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Modeling of voice registers and bifurcation theory

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The exact definition of registers in the human voice is still under debate. Especially the quantitative analysis of transitions between these registers have not been investigated in much detail yet. Experiments show different kinds of voice instabilities that appear close to the transition from chest to falsetto register. These instabilities include abrupt jumps between the two registers exhibiting hysteresis, aphonic episodes, subharmonics and chaos.

To model these phenomena we start with a three mass cover model of the human larynx which can vibrate in chest and falsetto like patterns. We extend our model to a four mass body-cover polygon model with a supraglottal resonator. We more realistic make use of bifurcation theory to understand how small smooth changes of parameter values can cause sudden qualitative changes in the dynamical behavior of the larynx.

Experiments with excised human larynges and untrained singers show comparable coexistence of both registers in a extended parameter region. Our study suggests that voice range profiles can be generalized as two dimensional bifurcation diagrams.