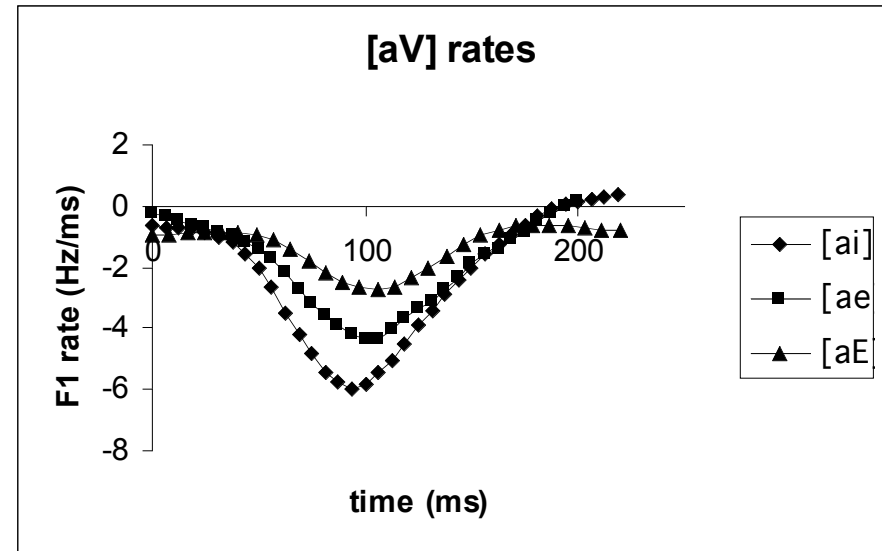


Formant transition rate and  
phase transition rate in V1V2  
production

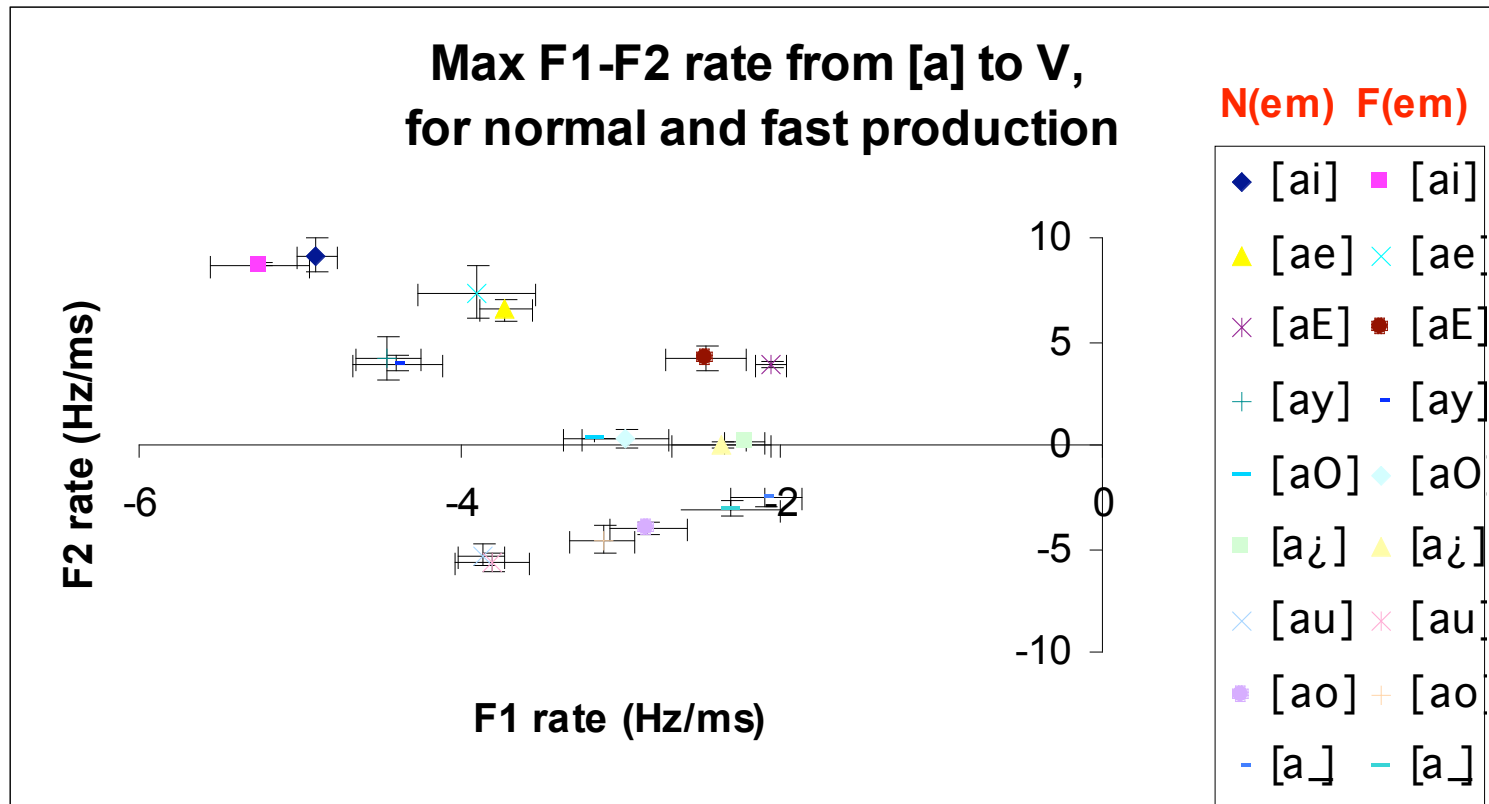
René Carré

# Formant transition rate

- In the case of V1V2 production, if the duration of the transition is constant (Kent and Moll, 1969; Gay, 1978), then:
- [ai] formant transition rate > [ae] rate > [aE] rate
- Information on V2 can be obtained at the beginning of the transition (and all along the transition)



# Vowel representation in the F1 rate / F2 rate plane



# How to have an accurate measure of the formant transition rate?

- Difficult to measure formant frequencies in order to compute the frequency transition rate!
- Why not to measure the phase transition rate?

# Transfer function of the vocal tract (Fant 1960)

- Series of second order lowpass filters with cutoff frequencies corresponding to resonant frequencies of the vocal tract

# Second order filter's transfer function

- The transfer function is given by:

$$H(j\omega) = \frac{v_o}{v_i} = \frac{K\omega_o^2}{\omega^2 - j\omega\frac{\omega_o}{Q} - \omega_o^2}$$

- $\omega = 2\pi f$
- $\omega_o = 2\pi f_o$
- $Q = \omega_o / \Delta f_o$

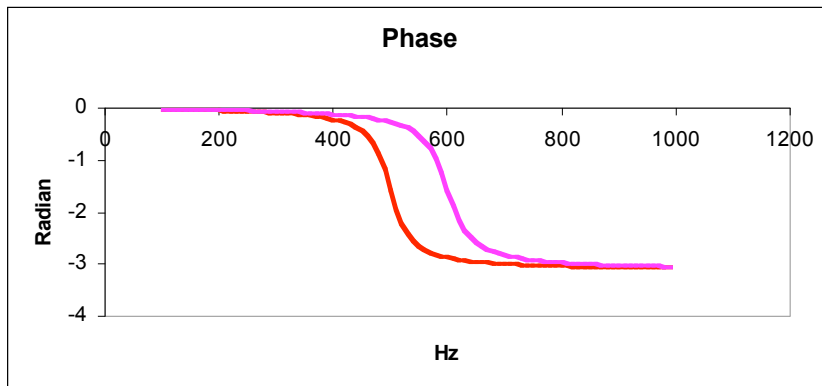
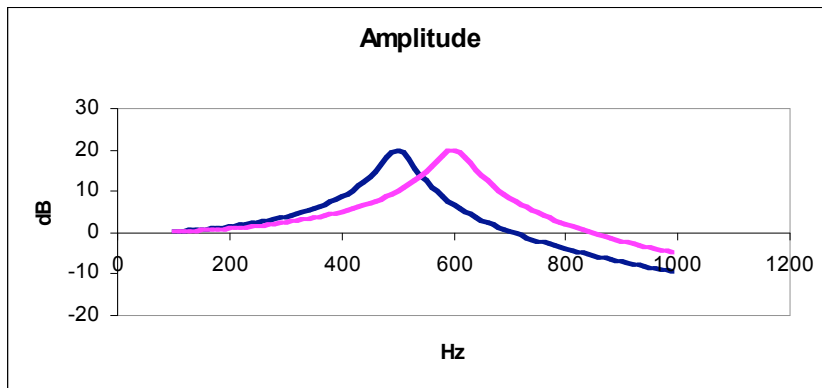
- The amplitude is given by:

$$|H(\omega)| = \left| \frac{v_o}{v_i} \right| = \frac{K}{\sqrt{\frac{\omega^2}{Q^2\omega_o^2} + \left(1 - \frac{\omega^2}{\omega_o^2}\right)^2}}$$

- The phase is given by:

$$\phi(\omega) = -\arctan\left(-\frac{\frac{\omega}{Q\omega_o}}{1 - \frac{\omega^2}{\omega_o^2}}\right)$$

# Phase variation



- For the component corresponding to the dotted line, a formant frequency transition from 500 to 600 Hz gives a phase change of approximately  $\pi$  radians.
- The rate of this change translates into the rate of formant transition