Studying Morphological Computation and Storage via Lexical Decision Data

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A basic question for theories of morphology is what parts of words are stored in memory and which structures are composed on the fly. A number of theories make differing predictions in these regards (O'Donnell, 2015; Yang, 2016; Goldberg, 2006). One potential source of evidence about computation and storage is lexical decision data (Baayen *et al*, 1997; Sereno & Jongman, 1997; New *et al*, 2004). Within this lexical decision data, it is well known that reaction times exhibit frequency effects. Generally, the more frequent the stimulus, the quicker a participant will react to it. When stimuli are morphologically complex, however, several different kinds of frequency are relevant, including the frequency of whole word forms and the subparts of words. It is widely assumed that frequency has a facilitatory effect on processing time because processing time is dependent on the strength of a memory trace, and this trace will only become stronger when used more frequently. Since composition and storage entail different memory usage (access to the whole word form in the case of storage, and access to the parts in the case of composition), it has been assumed that the measure of frequency which better correlates with reaction time is indicative of how a word has been assembled. Thus, lexical decision data has often been used to test theories of morphological storage and computation (Alegre & Gordon, 1999; Baayen *et al*, 1997).

One popular class of hypotheses about storage and computation posits that absolute whole-form frequency is the determinant of storage. More frequent forms will be stored as wholes, while less frequent forms will be composed on the fly. Lignos & Gorman (2012) call this assumption into question with a detailed analysis of lexical decision data from the English Lexicon Project (ELP; Balota et. al. 2007). Analyzing this corpus while controlling for a number of factors, they show that there is a whole form frequency effect at all frequency ranges. Additionally, they show that this effect is stronger for low frequency words than high frequency words — contra the hypothesis above. This work is notable for its methodological innovations, such as the use of a larger lexical decision corpus, improved word frequency estimates, and newer statistical methods than earlier work. However, we use simulated reaction time data to find that despite these improvements, Lignos & Gorman's results are likely an artefact of their analytical techniques. Particularly, we find that when simulating reaction time data in which a simple threshold of whole-form frequency for storage exists, the L&G model produces the same results as on the actual data, even when the effect of frequency is pushed to implausible levels (See figure 1). This suggests that Lignos & Gorman's model is liable to type II error.

	Effect size in low group	Effect significance in low group	Effect size in high group	Effect significance in high group
-1e0	-0.33006	**p = 2e-16**	-1.01377	**p = 2e-16**
-1e-1	-0.12133	**p = 2e-16**	-0.13971	**p = 2e-16**
-1e-2	-0.12327	**p = 2e-16**	-0.04935	**p = 7.74e-5**
-1e-3	-0.12756	**p = 2e-16**	-0.03506	**p = 0.00356**
No Effect Data	-0.02612	**p = 0.0446**	-0.02138	**p = 0.0445**
Original Data	-0.13306	**p = 2e-16**	-0.08393	**p = 5.97e-12**

Figure 1: A table showing effect of whole-form frequency in various species of simulated data. Lignos and Gorman make much of the fact that the effect size is higher below the threshold; yet this is true even when we simulate the threshold existing and have its effect be quite large.

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