
My beginning is my end: The processing of unidirectional frequency modulations

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Abstract

Over the last two decades a fair number of investigations have been focused on modulation spectra in the modulation frequency range proper to the everyday soundscapes that carry useful or important information for the daily lives of humans and animals. One sub-area of this topic, however, has received relatively little attention as of late although its crucial ecological importance: single up-or-down frequency sweeps – signals present in nearly all corners of daily life. The peculiar aspect of these FM signals (which can be viewed as linear when using the proper transform) is that their processing by the auditory system grants an overwhelming weight to their beginning, as if they were handled by an accelerometer-like processor in the auditory cortex (Heil and Irvine, 1998, doi.org/10.1093/cercor/8.2.125). Indeed, musical timbre was found by John Grey (1977, doi.org/10.1121/1.381508) to be determined at their onset. Also, Sadaoki Furui's 1986 study (doi.org/10.1121/1.393842) on the perception of Japanese mora-like syllables demonstrated that it was the spectral transition of their onset portion that determined recognition of the syllables. FM glides of complex tones appear to trigger a velocity-measuring device. A study by Crum and Hafter (2008, doi.org/10.1121/1.2945117) found that upward FM sweeps of multicomponent tones interrupted by a loud noise burst were heard as having stopped at frequencies higher than those at which the noise came on. A transition from a first vowel to a second represents an FM sweep starting at the lowest three or four formants of the starting vowel to those of the final vowel. Lindblom and Studdert-Kennedy (1967, doi.org/10.1121/1.1910655) that, although the formants seldom reach the values of the final vowel presented in isolation, the transition is heard as complete. Our own work (Divenyi, 2009, doi.org/10.1121/1.2945117) showed that a constant velocity transition from an initial to a final vowel could be heard as complete even if its duration is significantly decreased, or when its velocity was decreased while keeping its duration constant. Among the many examples we encounter day by day and those in the literature, the ones cited here show that the onset of an FM signal predicts where it is going. By describing these and other observations regarding the processing of sweeps, the talk emphasizes the importance of the starting portion of monotonically increasing or decreasing frequency-modulated signals. It also hopes to generate impetus for further studies on the perception and the processing of simple frequency-modulated sweeps, omnipresent in our daily life.

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