The interface between morphology and phonology: Exploring a morpho-phonological deficit in spoken production

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ABSTRACT

Morphological and phonological processes are tightly interrelated in spoken production. During processing, morphological processes must combine the phonological content of individual morphemes to produce a phonological representation that is suitable for driving phonological processing. Further, morpheme assembly frequently causes changes in a word's phonological well-formedness that must be addressed by the phonology. We report the case of an aphasic individual (WRG) who exhibits an impairment at the morpho-phonological interface. WRG was tested on his ability to produce phonologically complex sequences (specifically, coda clusters of varying sonority) in heteromorphemic and tautomorphemic environments. WRG made phonological errors that reduced coda sonority complexity in multimorphemic words (e.g., passed → [pæstɪd]) but not in monomorphemic words (e.g., past). WRG also made similar insertion errors to repair stress clash in multimorphemic environments, confirming his sensitivity to cross-morpheme well-formedness. We propose that this pattern of performance is the result of an intact phonological grammar acting over the phonological content of morphemic representations that were weakly joined because of brain damage. WRG may constitute the first case of a morpho-phonological impairment—these results suggest that the processes that combine morphemes constitute a crucial component of morpho-phonological processing.

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1. Introduction

By means of largely predictable changes in word form, the morphological system allows speakers to expand word meaning, coin novel words, and allows syntactic features to surface in speech. Descriptively, the function of morphology is to govern the combination of morphemes, the meaning-bearing units of language. Morphological processes determine, for example, that the features {cat, plural} are best expressed in English by cat and -s while

the features {mouse, plural} are best expressed by mice. Given the central role of morphology in speaking, it is essential that processing theories of language production include accounts of morphological mechanisms.

A variety of issues pertaining to morphology remain hotly debated in the psycholinguistic literature—most notably, the extent to which morphologically complex words are represented in a decomposed or whole-word format (Butterworth, 1983; Bybee, 1995; Elman, 2004; Fiorentino & Poeppel, 2007; Marslen-Wilson & Zhou, 1999; Rubin, Becker, & Freeman, 1979; Seidenberg & Gonnerman, 2000; Stockhall & Marantz, 2006; Taft, 2004) and whether morphological knowledge is instantiated by one or two processing routes (Burzio, 2002; Clahsen, 1999; Halle & Marantz, 1993; Joanisse & Seidenberg, 1999; Miozzo, 2003; Pinker,

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1999; Rumelhart & McClelland, 1986; Ullman, 2001). Despite these debates, theories of spoken production generally share a *compositional* view, which proposes that morphemes are distinctly represented and that morphologically complex words are assembled from individual morphemes (Dell, 1986; Levelt, Roelofs, & Meyer, 1999). Although these accounts do not rule out the possibility that some morphologically complex words are represented in an undecomposed fashion as whole words, the basic claim is that morphological composition remains a key process in production. The evidence for compositionality in spoken production comes from a variety of sources including speech errors (Garrett, 1975; Garrett, 1980; Stemberger, 1982), reaction time tasks (Bien, Levelt, & Baayen, 2005; Janssen, Roelofs, & Levelt, 2002; Janssen, Roelofs, & Levelt, 2004; Roelofs, 1996; Roelofs & Baayen, 2002) and acquired language impairments (Badecker, 2001; Cholin, Rapp, & Miozzo, 2010; Miceli, Capasso, & Caramazza, 2004). In the present work, we specifically investigate the implications of compositional morphological processing for the encoding of the phonology of multimorphemic words. That is, we examine word production at the morphology–phonology interface.

1.1. Morpheme integration and phonological processing

In spoken production, there is an intimate link between morphological and phonological processing. First and foremost, the output of morphological operations serves as the input to phonological processes. When morphological processes combine lexical representations (morphemes) to form a multimorphemic word, the constituent sounds must also be combined in such a way that the resulting phonological representation is suitable for driving spoken production. For example, once the morphemes *cat* and *-s* have been selected, the phoneme sequences /kæt/ and /s/ must be combined into /kæts/ in order to allow subsequent phonological processing to take place. This assembly process, though currently underspecified in theories of spoken production, likely involves—at the very least—updating segmental position information to reflect the newly constructed multimorphemic environment (e.g., the /k/ in *cloth* is no longer in word-initial position when it appears as part of the compound *tablecloth*). Whatever specific operations this process may entail, the integration of the phonological content of a word's morphemes is crucial to the ability of downstream processes to operate over the word.

The second reason that morphological and phonological processing are intimately related in production is because the combination of morphemes frequently results in the creation of new phonological environments that vary in how well they conform to universal and language-specific phonological constraints. In many cases, the phonological environment created by combining morphemes must be overtly modified by the phonology in order to satisfy a language's phonological constraints. For example, affixation in English frequently requires the phonological content of morphemes to be resyllabified in order to create optimal syllables (*find* + *ing* = [faɪn.dɪŋ]). Far more dramatic modifications also abound—for example, in languages containing vowel harmony rules, root and affix vowels are modified so

that they agree in particular features. In Turkish, suffix vowels must agree with root vowels in backness and rounding. Thus, the phonetic form of the genitive suffix depends on the features of the root vowel: [es-in] 'spouse-GEN' but [tur-un] 'tour-GEN'. In languages with consonant dissimilation rules, the merger of morphemes may cause root and affix consonants to be modified so as to not share features (e.g., Tashlhyit Berber dissimilation causes prefixes to delabialize before roots containing a labial consonant: /m-fara/ → [n-fara] 'REFLEXIVE-disentangle'; Alderete, 2003).

In other cases, morpheme combination does not trigger overt changes to a word's phonological form (e.g., *unique* + *-ness* = *uniqueness*), but instead involves changes to the word's phonological well-formedness. For example, *uniqueness* contains a metrical configuration known as 'stress clash', where stress appears on adjacent syllables: [ju.ník.nès]. Stress clash, though it requires no modification when it involves the suffix *-ness*, is generally dispreferred (marked) in English, as demonstrated by its rarity in monomorphemic words (Hammond, 1999). The merger of *unique* and *-ness* thus results in a word with a relatively low degree of phonotactic well-formedness. Another example of a change in phonological well-formedness can be seen in the case of the English past tense. When combined with consonant-final roots, the past tense suffix *-ed* creates consonant clusters of varying sonority profiles, either obstruent–obstruent coda clusters (e.g., *walked* [wakt]) or sonorant–obstruent clusters (e.g., *spanned* [spænd]). Both sonority profiles are tolerated in English and appear in monomorphemic words (e.g., *act*, *band*), however while sonorant–obstruent codas are common both in English monomorphemic words and across languages, obstruent–obstruent codas are relatively infrequent in English monomorphemic words and are cross-linguistically marked, suggesting that the latter profile is relatively less well-formed than the former (Clements, 1990; Hammond, 1999).

It is likely that these changes in well-formedness have a substantial influence on phonological processing. Evidence from normal and brain-damaged individuals indicates that phonological processes are sensitive to phonological well-formedness (often referred to as phonological complexity) (e.g., Buchwald, 2009; Goldrick & Rapp, 2007; Janssen & Domahs, 2008; Laganaro, 2005; Romani & Calabrese, 1998; Romani & Galluzzi, 2005; Stenneken, Bastiaanse, Huber, & Jacobs, 2005; Vitevitch, Armbrüster, & Chu 2004), suggesting that words that are less well-formed as a result of morpheme combination may strain phonological processes more than words that are relatively more well-formed. Thus, conditions where morphemes are combined create environments that are taxing for the phonology and may provide an opportunity to investigate the morphology–phonology interface.

1.2. Morpho-phonological deficits

The two aspects of the relationship between morphology and phonology outlined above – the fact that morphological processes stitch together representations that phonological processes must act over and the fact the