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Tracing perceptual development with Swedish vowel quantity

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Swedish is traditionally described as having a distinction between long and short vowel quantities (Elert, 1964). This distinction is realized acoustically through differences in vowel duration. The greater amount of time associated with a long vowel quantity also allows for a more extreme articulation than short vowel quantities, and consequently may also affect the vowel spectrum. Early research (Hadding-Koch *et al.*, 1964) demonstrated that vowel duration is a primary perceptual cue to Swedish vowel quantity. Recent work (e.g., Behne *et al.*, 1996) shows that adult listeners also make use of vowel spectra to identify /a:/ and /a/. If vowel duration is a primary cue, the use of the vowel spectrum in special cases may be seen as perceptual fine-tuning to improve the efficiency of processing vowel quantities. In that case we would expect young children to develop the use of vowel duration for vowel quantity identification around the same time for all vowels, and independently develop the use of vowel spectra to identify vowel quantities. The aim of this project is to gain an overview of the developmental sequence by which these acoustic cues developmentally come to be used to identify long and short vowel quantities. For a direct comparison between developing listeners and adults, this phase of the project focuses on older children who could easily manage the adult-directed task in Behne *et al.* (1996).

Based on recordings by a native Swedish speaker, /kVt/ words were synthesized using the Swedish vowel pairs /i:/-/i/, /o:/-/o/, and /a:/-/a/. For each set of words, the original vowels of the pair were used as extreme points of a 10x10 synthesis matrix, having ten degrees of vowel duration and ten degrees of simultaneous spectral adjustment. The resulting words were systematically presented to 107 children from 9 to 15 years old. Listeners' responses and reaction times were recorded in a rhyme task and analyzed to determine the extent to which vowel duration and spectral characteristics are used for vowel quantity identification. Results show children approximating adult behavior around 12 years old. The use of vowel duration is acquired simultaneously for the vowels investigated. However, children used vowel spectra to identify /a:/ and /a/ earlier than they generally use vowel duration for quantity identification. These findings are discussed in terms of the perceptual role of vowel duration and spectra as cues for vowel quantity as a listener develops, and more generally, in speech perception.

Behne, D., Czigler, P. and Sullivan, K. (1996) Acoustic characteristics of perceived quantity and quality in Swedish vowels. Adelaide, Australia. *Speech Science and Technology '96*, 6, 49-54.

Elert, C-C. (1964) *Phonologic studies of quantity in Swedish*. Stockholm: Almqvist & Wiksell.

Hadding-Koch, K., and Abramson, A. (1964) Duration versus spectrum in Swedish vowels: some perceptual experiments. *Studia Linguistica* 2, 94-107.