Formalizing modulation and the emergence of heads

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Modulation theory (MT; e.g. Traunmuller 1994, Harris 2009) assumes that phonological primes are constructed of perceptually salient modifications to an acoustic carrier, which is commonly described as a schwa-like vocoid with evenly spaced formants. Taking this as a starting point for the construction of phonological representations, we may envision two basic types of modulation: spectral modulation and amplitude modulation, each of which must be specified with a temporal envelope capturing rate of change.

Spectral modulation corresponds to place of articulation - the resonance properties of the vocal tract are of course influenced by the location of a given cosntriction. In the acoustic-perceptual domain, there are two distinct shapes a modulation may take. Formants may be (1) converged with another spectral prominence (e.g. F1 with f0 and F2 with F3 in the element I), or (2) they may be high or low relative to the values associated with schwa, but still perceptually distinct from neighboring formants. It may be assumed that the former type of modulation, the formant convergence, is more perceptually robust, and contributes to apparent headedness effects in vowel quality.

The ampitude domain is more complex, since in the case of voiced sounds the listener must discern the status of periodic portion signal. However, if we take MT seriously, we must assume that voicing is *part* of the carrier, leaving two degrees of modulation: aperiodic noise and silence. This view has two primary consequences with regard to manner and laryngeal features. First, manner contrasts may be expected to enter into relations by which stops dominate fricatives. Second, and more controversially, voiceless consonants should always be phonologically specified regardless of the true-voice or aspiration status of a language. In both types of langauge, voiceless consonants constitute more robust modulations of the carrier - the true voice vs. aspiration dichotomy must arise from other sources.

The Onset Prominence framework (OP; Schwartz 2013 inter alia) provides the representational materials to formalize each of these aspects of MT. OP structures are built down from stop closures followed by aperiodic noise, encoding manner of articulation as a prosodic property, and capturing the position of plosives in traditional strength hierarchies. Spectral modulations may be seen as melodic place primes, but salience is encoded not as headedness but as the perceptual robustness of formant convergences vs. single resonances. Finally laryngeal specifications may be constructed from either amplitude or spectral modulation on a language-specific basis.

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