Spoken word frequency counts based on 1.6 million words in American English

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Written word frequency (e.g., Francis & Kučera, 1982; Kučera & Francis, 1967) constitutes a popular measure of word familiarity, which is highly predictive of word recognition. Far less often, researchers employ spoken frequency counts in their studies. This discrepancy can be attributed most readily to the conspicuous absence of a sizeable spoken frequency count for American English. The present article reports the construction of a 1.6-million-word spoken frequency database derived from the Michigan Corpus of Academic Spoken English (Simpson, Swales, & Briggs, 2002). We generated spoken frequency counts for 34,922 words and extracted speaker attributes from the source material to generate relative frequencies of words spoken by each speaker category. We assess the predictive validity of these counts, and discuss some possible applications outside of word recognition studies.

The influence of word familiarity on word recognition has been very well established in the literature. Familiarity can be measured in a number of ways, typically in the form of written frequency, subjective ratings, or age of acquisition. In general, words that are more familiar are recognized more rapidly than those words that are less familiar (e.g., word frequency—Alegre & Gordon, 1999; Connine & Mullenix, 1990; age of acquisition—Dewhurst, Hitch, & Barry, 1998; Gerhand & Barry, 1998). When other factors such as word length are held constant, high frequency words or words acquired at an earlier age are recognized faster than low frequency words or words acquired at a later age. It should be noted that typically, the earliest words acquired are learned through conversation. Moreover, throughout a lifetime, most individuals (presumably) encounter words more often in speech than in texts, and this reality highlights the importance of suitable spoken counts to analyze speech-based word familiarity. Although written frequency counts are readily available (most notably, Francis & Kučera, 1982; Kučera & Francis, 1967), few (if any) spoken counts exist for American English. The present paper reports the construction of a 1.6 million word spoken frequency database tagged for speaker attributes such as gender and age.

The use of spoken word frequency counts is conspicuously absent in the literature, presumably due to a lack of appropriate frequency counts for American English. The most notable spoken frequency database is based on a British English corpus of 190,000 words (which included 10,630 different words) that were recorded without the direct knowledge of the speaker (Brown, 1984). Given the inherent difficulty of speech transcription for the purpose of generating spoken counts, the Brown (1984) corpus is commendable, although still considerably smaller in scope than typical written frequency databases (e.g., Kučera & Francis, 1967, collected over 1 million words representative of over 40,000 different

words). The discrepancy in scope between spoken and written counts in conjunction with the absence of a large-scale spoken frequency database in American English motivated the construction of a new spoken frequency database.

Spoken English Corpus

Our spoken frequency counts were derived from the Michigan Corpus of Academic Spoken English (MICASE). The corpus is available online, and includes 152 transcriptions of lectures, meetings, advisement sessions, public addresses, and other educational conversations recorded at the University of Michigan (Simpson, Swales, & Briggs, 2002). On average, each of the 152 transcriptions contains approximately 11,000 words spoken by students, faculty, and other staff members in a variety of academic fields. The speakers ranged in age and gender and a majority of the speakers were educated native speakers of American English with a small percentage of nonnative speakers. In total, the transcripts derive from approximately 190 hours of recordings made between 1997 and 2001. Further information about how these recordings were collected as well as summaries of speaker attributes and speech contexts can be obtained from the MICASE Web site (Simpson et al., 2002).

Although the MICASE contains 1,848,364 spoken words (i.e., *token count*), 152,824 tokens were excluded because the speakers did not give their consent for their data to be used for research. After removing an additional 29,919 tokens that were read aloud from a written source¹ by the speaker as well as 35,245 tokens that could not be transcribed accurately, we extracted 1,630,376 tokens from the 152 MICASE transcripts, which represented 34,922 different words (i.e., *type count*).

Spoken Frequency Database

To construct the spoken frequency database, we first downloaded all 152 transcriptions in an html format. We

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Table 1
Numbers of Different Words (Type Count) and
Total Numbers of Words Spoken (Token Count)
As a Function of Each Speaker Attribute

Participant Characteristics	Count		
	Type	Token	%Total
Language Status			
Native	32,463	1,404,006	86
Near native	7,806	121,206	7
Nonnative	5,501	74,368	5
Non-American English	3,250	30,796	2
Total		1,630,376	
College Role			
Faculty	25,544	804,238	49
Graduate student	13,500	358,233	22
Undergraduate	13,904	350,251	21
Other	5,928	83,719	5
Unknown	3,801	33,935	2
Total		1,630,376	
Gender			
Female	24,541	878,261	54
Male	23,617	751,188	46
Unknown	479	927	<1
Total		1,630,376	
Age (years)			
17–23	15,002	400,584	25
24–30	10,740	253,385	16
31–50	21,085	590,815	36
51+	15,659	345,945	21
Unknown	4,171	39,647	2
Total		1,630,376	

wrote a series of AWK scripts to remove html tags so that only the spoken words remained. Additional AWK scripts were written to tag frequency counts for speaker status, which is clearly indicated within each transcription (for a summary of speaker attributes, see Table 1). The factorial combination of speaker attributes recorded with the speech in the MICASE results in a total of 128 possible speaker groups; however, as illustrated in Table 2, only 56 groups were represented. Not surprisingly, an analysis of the spoken frequency counts reveals that not all groups are equally represented. For example, 54% of all words spoken derived from female speakers, and 46% derived from male speakers. Thus, to facilitate meaningful comparisons across gender, age, college role, or language status, we also computed relative frequency (i.e., frequency of word/total number of words spoken by the speaker group).

Frequency and Speaker Variability

To our knowledge, our spoken frequency database is the first word frequency database tagged for speaker characteristics, which allows for a number of interesting analyses with implications for gender and developmental studies. Inspection of Table 3 reveals that although each speaker group is not equally represented in the original corpus, there are sufficient data for a number of between-groups comparisons. For example, females in the 17–23-year age group said LIKE 6,296 times compared to 2,680 occurrences for male speakers in the same age group, making females more than twice as likely as males to say LIKE. Although the same pattern emerges with relative frequency

Table 2
Distribution of Words Spoken by Each Speaker Category

Language Status	College Role	Age (years)																
		17-23				24-30				31-50				51+				
		Female		Male		Female		Male		Female		Male		Female		Male		
Type	Token	Type	Token	Type	Token	Type	Token	Type	Token	Type	Token	Type	Token	Type	Token	Type	Token	
Native	Faculty	-	-	417	1,402	2,048	16,492	2,290	18,166	12,392	232,556	9,501	137,881	7,465	101,723	10,555	-	173,695
	Graduate student	3,018	26,565	2,043	18,291	6,081	97,432	5,125	74,974	4,760	55,489	1,561	9,587	-	-	-	-	-
	Undergraduate	9,880	202,364	7,946	117,853	718	2,687	648	2,189	379	1,202	-	-	162	310	-	-	-
	Other	212	384	44	61	145	288	116	201	3,740	43,560	2,068	16,037	1,830	10,968	450	-	1,543
Near Native	Faculty	-	-	-	-	-	-	-	-	1,075	5,973	2,860	28,781	-	-	2,311	-	18,578
	Graduate student	-	-	-	-	-	-	-	-	658	3,011	1,230	7,151	-	-	-	-	-
	Undergraduate	1,060	4,869	1,950	12,473	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonnative	Other	-	-	-	-	-	-	-	-	2	4	11	15	1,210	8,331	-	-	-
	Faculty	-	-	-	-	-	-	-	-	1,875	13,764	2,332	23,057	141	267	-	-	-
	Graduate student	9	9	97	167	1,542	14,417	1,400	8,635	1,250	6,424	549	1,925	-	-	-	-	-
	Undergraduate	482	1,657	414	1,454	-	-	-	-	53	88	-	-	-	-	-	-	-
Non-American English	Other	-	-	-	-	37	50	-	-	348	1,266	181	388	-	-	-	-	-
	Faculty	-	-	-	-	-	-	-	-	455	1,620	-	-	483	1,362	2,975	-	27,814

Table 3
Number and Percentages of Different Groups (Out of 56)
With the Specified Minimum Type or Token Count

Type Count	<i>n</i>	%	Token Count	<i>n</i>	%
500+	37	66	1,000+	43	77
1,000+	31	55	2,000+	34	61
1,500+	26	46	3,000+	32	57
2,000+	22	39	4,000+	31	55
2,500+	15	27	5,000+	30	54
3,000+	12	21	10,000+	24	43
4,000+	10	18	15,000+	20	36
5,000+	8	14	20,000+	14	25
10,000+	4	7	30,000+	10	18
			40,000+	10	18
			50,000+	9	16
			75,000+	7	12
			100,000+	6	11
			150,000+	3	5

measure, the difference is less extreme (female = 2.58%, male = 1.72%). Not surprisingly, the frequency database reveals that LIKE usage declines with age. Other age effects are readily observable. A quick analysis across the age ranges represented in the database (17 to 51+ years) reveals a steady decline in the use of the words I and NO, which may have implications for theories of aging.

The raw spoken frequency counts and the relative frequency measure can be accessed easily through an online Web interface that we have constructed (wordplay.geneseo.edu). The interface allows the user to specify speaker characteristics (either for comparison across groups, or to limit the results to a specific group) and basic search criteria that includes the option to enter a word (or a word list). The user can make comparisons within an attribute (e.g., gender), or can explore interactions across attributes (e.g., gender $\times$ age). Independent of gender and developmental applications, it is clear that this spoken frequency database is applicable to word recognition studies.

Frequency Effects and Visual Word Recognition

Typically, researchers manipulate or control written frequency in word recognition studies (e.g., Connine & Mullennix, 1990). Our first interest was to confirm that the spoken frequency counts that we generated approximate

written measures. Consistent with the significant correlation previously observed between written and spoken frequencies (Brown, 1984), we observed a moderately strong, positive correlation between log written frequency (Kučera & Francis, 1967) and log spoken frequency [$r(17,170) = 0.754, p < .01$], and this relation suggests that a written measure can be replaced with spoken counts. Given the well-established (e.g., Brown & Watson, 1987) negative correlation between familiarity and word recognition (assessed via lexical decision or naming) such that high frequency words are recognized faster than low frequency words, our second interest was to assess the predictive validity of our spoken frequency counts with respect to behavioral data. Given that our spoken frequency counts are distributed in a Zipfian manner (see Baayen, 2001), all analyses are based on log-transformed data.

Balota et al. (2002) collected lexical decision (LD) and naming latencies for over 40,000 visually-presented words, 17,170 of which occur in both our spoken frequency database and the Kučera and Francis (1967) database. As expected, LD latencies were predicted by both the written and spoken frequency [$r(17,170) = -.490, p < .01$ and $r(17,170) = -.404, p < .01$, respectively]. Likewise, naming latencies obtained from the Balota et al. (2002) database were predicted by both the written and spoken frequency measures [$r(17,170) = -.405, p < .01$ and $r(17,170) = -.334, p < .01$, respectively].

Although the observed correlations between the behavioral measures of visual word recognition and frequency were stronger for written counts relative to spoken counts, closer inspection of the data revealed that in some cases spoken frequency was a better predictor. Given that the LD and naming data (Balota et al., 2002) derives from a student population (across 6 different universities), we expected that spoken frequencies derived from the 17–23-year-old age group would best reflect participant familiarity and therefore would be the best predictor of recognition (N.B., a comparable analysis is not possible with written frequency). To increase the sensitivity of our test, separate analyses were conducted for the top, middle, and bottom frequency ranges. Fisher's z transformation was employed to compare the Pearson coefficients observed for spoken and written frequency counts as predictors of lexical decision and naming latencies. As illustrated in Tables 4 and 5,

Table 4
Pearson r Correlation Coefficients Reported for Log-Transformed Data

Frequency Range	Written	Spoken (years)				
		All	17–23	24–30	31–50	51+
Top Third						
LD	–0.152	–0.159	–0.186	–0.131	–0.138	–0.156
NAM	–0.193	–0.206	–0.251	–0.168	–0.179	–0.201
Middle Third						
LD	–0.147	–0.096	–0.182	–0.032 (n.s.)	–0.033 (n.s.)	–0.047 (n.s.)
NAM	–0.113	–0.088	–0.180	–0.020 (n.s.)	–0.017 (n.s.)	–0.076
Bottom Third						
LD	–0.201	–0.071	–0.152	–0.019 (n.s.)	–0.034 (n.s.)	–0.014 (n.s.)
NAM	–0.137	–0.075	–0.186	–0.023 (n.s.)	–0.020 (n.s.)	–0.045 ($p < .10$)

Note—LD, lexical decision latency; NAM, naming latency (Balota et al., 2002). Unless otherwise noted, all correlations are significant at $p < .01$ (two-tailed).

Table 5
Fisher z Tests to Compare Observed Correlations Reported in Table 4

Frequency Range	Fisher z					
	One-Tailed				Two-Tailed	
	Spoken (17–23 years) vs. Written		Spoken (17–23 years) vs. Spoken (All)		Spoken (All) vs. Written	
	Diff	z	Diff	z	Diff	z
Top Third						
LD	–0.034	–0.945 (n.s.)	–0.027	–0.745 (n.s.)	–0.007	–0.200 (n.s.)
NAM	–0.058	–1.654*	–0.045	–1.290†	–0.013	–0.365 (n.s.)
Middle Third						
LD	–0.035	–0.969 (n.s.)	–0.086	–2.373	0.051	1.404 (n.s.)
NAM	–0.067	–1.866*	–0.092	–2.542	0.025	0.676 (n.s.)
Bottom Third						
LD	0.049	1.415†	–0.081	–2.286*	0.131	3.701
NAM	–0.049	–1.394†	–0.111	–3.125	0.062	1.732†

Note—Negative differences (and negative z-scores) indicate a stronger negative correlation for the first count indicated (i.e., spoken [17–23 years], spoken [all]). Diff, the difference in correlation coefficients. Unless otherwise noted, all differences are significant at $p < .01$. * $p < .05$. † $p < .10$.

word recognition was *always* better predicted by spoken frequency counts specific to 17–23-year-old speakers relative to spoken frequency based on all speakers. In addition, spoken frequency based on 17–23-year-old speakers was in most cases a stronger predictor of naming latencies relative to written frequency.

To summarize, our spoken frequency counts are highly correlated with written counts (i.e., Kučera & Francis, 1967), and spoken frequency is a significant predictor of visual word recognition as measured by lexical decision and naming tasks (Balota et al., 2002). Further, the strength of the correlation between spoken frequency and behavioral measures of word recognition appears to vary with speaker characteristics, and in some cases, spoken frequency accounts for significantly more variability in recognition latency relative to written counts.

Conclusion

Presumably, many people hear words more often than they read words, in which case, spoken frequency should provide a better measure of familiarity in comparison with written frequency. Consistent with this prediction, analyses confirmed that when the age of the speakers matched the age of participants that performed the naming task, spoken frequency, better predicted naming latencies relative to written frequency. Historically, the introduction of written frequency databases has prompted research questions and spurred investigations that would not have been possible without an objective measure of familiarity for a large number of words. Given the increasing sophistication of psycholinguistic investigations, the introduction of a large-scale spoken frequency database in American English has been long overdue. The spoken frequency counts reported in this paper are easily applied to traditional word recognition paradigms, and may also be used in research on cognitive processing as a function of age and/or gender.

Availability

The database reported in this article can be accessed at wordplay.geneseo.edu.

AUTHOR NOTE

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NOTE

1. To generate frequency counts that reflect spoken rather than written language, we deemed it appropriate to exclude words that were simply read aloud by the speaker.

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