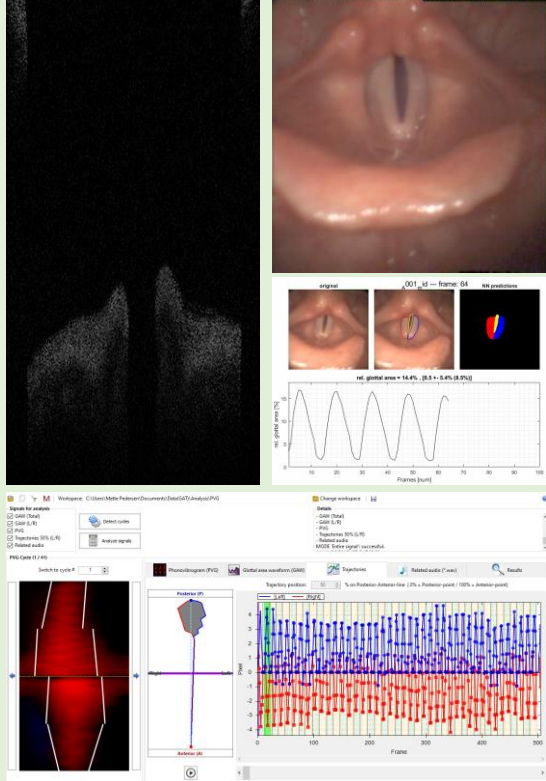


Voice analysis includes the quantitative GAT (glottal analysis tools), OCT (optical coherence tomography) and deep learning research on the vocal folds, among others.



# Regulation of Voice Development in Childhood and Puberty, A Review

2021 Virtual World Congress on Brain Injury

Mette Pedersen MD, Ph.D., FRSM, HON. Prof. IBC Cambridge UK, ENT Specialist. Medical Centre, Østergade 18, 1, 1100, Copenhagen, Denmark, mettepedersen.org

Christian Larsen, Copenhagen Business School, 2000 Frederiksberg, Denmark

Our aim with this systematic review was to research the biological background of the normal human voice production. Only 18 papers were found in a search made by the library of the Royal English Society of Medicine. We supplemented the systematic search with references, found in papers that did have interesting information even if no voice production measures were found.

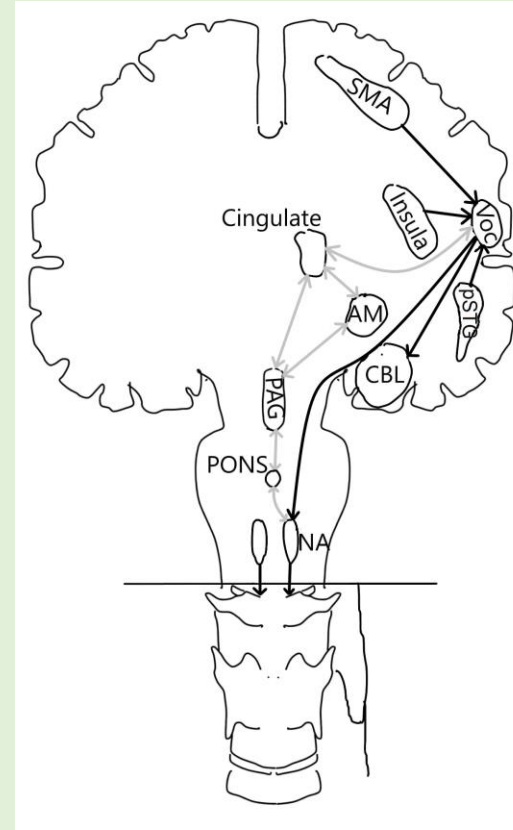
## In the future

Combined updated online highspeed film measures of voice production can give a much better quantitative understanding of voice production development - eventually combined with optical coherence tomography and analyzed with neural networks.

**Especially in pathology, mostly genetic multihandicaps´ syndrome patients could get better treatment if quantitative measures of several kinds of examinations were used.**

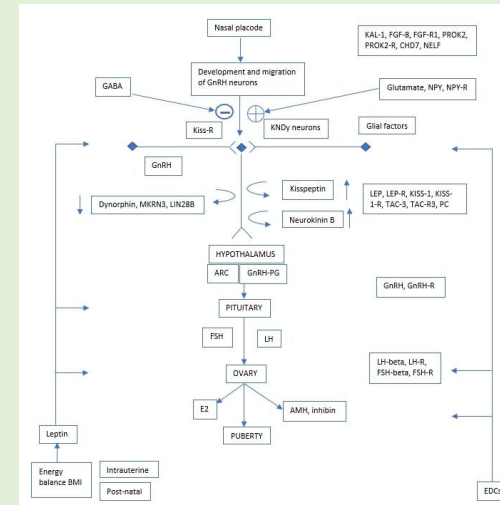
## Geometrical average of hormonal, pubertal and vocal parameters for boys

Age	(years)	8.7-12.9	13.0-15.9	16.0-19.5 pr yr.	% change
No of boys		19	15	14	
Serum testosterone	(n mol/l)	0,54	10,5	18,9	68
Dihydrotestosterone	(n mol/l)	0,18	1,21	1,57	37
Free testosterone	(n mol/l)	0,007	0,14	0,33	77
Sexual hormone binding globulin	(n mol/l)	134	66	45	-16
Delta 4 androstene dione	(n mol/l)	0,54	1,17	2,5	24
Dehydro epi andro sterone sulfate	(n mol/l)	1400	4100	5900	25
Testis volume	(ml)	2,3	13	20	36
Fundamental frequency	(Hz)	237	184	125	-11
Voice range	(semitones)	3,7	4,8	5	3,9
Phonotogram area	(cm <sup>2</sup> )	19	28	34	9,2
Lowest biological tone	(Hz)	158	104	72	-12



Input and ongoing voice modulation is from the posterior superior temporal gyrus (PSTG) as well as from the supplementary motor area (SMA) and Insula.

Two signal processing brain functions for voice production of voluntary and involuntary processing have different developmental aspects. Marked in black and grey, respectively.



## Brain and genetics

The genetic brain development related to voice is presented. At the beginning the reactivation of the hypothalamic hypophysis gonad axis is a result of a complex network of genes, neurotransmitters, and neuronal interactions in the hypothalamus. It all begins from the nasal placode where from GnRH (gonadotropin releasing hormone) neurons migrated to hypothalamus.