6.26
year	N	4.57	2.39	2,356	1,648	514	651	-137	546	663	-117	5.78
yearn	V	4.07	2.02	2,512	1,372	691	622	69	643	645	-2	2.96
yelp	B	5.32	1.91	1,990	952	739	751	-12	759	767	-8	2.59
youth	N	5.11	1.71	2,580	1,033	492	634	-142	498	635	-137	4.17
zeal	N	2.71	1.76	2,146	834	650	683	-33	650	683	-33	2.85
zip	V	5.46	2.06	2,806	1,422	496	573	-77	504	575	-71	4.28
zoom	V	4.86	2.09	2,655	1,290	485	554	-69	504	570	-66	3.78

Note—FK, Francis–Kučera; NDist, noun distance; VDist, verb distance; NVDD, noun–verb distance difference. *Item has adjective usage (Francis & Kučera, 1982). [†]No entry indicates the uninflected form is not in the HAL matrix. [‡]No entry indicates that this word (inflected or uninflected) is not in the HAL matrix.

APPENDIX C

Part of Speech Coding of Representative Usenet Contexts for 50 Sample Uninflected Words

The first author examined each of the randomly selected contexts for all 50 sample target words. Ninety-seven percent of the target word occurrences were classifiable as nouns, adjectives, prepositions, adverbs, or verbs. Proper nouns and nouns used to modify a head noun (e.g., *work experience*) were coded as nouns; all verb occurrences were used as main verbs (none was used as an auxiliary). In the remaining 3% of the sample contexts, part of speech could not be determined (%?). In such cases, the word occurred in a nonsyntactic context (e.g., within a line of computer code), occurred within a foreign phrase, or the context was too brief to permit classification (e.g., *bolt, r*).

In the table below, each sample word is listed with its Francis-Kučera (FK; 1982) word class code, HAL NVDD score, and its percentage occurrence in the sample for each part of speech. The column labeled %V-%N is the difference between each word's percentage of verb and percentage of noun occurrences. The final column provides other information relevant to interpreting the part of speech coding.

Word	FK Code	NVDD	%Noun	%Adj	%Prep	%Adv	%Verb	%?	%V-%N	Comments
sword	N	-171	98.0				0.0	2.0	-98.0	
circus	N	-160	97.0				0.0	3.0	-97.0	
ring	B	-157	83.0				10.0	7.0	-73.0	
blade	N	-156	96.0				1.0	3.0	-95.0	
slug	B	-153	92.0				7.0	1.7	-85.0	
demon	N	-151	94.5				0.0	5.5	-94.5	
crease	B	-144	95.5				0.0	2.7	-95.5	
bolt	B	-139	82.5			2.5	12.5	2.5	-70.0	
arch	B	-137	80.0	6.3			8.6	5.1	-71.4	15% of N are abbreviations
hammer	B	-113	81.5				12.8	5.9	-68.7	
daze	V	-112	97.3				2.7	0.0	-94.6	18% of N are misspelled "days"
shelf	N	-112	98.5				1.0	0.5	-97.5	
mar	V	-85	82.5				0.6	17.0	-81.9	85% of N are abbreviations of March
zip	V	-77	89.1				7.8	3.1	-81.3	
errand	N	-74	99.5				0.0	0.5	-99.5	
shriek	B	-74	69.6				26.5	3.9	-43.1	
wed	V	-74	95.8				4.2	0.0	-91.6	98% of N are abbreviations of Wednesday
nag	V	-72	77.3				21.8	0.9	-55.5	
sear	V	-51	59.4				29.7	10.9	-29.7	
bout	N	-9	12.1		75.8	10.6	0.5	1.0	-11.6	all Prep and Adv are reduced "about"
shrink	V	-6	36.9			0.5	56.9	5.6	20.0	
niece	N	-4	95.8	3.4			0.0	0.8	-95.8	
hush	B	-3	53.2	3.7			43.1	0.0	-10.1	
rhyme	B	-1	65.7				30.7	3.6	-35.0	
wit	N	0	68.9		19.7		8.8	2.5	-60.1	all Prep are reduced "with"
munch	V	0	61.1			1.8	29.2	10.8	-31.9	
punt	B	0	43.1			1.0	33.3	22.5	-9.8	87% of ? are in foreign phrases
slouch	B	0	69.7				28.3	2.0	-41.4	89% of N are "(is) no slouch"
cure	B	1	66.2				30.8	3.0	-35.4	
swap	V	2	57.6				39.9	2.5	-17.7	
erect	V	3	0.0	90.5			9.0	0.5	9.0	
idiot	N	6	100.0				0.0	0.0	-100.0	25% of N are "X is an idiot," 15% are parenthetic
extent	N	18	99.5				0.5	0.0	-99.0	76% of N are "to X extent" or "to extent that"
cod	N	18	6.4				0.0	0.0	-6.4	additional 93% abbreviated c.o.d.
invert	V	24	17.3				78.8	3.8	61.5	
rinse	B	25	26.5				72.8	0.7	46.3	
access	N	61	84.4				15.6	0.0	-68.8	
croak	B	75	8.0				88.0	4.0	80.0	
care	B	84	53.3				46.2	0.5	-7.1	30% of N "take care (of)"
pout	B	89	35.7				53.6	10.7	17.9	
send	V	93	2.0				97.5	0.5	95.5	
work	B	95	35.9				62.6	1.5	26.7	
gain	B	105	30.7				69.3	0.0	38.6	
change	B	106	32.7				67.3	0.0	34.6	
berate	V	174	0.9				99.1	0.0	98.2	
punish	V	182	0.6	1.8			96.5	1.2	95.9	
prove	V	186	0.0				100.0	0.0	100.0	
delve	V	190	0.0				100.0	0.0	100.0	
defend	V	191	0.0				100.0	0.0	100.0	

APPENDIX D **Part-of-Speech Coding of Representative Usenet Contexts for 28 Sample Inflected Words**

The first author examined each of the randomly selected contexts for all inflected forms of the 28 sample words. The sampling procedure was the same as that employed for the uninflected forms, except that now a sample of contexts was selected for each (uninflected and inflected) form of the word. Part of speech usages were coded separately for each form of the word, and these percentages were weighted by the Usenet frequency for that particular inflected form before being combined across all forms of the word. Because samples of the same size were culled regardless of the form's frequency, this weighting ensured that the part of speech percentages were not disproportionately influenced by inflected forms having very low frequencies of occurrence. Thus, the percentages reported in the table below reflect the weighted averages for each part of speech, across all inflected forms of the word.

The sampled context could not completely disambiguate the part of speech occurrence for some forms. Some contexts could be read as either adjective or verb usages (labeled %Adj/V); others could be read as either noun or verb usages (labeled %N/V). The frequency of occurrence of these ambiguous forms is listed separately in the table.

In the table below, each sample word is listed with its Francis-Kučera (FK) word class code, inflected noun-verb distance difference (NVDD) score, and its percentage occurrence in the sample for each part of speech. The column labeled %V-%N is the difference between each word's percentage of verb and percentage of noun occurrences. The final column provides other information relevant to interpreting the part of speech coding.

Word	FK Code	Inf NVDD	%Noun	%Adj	%Adj/V	%N/V	%Intrj	%Verb	%?	%V-%N	Comments
sword	N	-144	96.6	0				0	3.4	-96.6	
wrath	N	-122	96.9	0				0	3.0	-96.9	41% unmodified
clay	N	-117	92.1	0				2.0	5.9	-90.1	
dwarf	B	-115	90.7	0.3				3.8	5.2	-86.9	
tatter	V	-109	15.2	81.4				0	3.4	-15.2	
pecan	N	-99	98.0	0				0	2.0	-98.0	
smudge	B	-98	57.2	10.7	0.3			18.0	13.7	-39.2	
elapse	V	-86	0.4	47.0				52.6	0	52.2	61% with "time"
blight	B	-83	76.1	2.0	0.2			4.9	16.5	-71.2	
brow	N	-81	100.0	0				0	0	-100.0	39% with possessive pronoun only
daze	V	-77	58.5	28.2				5.4	4.6	-53.1	
cousin	N	-45	99.3	0				0	0.7	-99.3	61% with possessive pronoun only
bind	V	-44	29.6	38.9	4.6	1.7		21.1	3.9	-8.5	
apathy	N	-27	99.0	0				0	1.0	-99.0	64% unmodified
deceit	N	-14	98.7	1.3				0	0	-98.7	51% are unmodified
rhyme	B	-12	59.5	7.7				27.8	5.0	-31.7	
occupy	V	-10	0	23.4	0.5	0.2		75.6	0.2	75.6	
focus	B	-6	39.0	5.2		2.2		53.2	0.3	14.2	70% with "on"
plea	N	-6	75.5	0.7			20.4	3.4	0	-72.1	Intrj "pleas" used for "please"
tack	B	3	46.8	4.7		0.2		44.4	4.0	-2.4	31% are "tack on"
erode	V	17	0.7	12.7	6.4			79.5	0.7	78.8	
frolic	B	40	39.4	5.8				51.9	3.0	12.5	
toil	B	41	26.4	1.4		2.1		66.6	3.4	40.2	
grieve	V	52	16.8	16.4				64.9	1.9	48.1	
care	B	74	52.7	2.0				44.9	1.0	-7.8	31% of N "take care of"
delve	V	122	1.2	0				98.3	0.5	97.1	
grovel	V	122	30.0	7.9		1.3		51.4	9.4	21.4	
repent	V	161	4.3	0		0.3		90.2	5.2	85.9	21% of V "who cares"

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