

Syllable repetition

Speech feature	Subsystem	Definition	Description
Voice onset time (VOT)	Articulation	It is defined as the entire length of consonant from initial burst to vowel onset	Decreased ability of laryngeal muscles to initiate voicing.
Diadochokinetic rate (DDKR)	Articulation	The DDKR is estimated as the inversion of the median duration between consecutive voice onsets.	Abnormally slow motion rate of articulators.
Diadochokinetic irregularity (DDKI)	Articulation	The DDKI is estimated as the standard deviation of the measured durations between consecutive voice onsets.	Irregular or timing deficits of repetitive movements.
Vowel duration (VD)	Timing	The VD is estimated as the mean duration of detected voiced intervals	The slowness of repetitive movements with excessive vocal emphasis.
Standard deviation of power (stdPWR)	Articulation	stdPWR is computed as the standard deviation of the resulting loudness envelope computed on all voiced intervals.	Poor respiratory-phonatory coordination and control.

Sustained phonation

Speech feature	Subsystem	Definition	Description
Maximum phonation time (MPT)	Respiration	Maximum duration of sustained vowel phonation.	The rigidity of respiratory muscles leads to decrease ability to sustain vowel.
Standard deviation of fundamental frequency (stdF0)	Phonation	The stdF0 is computed as the standard deviation of detected modal F0 in semitones estimated via the median absolute deviation.	Irregular or timing deficits of vocal folds vibration.
Jitter	Phonation	Frequency perturbation.	Harsh, rough and raspy voice.
Shimmer	Phonation	Amplitude perturbation.	Harsh, rough and raspy voice.
Harmonics-to-noise ratio (HNR)	Phonation	Amount of noise in voiced speech.	Harsh, rough and raspy voice.
The proportion of sub-harmonic intervals (PSI)	Phonation	PSI is calculated as the ratio between the total duration of sub-harmonic intervals per total duration of voicing.	Changes in the mass or control of vocal folds.
Cepstral peak prominence (CPP)	Phonation	Measure of cepstral peak amplitude normalized for overall amplitude.	Deteriorated control of laryngeal muscles leads to unstable periods of vocal fold opening, causing a dysphonic and breathy voice.
Frequency of vocal tremor (FF0T)	Phonation	Frequency of dominant frequency tremor. The dominant tremor track was determined from the contour of modal fundamental frequency.	Loss of muscle control leads to involuntary oscillatory movements in the throat, which cause rhythmical or quasi-rhythmical fluctuations in pitch perceived as quavering of the voice.
Modulation depth of vocal tremor (PF0T)	Phonation	Median modulation depth of dominant frequency tremor. The dominant tremor track was determined from the contour of modal fundamental frequency.	Loss of muscle control leads to involuntary oscillatory movements in the throat, which cause rhythmical or quasi-rhythmical fluctuations in pitch perceived as quavering of the voice.
Frequency of amplitude tremor (FAT)	Phonation	Frequency of dominant amplitude tremor. The dominant tremor track was determined from the signal envelope within voiced intervals.	Loss of muscle control leads to involuntary oscillatory movements in the throat, which cause rhythmical or quasi-rhythmical fluctuations in loudness perceived as quavering of the voice.
Modulation depth of amplitude tremor (PAT)	Phonation	Median modulation depth of dominant amplitude tremor. The dominant tremor track was determined from the signal envelope within voiced intervals.	Loss of muscle control leads to involuntary oscillatory movements in the throat, which cause rhythmical or quasi-rhythmical fluctuations in loudness perceived as quavering of the voice.

Connected speech (reading or monologue)

Speech feature	Subsystem	Definition	Description
Entropy of speech Timing (EST)	Timing	Shannon information entropy was computed from the frequency of voiced, unvoiced, pause and respiration intervals.	Increased orderliness and predictability of pathological speech results in decreased entropy and lower variation of timing.
Rate of speech timing (RST)	Timing	Rate of voiced, unvoiced and pause intervals measured as the slope of the regression line of total interval count per time. Each interval was described as mean time between onset and offset of interval.	Hypokinetic movements of speech apparatus lead to reduced stream of voiced, unvoiced and pause intervals.
Duration of pause Intervals (DPI)	Timing	Median length of pause intervals.	Hypokinesia of speech apparatus makes initiating of speech difficult, leading to prolonged pause intervals.
Acceleration of speech timing (AST)	Timing	Mean difference between RST of a segment parted in two halves with 25% overlap.	Acceleration of speech rate is achieved at the expense of reduced RST.
Duration of voiced Intervals (DVI)	Phonation	Mean length of voiced intervals.	Incomplete or unperformed closure of vocal folds leads to longer voiced intervals and voicing leakage through inter and intra-word pauses.
Gaping in-between voiced intervals (GVI)	Phonation	Rate of clear pauses between voiced intervals. Clear pause is a gap between two voiced intervals containing no consonant or respiration. Formal pauses were excluded from the bimodal distribution of length of clear pauses using an Expectation Maximization algorithm.	Deteriorated ability to properly stop vocal fold vibration.
Duration of unvoiced Stops (DUS)	Articulation	Median length of unvoiced stop consonants identified from the bimodal distribution of length of unvoiced stop consonants and unvoiced fricatives using an Expectation Maximization algorithm.	Period of stop consonants is prolonged by friction-like noise of insufficiently closed articulators.
Decay of unvoiced Fricatives (DUF)	Articulation	Mean difference between the second Mel-frequency cepstral coefficients, associated with the ratio between energies of low and high Mel-frequency bands, of unvoiced fricatives weighted on squared duration of speech which was divided in two halves with 25% overlap.	Temporal decrease of range of articulatory movement is manifested by loss of high-frequency energy in unvoiced fricatives.
Rate of speech Respiration (RSR)	Respiration	Number of respirations per unit time.	Rigidity of respiratory muscles, respiratory dyskinesia or posture issues are related to increased respiratory rate.
Pause intervals per respiration (PIR)	Respiration	Median number of pauses between respirations.	Impaired ability to stop respiratory airflow manifests as decreased pause production.
Relative loudness of respiration (RLR)	Respiration	Median of loudness measured relatively between respirations and speech as difference in logarithmic scale.	Hypokinesia of respiratory muscles and decreased range of rib cage motion make respiration quieter.
Latency of respiration exchange (LRE)	Respiration	Mean duration between end of speech and start of respiration.	Rigidity and bradykinesia of respiratory muscles causes higher latency of exchange between expiration and inspiration.
Standard deviation of power (stdPWR)	Prosody	Standard deviation of speech intensity contour extracted from voiced segments.	Hypokinesia leads to decreased amplitude of respiratory and thyroarytenoid muscles.

Standard deviation of fundamental frequency (stdF0)	Prosody	Standard deviation of fundamental frequency contour converted to semitone scale	Hypokinesia causes reduced amplitude of vocal cord movements, leading to glottal incompetence.
Net speech rate (NSR)	Prosody	The total number of syllables was divided by the total duration of speech.	Slowness of individual movements of articulators.