DIVERGING EFFECTS OF LEXICAL DIMENSIONS IN SPEED AND ACCURACY

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Not all fast words are easy words.

Lexical features impact speed and accuracy differently

INTRO

Lexical decision tasks typically emphasize reaction time, treating accuracy only as a criterion for discarding incorrect trials. Links between lexical properties (e.g., frequency, length) and reaction time are well established, but less is known about how these properties relate to word-level accuracy, or how their effects on accuracy may operate through reaction time.

METHODS

English Lexicon Project (Balota et al., 2007). We used word-level aggregate data on 39,091 words, where 816 native English speakers attending American universities each completed 3,374 trials, and each word received 34 observations.

British Lexicon Project (Keuleers et al., 2012). We also analyzed 18,396 words which, importantly, were restricted to mono- and di-syllabic words. Seventy-eight native English speakers at University of London completed 28,700 trials each, and each word received 38 observations.

Latent Lexical Dimensions (Knoph et al., 2023). Scores on five latent lexical dimensions (Frequency, Complexity, Proximity, Polysemy, and Diversity) were estimated using a factor model trained on 2,060 words from the General Service List (West, 1953), summarizing 22 non-behavioral lexical features.

Analysis. We fit a mediation-style SEM in which each of the five lexical dimensions predicted standardized reaction time (path *a*), reaction time predicted accuracy (path *b*), and each dimension also predicted accuracy directly (path *c*). Total effects (*c'*) combined direct and indirect paths. Figure 1 conceptually illustrates these paths.

RESULTS

Constraining all paths equal across the ELP and BLP significantly worsened fit ($\Delta\chi^2$ = 1,647, p < .001), so results are reported separately. Both single-group models were just-identified. The ELP model explained 53% of reaction time variance and 44% of accuracy; the BLP model explained 46% and 52%, respectively. Despite differing magnitudes, effects showed the same directional pattern (Table 3; Figure 2):

	Frequency	Complexity	Polysemy	Diversity	Proximity
Speed	🐇	🐢	🐇	🐇	🐢
Accuracy	👍	👍	👍	👍	👎

CONCLUSION

The lexical dimensions indicate general patterns that fit with current theory, but are not necessarily parallel between speed and accuracy. Frequency and Polysemy facilitate processing through familiarity and semantic connectivity (and, to a lesser extent, Diversity), yielding faster and more accurate responses. Proximity slows and reduces accuracy due to competition and misactivation (though contradicting effects between models exist), while Complexity slows responses with more to decode, but improves accuracy through richer structural cues. Overall, slower responses do not necessarily reflect harder words, highlighting the need to treat speed and accuracy as distinct outcomes.

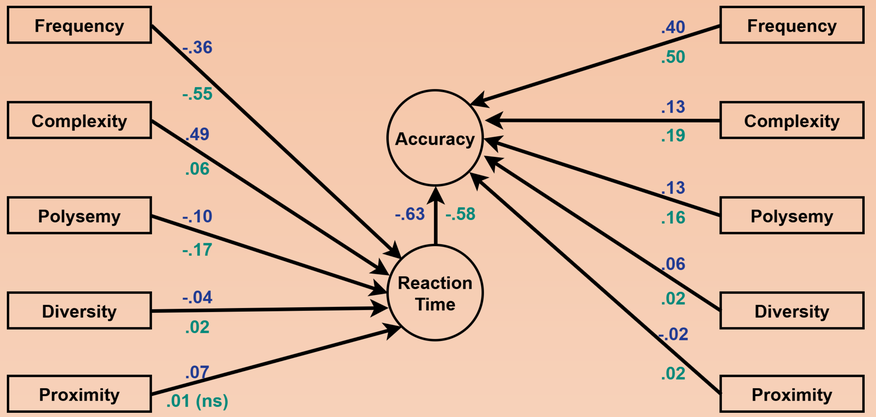

FIGURE 2. Standardized beta weights from each lexical dimension to reaction time and accuracy.
ELP effects are in blue; BLP effects in green. Accuracy values show the total effect (c'), reflecting both direct and RT-mediated influences.

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Lexical Dimensions >

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TABLES AND FIGURES

TABLE 1. Descriptive Statistics by Sample

	English Lexicon Project				British Lexicon Project			
Variable	**Mean**	**SD**	**Minimum**	**Maximum**	**Mean**	**SD**	**Minimum**	**Maximum**
Behavioral Measures								
Reaction Time	784.87	136.01	415	1876	631.84	77.89	431	1340
Accuracy	0.84	0.20	0.03	1.00	0.85	0.21	0.03	1.00
Frequency (Latent Estimate)	-2.46	1.51	-5.81	4.92	-1.93	1.37	-5.78	4.92
COCA	2.96	1.24	0.38	7.78	3.39	0.99	0.38	7.78
Brown Corpus	0.54	0.60	0.00	4.84	0.65	0.66	0.00	4.84
Educator's WFG	3.11	0.91	1.79	7.48	3.43	0.89	1.79	7.48
HAL Corpus	6.23	2.37	0.00	16.96	6.81	2.24	0.00	16.96
Subtitle Lexicon	2.71	0.99	1.30	7.63	3.02	1.02	1.30	7.63
Oxford English Dictionary	4.41	1.07	1.00	8.00	4.57	1.05	1.00	8.00
Contextual Diversity	141.71	1013.63	1.00	37647	243.78	1414.26	1.00	37647
Word Age	380.11	110.33	14.00	495	403.52	92.93	28.00	495
Complexity (Latent Estimate)	1.13	1.29	-1.69	7.84	0.23	0.73	-1.65	3.20
Phonemes	6.68	2.27	1.00	17.00	5.15	1.35	1.00	11.00
Syllables	2.53	1.10	1.00	8.00	1.70	0.46	1.00	2.00
Letters	7.96	2.44	1.00	21.00	6.38	1.60	2.00	13.00
Phonologic LD20	2.85	1.23	1.00	10.85	2.06	0.74	1.00	5.75
Morphemes	2.10	0.86	1.00	7.00	1.72	0.60	1.00	4.00
Orthographic LD20	2.85	1.02	1.00	7.94	2.22	0.68	1.00	5.75
Polysemy (Latent Estimate)	-1.27	0.97	-3.02	2.86	-0.89	1.00	-2.66	2.86
Meanings (Wordnet)	0.84	0.79	0.00	4.32	1.11	0.85	0.00	4.32
Meanings (Wordsmyth)	0.74	0.69	0.00	3.61	0.96	0.74	0.00	3.61
Diversity (Latent Estimate)	-1.34	1.41	-6.38	2.31	-1.17	1.33	-6.29	2.31
Semantic Diversity	1.45	0.38	0.08	2.41	1.50	0.36	0.12	2.41
Dispersion	0.41	0.29	0.00	1.00	0.50	0.27	0.00	1.00
Semantic Precision	0.11	0.98	-1.26	4.12	0.10	0.91	-1.26	3.82
Proximity (Latent Estimate)	-0.42	0.58	-1.00	4.41	-0.19	0.73	-0.94	4.41
Phonographic Neighbors	1.11	2.58	0.00	24.00	2.09	3.33	0.00	24.00
Orthographic Neighbors	1.93	3.79	0.00	34.00	3.51	4.78	0.00	34.00
Phonologic Neighbors	4.26	8.61	0.00	67.00	7.75	10.61	0.00	67.00

TABLE 2. Correlations by Sample

	Reaction Time	Accuracy	Frequency	Complexity	Polysemy	Diversity	Proximity
Reaction Time	1.00	-0.53	-0.56	0.59	-0.53	-0.33	-0.32
Accuracy	-0.68	1.00	0.47	-0.04	0.35	0.31	0.05
Frequency	-0.66	0.55	1.00	-0.28	0.62	0.54	0.21
Complexity	0.29	-0.05	-0.33	1.00	-0.44	-0.12	-0.58
Polysemy	-0.51	0.41	0.61	-0.38	1.00	0.44	0.34
Diversity	-0.38	0.35	0.57	-0.15	0.47	1.00	0.11
Proximity	-0.20	0.05	0.22	-0.67	0.38	0.10	1.00

Note: Correlations above the diagonal are from the ELP; Correlations below are from the BLP.

FIGURE 1. Example of Mediation Paths

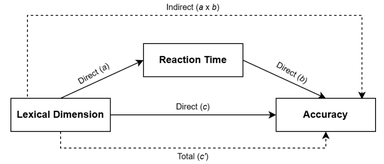

TABLE 3. Mediation Beta Weights by Sample

	Direct to RT (*a*)		Direct to Accuracy (*c*)		Indirect to Accuracy (*a x b*)		Total to Accuracy (*c'*)	
Predictor	**β**	**p**	**β**	**p**	**β**	**p**	**β**	**p**
ELP Model								
Frequency	-0.36	***	0.17	***	0.23	***	0.4	***
Complexity	0.49	***	0.44	***	-0.31	***	0.13	***
Polysemy	-0.1	***	0.07	***	0.06	***	0.13	***
Diversity	-0.04	***	0.03	***	0.03	***	0.06	***
Proximity	0.07	***	0.03	***	-0.05	***	-0.02	**
BLP Model								
Frequency	-0.55	***	0.19	***	0.31	***	0.5	***
Complexity	0.06	***	0.22	***	-0.03	***	0.19	***
Polysemy	-0.17	***	0.07	***	0.09	***	0.16	***
Diversity	0.02	*	0.02	***	-0.01	*	0.02	*
Proximity	0.01	0.14	0.02	**	-0.01	0.14	0.02	*

Note: path *b* (RT to accuracy) is consistent across predictors; β = -0.63 for the ELP and -0.58 for the BLP.
*** p < .001, ** p < .01, * p < .05

REFERENCES

Balota, D. A., Yap, M. J., Hutchison, K. A., Cortese, M. J., Kessler, B., Loftis, B., Neely, J. H., Nelson, D. L., Simpson, G. B., & Treiman, R. (2007). The English Lexicon Project. *Behavior Research Methods, 39*(3), 445–459. https://doi.org/10.3758/BF03193014

Knoph, R. E., Lawrence, J. F., & Francis, D. J. (2023). The dimensionality of lexical features in general, academic, and disciplinary vocabulary. *Scientific Studies of Reading, 28(2), 142-166.* https://doi.org/10.1080/10888438.2023.2241939

Keuleers, E., Lacey, P., Rastle, K., & Brysbaert, M. (2012). The British Lexicon Project: Lexical decision data for 28,730 monosyllabic and disyllabic English words. *Behavior Research Methods, 44*(1), 181–190. https://doi.org/10.3758/s13428-011-0118-4

West, M. (1953). *A general service list of English words: With semantic frequencies and a supplementary word-list for the writing of popular science and technology* (14th ed., reprint). Longman, Green and Co.