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Gonia Jarema
and Gary Libben (eds.)

Phonological and Phonetic Considerations of Lexical Processing

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Edited by Gonia Jarema and Gary Libben

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The integration of phonological and phonetic processing

A matter of sound judgment

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The goal of this book is to bring together research perspectives that both support and advance the investigation of phonological and phonetic factors in the functional architecture of the mental lexicon and in lexical processing.

It is paradoxical that a consideration of speaking and listening should warrant special treatment in the study of how words are represented and processed in the mind. It is clear that the ability to produce and comprehend written words is scaffolded upon our ability to say them and understand them aurally. Yet, there has been a strong tendency for researchers to employ the written forms of words to conceptualize how words may be represented in our minds. Indeed, even the term "mental lexicon" evokes images of a dictionary that is much more likely to be perceived as a repository of written words rather than of spoken words.

In many ways, the use of the written form of words as the unmarked metaphor in the scientific investigation of lexical representation and processing is innocuous. In order to refer to words in the pages of books and journals, they must be represented somehow – and it seems relatively obvious that the most convenient representations in such media are the visual written representations for which we already have conventionalized forms. Thus, we use representations such as 'BOOK' to refer to the representation – indeed the neurological instantiation – of the cognitive activities that correspond to the knowledge of 'book' and the ability to use that knowledge in acts of communication. This is primarily a matter of convenience. But that convenience carries with it some danger, for, to state this reflexively: *All metaphors are double-edged swords.*

This leads us to the question of why, in particular, and despite its convenience, the use of the written form of words as the unmarked metaphor may be a *double-edged sword.* In our view, there are two inter-related reasons for this: The first is that the written metaphor is by nature static and thus tends to de-emphasize

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the fundamentally dynamic nature of the mental lexicon and lexical processing. The second is that the relative dominance of the written form in the investigation of lexical processing has tended to de-emphasize the role of production in lexical ability among language users and therefore its importance in the modelling of that ability. As we discuss below, greater focus on the role of speech in lexical processing research will enhance considerations of the inherently dynamic nature of lexical ability and the importance of production in mental lexicon theory. Greater emphasis on the role of speech will also increase ecological validity and facilitate the development of new opportunities for knowledge advancement and integration.

The dynamic nature of the mental lexicon

At first blush, it may seem that the notion of dynamism is at odds with the inherently representational nature of the mental lexicon. In our view, however, this is not the case at all. Jarema and Libben (2007) present a definition of the mental lexicon, which has its dynamic nature as a core feature. Jarema and Libben (2007) define the mental lexicon as:

> the cognitive system that constitutes the capacity for conscious and unconscious lexical activity. (p. 2)

In this definition, the term *system* highlights the functional integrity that is characteristic of lexical activity. The key feature of the mental lexicon is the manner in which lexical representations are inherently linked in complex multidimensional networks. The definition situates the mental lexicon as not simply the repository of representations that enables lexical activity. Rather, it constitutes the claim that the mental lexicon *is* that lexical activity. Perhaps most importantly, the use of the term 'capacity' within the definition highlights the importance of the productivity and dynamism in lexical knowledge and lexical ability. For example, the lexical knowledge of a speaker of English includes not only the ability to acquire and retain a memory trace for a word such as *landscape* (common in English since 1800) but also to create and interpret words such as *seascape* (common since 1900), *cityscape* (common since 1950), *soundscape* (common since 1960), *textscape* and *screenscape* (both attested since 1990). The newness of many of these words and the ease with which they can be interpreted illustrate another key point – the lexical knowledge of an individual will change throughout the lifespan as new languages are acquired, as new words are learned, as words that have been previously learned fall into disuse, and as new connections among words and their sub-elements are formed and changed.

This phenomenon of change across the lifespan is addressed directly in this book by Michael Ramscar, Peter Hendrix, Bradley Love and Harald Baayen in their chapter entitled *Learning is not decline: The mental lexicon as a window into cognition across the lifespan.* The authors challenge the widely accepted view that healthy aging is linked to cognitive decline and claim that current models of learning in aging are based on erroneous assumptions about associative learning and are thus inaccurate, and cannot capture processing performance in the elderly in an adequate manner. Scores obtained from psychometric vocabulary tests are shown to distort and misrepresent performance, resulting in an underestimation of cognitive abilities in older adults. Ramscar et al. demonstrate that when learning models that adequately control for effects of lexical learning on performance are employed, there is little evidence of cognitive decline among older adults. Rather, they claim that "lexical knowledge becomes more and more attuned to the information structure of the lexicon". Under their view, the continued experience of acquiring lexical knowledge comes at a cost: it augments processing load over the lifespan. But the ability to learn vocabulary items is not fixed, it improves over time as increase in accuracy scores clearly demonstrates. Thus slow-down of lexical processing in the aging population should not be equated with cognitive decline. Ramscar et al. argue that, rather than adopting the prevalent stereotype of decline in aging, we should be placing emphasis on increased expertise through experience, a dynamic which can be captured through the use of discriminative learning models that provide a meaningful framework for the understanding of lexical processing across the lifespan.

Phonological and phonetic processing as a window to dynamic lexical knowledge and processing

Our discussion above of the fundamentally dynamic nature of the mental lexicon and the manner in which the lexical abilities of individuals change across the lifespan leads us to the question of the fundamental role that phonological and phonetic properties of words play in those representations and in their dynamic nature.

Perhaps the first place to begin the exploration of the role of phonological and phonetic properties is through a consideration of the individuality and variability associated with spoken words. The written word is, by design and by circumstance, considerably more invariant synchronically and more conservative diachronically than the spoken word. Consider, as an example, the word *light* in English. Its spelling has been relatively invariant for over 500 years, as evidenced in the title of the 1582 essay of the Puritan Christopher Fetherston "*A Dialogue*

Agaynst Light, Lewde, and Lasciuious Dauncing". In this essay, C. Fetherston cautioned against allowing singing and dancing on Sundays. We can expect that his and his contemporaries' pronunciation of 'light' in his reading of the essay would have differed rather dramatically from the current pronunciation, retaining the Germanic /xt/ as the final consonant cluster that has disappeared in modern English. But, of course, this does not mean that either the pronunciation 500 years ago or now would be invariant across dialects and speakers. We see, for example that, even in current North American pronunciation, there is considerable variation. Canadians will most likely produce *light* as /lʌɪt/, demonstrating the phonological phenomenon known as Canadian Raising. Americans will likely pronounce it as /laɪt/, with the diphthong being present or absent, depending on local dialect.

What effects does this inherent variability within the speech signal have on the representation of words in the mind and on an individual's ability to recognize words spoken by members of his or her own speech community, or by other individuals that they might perceive as having 'an accent'? The ability to answer this and related questions is central to the attainment of a comprehensive and ecologically valid science of lexical representation and processing. Moreover, in an increasingly multilingual world, more and more people vary in the manner in which they pronounce a word in a given language. As a consequence, listeners may need to be able to recognize words spoken with an accent that is quite different from their own.

Matters of lexical processing related to the issues noted above are treated in this volume by Kit W. Cho and Laurie Beth Feldman in their chapter *Production and accent affect memory.* They examined how native speakers of English recall and recognize words spoken in either a highly familiar accent (American English), or a less familiar accent (Dutch). The main purpose of the study was to determine whether production benefits recognition. They found that performance on a memory task benefits from production more than from listening, and that irrespective of whether one pronounces words in one's own accent or whether one imitates the accent of the speaker, producing words presented with an unfamiliar accent facilitates recall and recognition. They demonstrate that acoustic-phonetic details are retained in listening, but "overshadowed or attenuated by production", and thus provide empirical evidence in support of the view that acoustic-phonetic and articulatory information interact in memory tasks.

The chapter by Cho and Feldman raises the question of the fundamental nature of lexical representations generally and, more specifically, with respect to their encoding of the phonological and phonetic properties of words. Given that, in terms of acoustic detail, spoken words may be considered to be unique events, what kinds of representations in the mental lexicon are likely to be developed in

order to accommodate this inherent variation? In their chapter *How robust are exemplar effects in word comprehension?*, Iris Hanique, Ellen Aalders, and Mirjam Ernestus address the central question of whether a word's pronunciation is stored in terms of abstract information about its acoustic properties, or rather in terms of exemplars, that is as a set of representations of exact pronunciations of each instance of the word as it is heard. They probed the validity of the exemplar model in four long-term priming experiments varying the distance in trials between prime and target, pronunciation (unreduced-reduced), speaker match between prime and target (same-different) and type and number of variation (degree of reduction and/or speaker voice). Exemplar effects were only found in the first of the four experiments, a short experiment with no speaker variation and a high proportion of repeated words. Hanique et al. argue that because, in spontaneous speech, degree of variation varies greatly, abstract lexical representations may play a more prominent role than exemplars. They conclude that spoken language comprehension can be accounted for in a hybrid model that combines abstract representations *and* exemplars, or in a model that posits only abstract lexical representation and that "assumes domain-general episodic memory". This leads them to suggest that in natural conversation, which is as a rule characterized by great reduction variation, exemplars do not play a prominent role.

Considering Second Language and bilingual processing as core phenomena

An important theme that emerges across this book is that second language acquisition across the lifespan plays a key role in the variable phonetic and phonological properties of speech that will be encountered by hearers of a language. As noted by Libben and Goral (2015), seminal contributions by authors such as Grosjean (1989) have stressed that language processing by speakers of more than one language must be taken as a theoretical primitive and cannot be well understood by simply combing models of monolingual processing (see also Grosjean, 2008). It has been repeatedly shown that bilinguals' performance in each of their languages differs from monolingual norms (e.g., Gollan & Goldrick, 2012). And, this is particularly so in the phonological and phonetic domains.

This phenomenon is taken up by Isabelle Darcy, Danielle Daidone, and Chisato Kojima in their chapter entitled *Asymmetric lexical access and fuzzy lexical representations in second language learners*. The authors begin with the observation that L2 learners have been demonstrated to exhibit less efficient word recognition abilities than native listeners, due to difficulties with the perceptual discrimination of sounds and/or with accurate (native-like) lexical encoding of words in L2. They expand previous studies on asymmetries in phonemic contrast

discrimination by attempting to tease apart the "phonetic coding deficiency hypothesis" from the "lexical coding deficiency hypothesis" by studying phonetic categorization and lexical decision among native speakers of American English learning German and Japanese. Results revealed that both learners of Japanese and learners of German discriminate phonemic contrasts much like the control group of native speakers, at both the high and the intermediate levels of proficiency. In lexical decision, the previously reported asymmetrical pattern was observed in both groups, confirming that encoding of new and difficult phonemic contrasts is not fully target-like and is influenced by L1. This asymmetry, combined with accurate phonetic categorization, is interpreted as revealing that such contrasts are inadequately represented at the lexical level, thus supporting the lexical coding deficiency hypothesis. Darcy and colleagues suggest that fuzzy lexical representations may in fact increase lexical competition in spoken word recognition in early stages of L2 proficiency and that lexically imprecise representations triggered by deficient lexical encoding, rather than inadequate acoustic perception, are at the root of assymetric patterns in lexical access.

How do speech and writing influence each other?

As we move toward a world characterized by global literacy, spoken-only language processing is a term that is increasingly reserved for the first years of childhood, rather than for literacy differences among adults. Accordingly, the possible interaction between phonological and phonetic factors on the one hand and orthographic factors on the other hand is very important to the effective modeling of lexical processing in both domains. Almost all native speakers of English encounter their basic core vocabulary aurally before the onset of literacy. Thus, there is an important way in with spoken word processing is prior to visual word processing both ontologically, and perhaps logically. Yet, this should not lead us to suppose that, as a result, we will find psycholinguistic effects of speech on reading and writing, but not vice versa. Returning to our example of the word *light* above, one would expect that as a high frequency word characterized by early age of acquisition, it would almost certainly be among those words that are learned aurally before visually. Yet, how would adult native speakers of North American English, who, as we noted above, might have very differing pronunciations for the word, characterize those differences? It is very likely that they would characterize them as differences in how people from different regions pronounce the word spelled "l-i-g-h-t". In other words, they would use the written form as the underlying, core, unbiased reference point for the characterization of their pronunciation, or the pronunciation of others. This raises important implications when considering

the orthographic effects on speech both within languages and between languages, because writing systems, as technical human inventions, are not, of course, unbiased at all, but rather represent particular engineering solutions constrained by a large number of factors, including the phonological and phonetic properties of the particular languages that they were designed to encode (bidirectional influence of this sort can also be a driver of spelling change, e.g., the use of *lite* for *light* in American spelling).

Perhaps one of the most successful writing systems developed is that used for Korean, and that which is the subject of the chapter in this volume by Naoko Witzel, Jeffrey Witzel, and Yujeong Choi, entitled *The locus of the masked onset priming effect: Evidence from Korean.*

Korean writing features both an alphabetic (Hangul) and a logographic (Hanja) script. The authors take as their starting point the view that producing words aloud involves computing the phonology of visually perceived letter strings and the experimental finding that in the presence of a masked prime, naming is facilitated when prime and target share an initial phoneme or phonemes, creating a masked onset priming effect, or MOPE. Under the assumption that the MOPE engages non-lexical grapheme-to-phoneme processes, they employed nonword Hangul prime-target pairs in order to force a non-lexical route in naming. Results obtained revealed that a MOPE emerges when primes and targets share an initial CV syllable or (but to a lesser degree) when they only share an initial phoneme, indicating that although Korean Hangul is a syllabary script, syllables are decomposed into individual units that operate during grapheme-to-phoneme conversion. Witzel et al. argue that their findings support the view that the MOPE reflects non-lexical grapheme-to-phoneme conversion processes and conflicts with an explanation in terms of a late facilitation in speech planning, because such an account would only predict priming at the level of a prosodic unit above the phoneme (i.e., the syllable) but not at the phoneme level.

The dynamics of dialect changes over time: Exemplar theory as capturing the interplay of phonology and orthography over time

As the discussion above indicates, understanding the roles of exemplars in the modeling of the phonological and phonetic properties of words and in the modeling of lexical representation is a key next step in mental lexicon research. This is, of course, particularly challenging if change is a ubiquitous characteristic of the system. Indeed, it may well be possible that this change is not constant in its trajectory. A very interesting case of such change in trajectory is brought to the foreground by Marjoleine Sloos in her chapter *The reversal of the Bären–Beeren*

merger in Austrian Standard German. The starting point for this study is the general tendency for variation in pronunciation, whether dialectally or socially determined, to give rise to 'merging'. This is a phenomenon where two sounds become perceptually undistinguishable, thus blocking any potential reversal to the two distinct sounds. But, Sloos shows that a merger can be reversed under contextual pressures. In a corpus study of younger and older speakers, the author investigates the current reversal of the Bären-Beeren merger that had evolved historically in both the Austrian and German varieties of Standard German. She found that younger adults increasingly adopt the prestige variety of Standard German (a 'multicentric' language), that is German Standard German, where the vowel distinction is prevalent. Sloos proposes that merger reversals can best be accounted for within exemplar theory. Besides information on how words are pronounced, competing exemplars also store sociolinguistic and orthographic information. However, "Orthographical information becomes available as a cue for pronunciation if, and only if, linguistic as well as social information fall short in the selection process." Orthography is not an implicit process "because it is learned separately and memorized consciously, unlike auditory information" and is stored at a level that is connected to the auditory level. In the reversal of a merger, it comes into play in the presence of sociolinguistic motivation.

Morphology, phonology, and phonetics

Across the world's languages, most words do not consist of a single meaning-bearing form (e.g. *book*) but rather are composite forms. Sometimes the subunits are easily identifiable lexical subunits (e.g., *bookcase*). Sometimes, they contain subunits that are formally identifiable but do not exist as independent words (as in our example above of *landscape*, in which *-scape* is derived from Dutch, *-schap*, making English *landscape* cognate with German *Landschaft*). In other cases (e.g., *booking, books, bookish, prebook*), subunits are best describes as affix forms.

From the outset of research on the mental lexicon, a great deal of research has dealt with the formal morphological properties of words and the question of how the morphological subunits of words may influence their representations in the mind and how they are accessed during the processes of language comprehension and production. The chapter by Joseph Stemberger in this volume entitled *Phonological reduction in the first part of noun compounds* ties into a key discussion in this domain – this is the discussion concerning whether regular and irregular lexical forms, in particular plurals, are stored and processed differently in the mind.