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Non-invasive evaluation of vibratory kinematics of phonation in children

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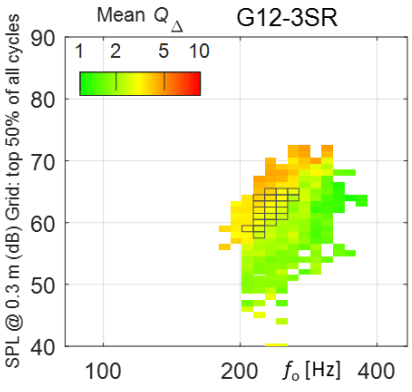
Introduction

Developmentally, children do not have five well-defined layers of the vocal folds as adults. Also, children are often less able to tolerate the invasiveness of endoscopy. Electroglottography (EGG) is not invasive, but little is known of how the EGGs of children differs from those of adults. The goal of this study was to quantify some differences in the shape of the EGG waveform between children and adults, while accounting for the sensitivity to variation in the independent variables f_o and SPL. A novel mapping of EGG waveform parameters over the speech and voice ranges was employed [1].

Method

22 vocally healthy children (9 boys, 13 girls) aged 4-8 years (mean 6.3) were recruited. 26 vocally healthy adults (13 men, 13 women), 22-45 years (mean 28.7) were recruited to obtain developmental end point of maturation of vibratory kinematics. Simultaneous recordings were made of EGG and airborne voice (44.1 kHz/16 bits) at calibrated SPL in dB(C) [2]. Habitual speech production for the speech range profile (SRP) was elicited for adult participants by 3 trials of reading the Rainbow Passage; while child participants were instead shown drawings of standardized outdoor scenes and asked to describe the scenes in detail. Then, phonations on the vowel /a/ were elicited so as to approximate a full voice range profile (VRP) [3]. A custom public-domain analysis software [1] was used to compute the audio crest factor, plus three EGG waveform variables [4]: (1) the quotient of contact by integration (Q_{ci}) (2) the normalized peak dEGG (Q_Δ), and (3) the index of contacting (I_c). In the SRPs, the 2-D region around the mode of the phonation density map which contained 50% of *all* EGG cycles was delineated, see figure. Over this small, 'most typical' region, the means, standard deviations and local slopes of the four dependent variables were computed.



Example: voice map of Q_Δ of girl #12, speech task. The grid marks the most visited region. Over this grid, statistics were weighted by the EGG cycle counts in each grid cell. Slopes in Q_Δ were computed in the SPL ↑ and f_o → directions, without cycle weighting.

Results and Discussion

The table shows partial results from the SRPs only, averaged over subjects within categories. The full/half stars denote significance with/without Bonferroni correction, and **bold** denotes a non-zero gradient (p<0.05). There was no difference between girls and boys in any of the metrics. All dependent variable means were slightly lower in children than in adults. All Q_{ci} and I_c slope metrics were positive in the group of men, but negative in the other groups. The crest factor increased with SPL in all groups except women. The results from the VRP, an unfamiliar task over the widest elicitable range, exhibited far more variation over the voice maps, and must be discussed qualitatively, which is out of scope here.

Variable		Unit	women	men	girls	boys	f/m	g/b	g/f	b/m
f_o	mean	Hz	190.2	116.0	253.1	246.5	★		★	★
SPL	mean	dB	71.67	73.58	68.46	69.19			☆	★
Q_{ci}	mean	-	0.430	0.461	0.408	0.405				☆
	slope vs f_o	1/ST	-0.86%	0.54%	**-1.78%**	**-3.60%**	☆			★
	slope vs SPL	1/dB	-0.34%	**0.59%**	**-1.04%**	**-1.16%**	★			★
Q_Δ	mean	-	4.28	4.38	3.69	4.06			★	
	slope vs f_o	1/ST	-0.67%	1.59%	-0.78%	-2.34%				☆
	slope vs SPL	1/dB	-0.26%	0.72%	**0.98%**	0.69%			☆	
I_c	mean	-	0.269	0.292	0.226	0.242			★	☆
	slope vs f_o	1/ST	**-1.57%**	**1.93%**	**-2.67%**	**-5.61%**	★			★
	slope vs SPL	1/dB	-0.63%	**1.25%**	-0.08%	-0.46%	★			☆
Crest	mean	-	2.211	2.947	2.023	2.012	★		★	★
	slope vs f_o	1/ST	**-1.11%**	0.19%	**0.84%**	1.48%			☆	
	slope vs SPL	1/dB	0.00%	**1.70%**	**1.63%**	**1.25%**	★		★	☆

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References

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