Why are three-level vowel length distinctions rare?
Insights from Dinka (Lyanyjang dialect)

The range of variation in the sound systems of the world's languages is bounded by the characteristics of the human speech apparatus. That is, for a hypothetical distinction to appear as phonemic in any language, the human vocal system needs to be able to produce it, and the human auditory system needs to be able to perceive it. In this way, knowledge about speech production and perception allows us to infer gaps in the existing typology, that may be waiting to be filled as more data become available. This means that, on a par with linguistic theories and existing typologies, knowledge about the human speech system offers a framework of reference that may prepare a researcher to encounter or not to encounter certain phenomena.

For certain questions, the combined articulatory and psychoperceptual framework of reference provides the better lead to go by. If we consider the question 'How many levels of vowel length can be found in human languages?', we find that most theories of phonological quantity impose a limit of two weight units (Chomsky & Halle 1968, Kenstowicz & Rubach 1987, Duanmu, to appear), be it at the level of the nucleus, or at the level of the syllable. This theoretical limitation may bias the researcher to interpret complex quantity systems in such a way that the limit of two is not violated – cf. work on Estonian by Prince (1980), Bye (1997), and Odden (1997). Typology, by contrast, suggests that three-level vowel length systems do exist – see e.g. Hoogshagen (1959) on Mixe, and Andersen on Dinka (1987). In this context, a phonetic perspective may lead us to an answer as to why three-level vowel length systems should be possible – and also, why four-level vowel systems should not be possible.

Experimental studies on speech perception have shown that the smallest difference in vowel duration that the human auditory system can pick up – i.e., the justnoticeable difference – lies between 7 and 20 percent of a reference sound (Fujisaki, Nakamura & Imoto 1975; Klatt & Cooper 1975; Goedemans 1998). In two-way vowel length systems, the proportional difference between short and long vowels can be up to 100 percent – for example, short and long vowels could have typical durations of 75 and 150 ms, respectively (cf. Broselow, Chen & Huffman 1997). In a recent study with Leoma Gilley (Remijsen & Gilley, to appear), we found that in Dinka, which has three levels of vowel length, short mid and long vowels have average durations of about 70, 100, and 145 ms, respectively. In other words, the proportional difference between adjacent levels of vowel length is about 50 percent. Importantly, it appears that the phonetic space of vowel length is about the same, irrespective of the number of levels (two or three) that are distinguished. As a result, an increase from two to three levels leads to greater crowding in this phonetic space. A further increase to four levels within the same phonetic space would bring the between-category distance in vowel duration down to 20 percent, the top of the just-noticeable difference range. Measurements on vowel quality in the three levels of vowel length reveal that most Dinka vowels are considerably centralised in the shortest level of vowel length. It appears that the three-level vowel length distinction constrains the duration of the short
vowel, to the extent that the vowel is not realised fully. Here again, we find an indication of the strain placed on the system.

Similarly, psychoperceptual studies on pitch perception, based on language or synthetic stimuli, have a bearing on the number of pitch levels that can be reliably distinguished by the human auditory system (Hogan & Manyeh 1996), the categories of f0 alignment (Nabalek, Nabalek & Hirsh 1970), and, if other parameters are also taken into consideration, into the independence between stress and tone distinctions (Berinstein 1979, Beckman 1986).

References