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Effects of Modality on Subjective Estimates of Frequency of Spoken and Printed Words

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The effects of word frequency are ubiquitous in research on visual and spoken word recognition (Forster & Chambers, 1973), and considerable modeling efforts have been devoted to explaining the mechanisms responsible for the findings that higher frequency words are recognized more quickly and accurately than low frequency words. Typically, frequencies of stimuli have been estimated from counts of printed material (e.g., Thorndike & Lorge, 1944, and Kucera & Francis, 1967). Recently, however, subjective ratings of word frequency have provided an alternative measure for investigating effects of frequency on recognition. To obtain subjective ratings, subjects are asked directly how familiar they are with individually presented words. Gernsbacher (1984) has shown that many previous inconsistencies in research on word recognition can be dispelled when objective frequency counts are supplanted by subjective ratings.

Even more recently, researchers have used subjective frequency ratings to examine the degree to which lexical representations that support word recognition are independent of modality of processing (i.e., visual or auditory). If subjective ratings are modality *independent*, ratings should not differ for words presented visually compared to words presented auditorily. On the other hand, modality *dependence* of lexical representations should be revealed by differential judgments of words that are processed in the visual or auditory modalities. If subjects' mental representations of visual and spoken words incorporate possible differences in frequency of processing in the two modalities, subjective frequency ratings should reveal these differences. In short, modality dependence should be reflected in lower correlations between subjective ratings of words processed in the visual and auditory modalities. Conversely, modality independent lexical representations should not produce differentially sensitive ratings.

Early versions of various models of word recognition have made at least implicit claims regarding the modality independence of frequency information. Morton's (1969) logogen model appears consistent with modality independence because logogens accept evidence from both auditory and visual input. Later versions of the model, however, explicitly acknowledge modality dependence by incorporating separate logogen systems for printed and spoken words (Morton, 1979). In addition, Forster's (1973) autonomous search model is consistent with modality dependence because the first stage of the model involves submitting an unanalyzed pattern to peripheral access files made up of bins that contain either frequency-ordered

orthographic entries or frequency-ordered phonetic entries. Thus, in Forster's model, frequency effects should depend directly on modality of processing.

The present research further examined whether frequency is a modality independent, unitary phenomenon. In particular, we attempted to determine if frequency information is coded strictly at an abstract lexical level or if this information is also present at one or more particular, form-based levels of representation, such as phonological and orthographic representations that support perception and production. This research attempted to extend previous findings to determine if form-based, modality dependent representations possess their own frequency indices.

We gathered subjective frequency ratings for 252 words using the following questions: "How often have you read the word ___ in your lifetime?"; "How often have you written the word ___ in your lifetime?"; "How often have you heard the word ___ in your lifetime?"; and "How often have you said the word ___ in your lifetime?". Separate ratings were collected for a list of words presented visually and the same list of words presented auditorily.

We were interested not only in the ratings themselves but also in their implications for processing times. In particular, we were interested in determining the degree to which each of the four types of ratings would correlate with performance in processing tasks. We attempted to determine if subjective ratings of the frequencies of producing words (writing, saying) correlate with performance in experiments with a production component (naming); if subjective ratings of frequencies of perceiving words (reading, hearing) correlate with performance in experiments with perception components (lexical decision); and if ratings of a given input modality correlate with performance within and across modalities. Again, we were interested in determining if frequency differences are coded strictly at an abstract lexical level or if this information is also present at one or more particular, form-based levels of representation.

In experiments 1A and 1B, subjects rated how frequently they read, wrote, heard, and said the stimulus words. Visually presented words and auditorily presented words were rated separately. Experiments 2 through 5 examined processing time and accuracy for the words rated in Experiment 1. These experiments were (1) auditory lexical decision, (2) visual lexical decision, (3) auditory naming, and (4) visual naming. These ratings were then correlated with processing times in auditory and visual lexical decision and naming tasks. Our results suggest modality dependence for some lexical representations, primarily for words that occur fairly rarely in the language.