CHAPTER TEN

PHONOLOGICAL ENCODING IN HEALTHY AGING:
ELECTROPHYSIOLOGICAL EVIDENCE

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Research on language production in older adults with unimpaired cognitive abilities suggests that the naming problems associated with advanced age arise in, or just before, the phonological stage. Various theories as to why there are lexical access difficulties have been proposed. The Transmission Deficit Hypothesis (TDH; Burke et al. 1991, James and Burke 2000, MacKay and Burke 1990) is one well-supported theory explaining that breakdowns, particularly with age, are due to a failure in the transmission of available semantic/syntactic information to the phonological system (Abrams, White and Eitel 2003, Burke et al. 1991, Cross and Burke 2004, Heine, Ober and Shenaut 1999, James and Burke 2000, Rastle and Burke 1996, White and Abrams 2002). The TDH proposes that older people are especially prone to word-retrieval problems due to weakening of lexical-phonological connections in memory.

But why are features at the phonological level more vulnerable to retrieval breakdowns than semantic/syntactic features at the conceptual/lexical level? The reasoning is that the phonological level generally has fewer inter-connections (e.g., one phoneme represents one sound), whereas the lexical-semantic system has multiple inter-connections (e.g., many words/concepts linked to a given word) (James and Burke 2000, MacKay and Abrams 1996). Aging weakens the links in the system, in particular, affecting the least innervated links. Factors such as word frequency or recency of use presumably influence the strength of phonological connections within a word and thus retrieval of those elements. Therefore, the lower the frequency of a word and the less recently it has been used, the weaker the connections to its phonological shape and the greater the difficulties in retrieving it.

The purpose of this chapter is to provide a neurolinguistic basis for understanding phonological encoding breakdowns in speech production in older persons using evidence from an electrophysiological
study of substages of phonological encoding in healthy aging (Neumann 2007).

Levelt and colleagues (1999) have constructed a model of spoken word recognition that provides the theoretical framework for this research (see also Dell and O’Seaghdha 1992). In this model there are two encoding stages in lexical retrieval. During the first stage, people conceptualize the word they want to say, which activates the semantic and syntactic description of the lexical item referred to as the lemma. During the second stage of encoding, the target lemma is phonologically encoded into a lexeme, which is an abstract representation of the phonological specifications of the lexical item.

There are various substages of phonological encoding according to this model. For example, when encoding the lemma “dresses”, first the segmental and metrical frame is created. This involves retrieval of morphemic and phonological codes, such that individual phonemes or ’segments’ (e.g. /d/ /r/ /ɛ/ /s/ /ə/ /z/) are ordered and spelled out. As well, the metrical structure or ‘frame’ of the target word is created which includes the number of syllables and location of stress (e.g. /dresəz/ has two syllables and initial syllable stress). The segments are inserted into the lexeme’s frame to construct a phonological word frame (e.g. /drɛ́z/, initial syllable stress). This is known as ‘segment-to-frame association’. The final substage is retrieval of the syllabic gestural codes from the mental syllabary, an abstract store of highly-practiced phonetic syllables. These phonetic codes are understood and accomplished by the articulatory apparatus, resulting in articulation, i.e. overt speech.

It is only within the past decade that researchers have begun to use the dynamic measure of real-time activation of event-related potentials (ERPs) and other imaging techniques to detect the temporal encoding of distinct types of word information in speech production (see Indefrey and Levelt 2004 for a meta-analytic review of imaging literature on word production). Most studies have used evoked cortical responses such as the laterialized readiness potential (LRP) and/or N200 to assess the points in time when different types of lexical information are retrieved for speech production.

The standard task employed is picture-naming, as it is assumed that this task requires the speaker to activate the complete process, both selection and encoding of a specific concept for word-retrieval (Glasser 1992). The LRP indexes response preparation (for example, getting ready to press a button to make a language-related judgment). It is