Measuring the Sounds of Silence: Latency and Duration of Word-Initial Plosives

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Naming latency, the latency of the onset of acoustic energy arising from a speeded verbal response, is the primary dependent variable in the vast majority of psycholinguistic tasks. Unfortunately, naming latency is not a valid measure of response latency for words beginning with plosive consonants (the obstruents /p/, /t/, /k/, /b/, /d/, and /g/, and the affricates, /ch/ and /j/) because the onset of acoustic energy occurs 50-100 ms after the articulators are in their target position. This delay arises because airflow through the vocal tract must be occluded while pressure is built up prior to the pressure's explosive release that finally generates acoustic energy. Thus, somewhat paradoxically, the onset of acoustic energy marks the end of plosive consonants, not their beginning.

A related problem stemming from the articulatory characteristics of plosives is that naming latency conflates response latency and the duration of the initial phoneme for words beginning with plosive consonants when the standard naming task is used. That is, for pairs of words matched on the initial plosive phoneme, response latency differences cannot be distinguished from initial phoneme duration differences. It is important to distinguish these two dependent variables to determine the locus of on-line processing difficulties: Response latency assesses processing difficulties that arise before the response initiation, whereas duration assesses processing difficulties that arise after a response initiation.

To solve the problem of when the articulation of a plosive begins, we introduce the post-vocalic naming task. Unlike the standard naming task in which the participant is silent immediately preceding the response, the participant says "uuhhh" before the stimulus is presented and continues doing so until producing the response. Thus, response latency corresponds to the offset of the "uuhhh" vocalization (the vocalic offset latency), and the initial phoneme duration corresponds roughly to the duration of the silent gap (the gap duration). The latency for the plosive's release corresponds to naming latency of the standard naming task (the vocalization onset latency).

To determine the locus of processing difficulties, we consider the effect of consistency of pronunciation for words whose vowels have an irregular pronunciation. We compared 16 low frequency words with irregular pronunciations with 16 low frequency words with regular pronunciations matched on initial phoneme, printed frequency, bigram frequency, and number of neighbors. All words began with a single plosive consonant. The stimuli were presented on a computer, and participants responded as quickly and accurately as possible. The verbal responses were digitized using a 16-bit audio board and stored for off-line analysis. After the experiment, we analyzed the responses to determine whether a word was correctly pronounced. Only correct responses were further analyzed. An algorithm was used to determine the vocalic offset latency and the vocalization onset latency, and the gap duration was simply the difference of these two latencies. Both the vocalic offset latency and gap duration were 14 ms longer for irregular words compared to regular words. The vocalization onset latency was 28 ms longer for irregular words compared to regular words.

Consistent with previous studies, response latencies for irregular words were longer than for regular words. In addition, the longer initial phoneme duration indicated that there was a processing difficulty for irregular words that arose after the response had been initiated. The existence of a duration effect provides evidence that participants begin pronunciation as soon as the initial phoneme of a word is known and do not wait until the entire pronunciation.

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