EFFECTS OF WESTERN CLASSICAL VOCAL TRAINING ON PHYSIOLOGICAL MEASURES DURING SPEAKING VOICE

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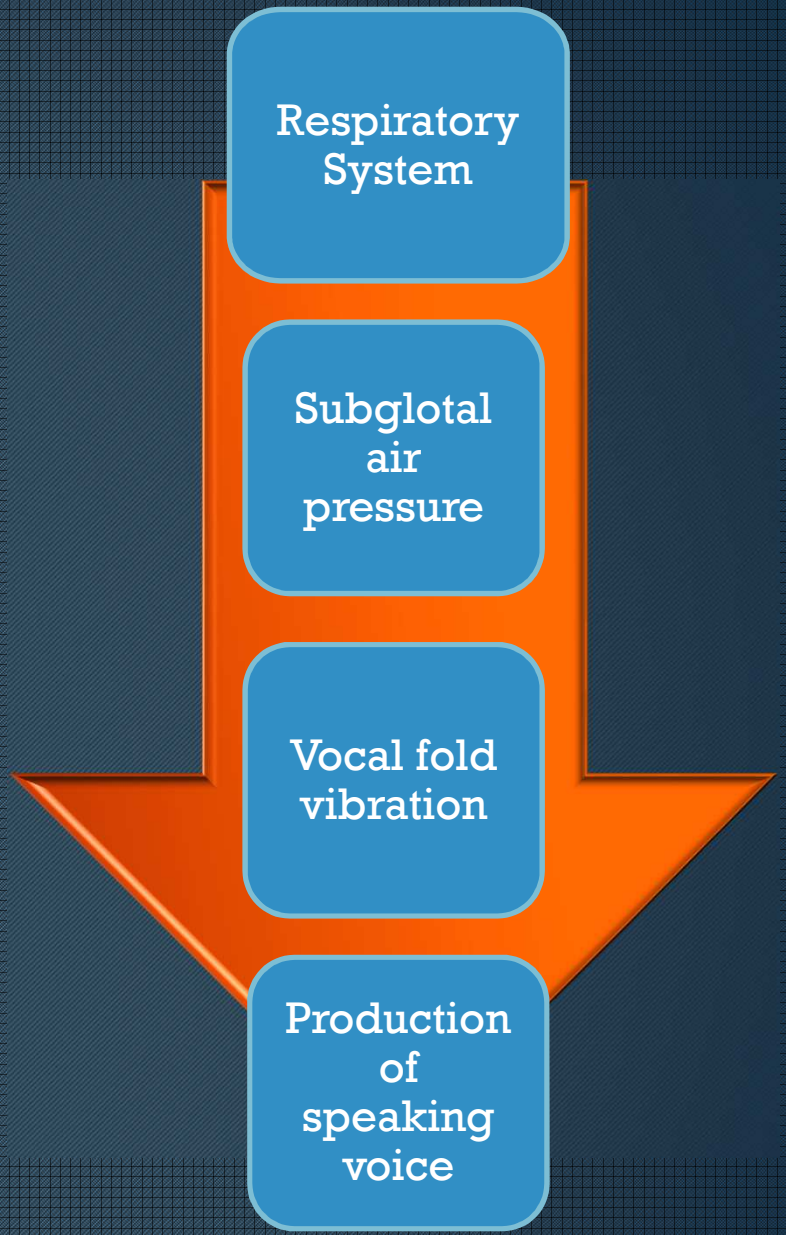
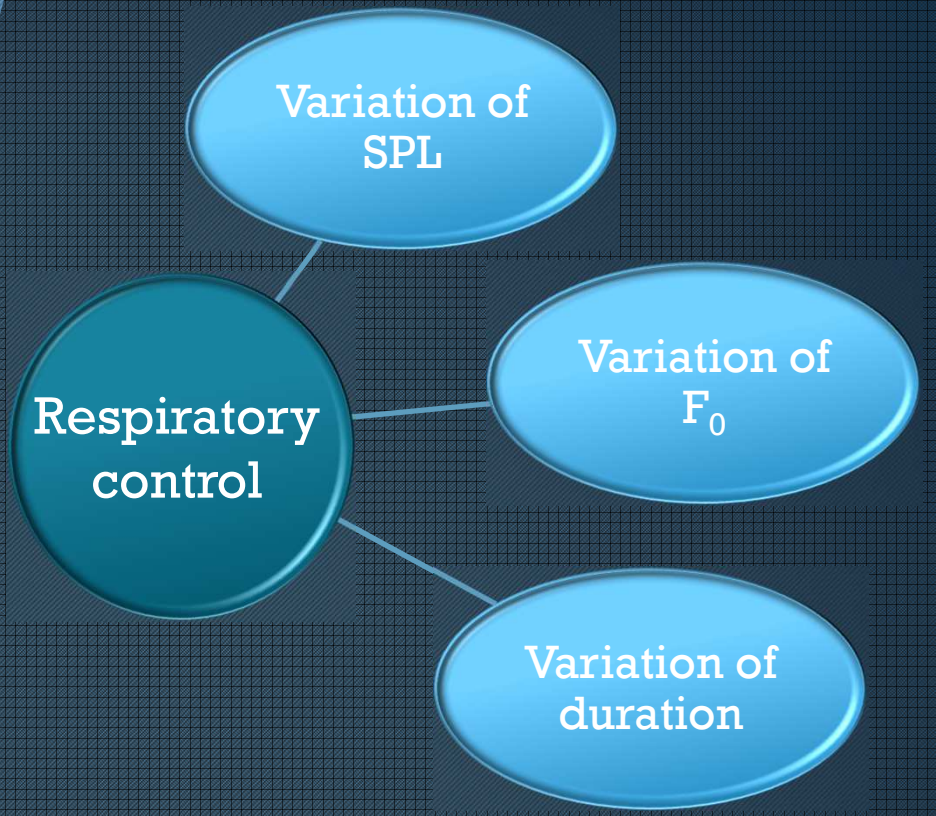
Respiratory System



Respiratory System



Important for speaking and singing

(Saladin, 2004; Sataloff & Heman-Ackah, 2005; Ladefoged, 1968, Proctor, 1974, Hoit et al., 1990, Stathopoulos & Sapienza, 1993 cited by Maclarnon & Hewitt, 1999)

Comparative Studies

Comparisons between singers and nonsingers:

1. Differences between the 2 populations → acoustic and physiologic parameters

2. Western classical vocal training (WCVT) and singing experience have an effect on electromyographic, respiratory kinematics and acoustic systems.

(Mendes, Brown, Sapienza & Rothman (2003, 2004, 2006); McCrea & Morris, 2005; Rothman, Brown, Sapienza & Morris, 2001; Rothman, Brown, Sapienza, & Morris 1998; Morris, Brown, Hicks, Howell, 1995; Xkerlund, Gramming, & Sundberg, 1992; Brown, Morris, Hollien, & Howell, 1991; Hixon, 1991; Brown, Morris, & Michel, 1990; Watson, Hoit, Lansing, & Hixon, 1989; Murry & Large, 1978; Lieberman, 1961)
(Hixon, Goldman, & Mead, 1973; Hixon, 1991).
(Watson, Hoit, Lansing, & Hixon, 1989), (Hixon, 1991) (McCrea & Morris, 2005; Rothman, Brown, Sapienza & Morris, 2001; Morris, Brown, Hicks, Howell, 1995; Brown, Morris, Hollien, & Howell, 1991; Xkerlund, Gramming, & Sundberg, 1992; Brown, Morris, & Michel, 1990; Lieberman, 1961; Murry & Large, 1978)

Studies

Mendes, Brown, Sapienza & Rothman (2003, 2004, 2006)

Few Longitudinal studies that studied effects of WCVT on speaking and singing voice during a period of time.

Mendes et al. (2003, 2006) → WCVT had a significant effect on acoustic and physiologic parameters of singing voice.

Mendes et al. (2004) → singing training had a slight effect on acoustic parameters of speaking voice.

Studies

- Brown, Rothman and Sapienza (2000) → no direct relationship between vocal training and its influence on speaking voice.

- **However,**

→Little evidence that modulation of respiration as an effect on vocal rehabilitation, despite the widely use of respiration techniques on voice rehabilitation by Speech Language Pathologists.

Objectives

The purpose of this study is to investigate:

1. If WCVT has an effect on respiratory kinematics and muscle activity during speaking tasks.

2. If there is a correlation between the respiratory physiology effects of WCVT on the spectral and temporal measures of the speaking voice.

Researcrh Questions

1. Is there a difference in the muscle force generation of the pectoralis major, rectus abdominis and external oblique muscles in voice majors after 3 semesters of WCVT that can be detected in EMG signals during speaking tasks?

2. Is there a difference in the rib cage, abdominal movements and in lung volume excursion, in voice majors after 3 semesters of WCVT that can be detected in respiratory kinematic signals during speaking tasks?

Researcrh Questions

3. Is there a correlation between respiratory physiology ,fundamental frequency and intensity, during speaking tasks?

4. Is there a correlation between respiratory physiology , phrase and sentence duration, during speaking tasks?

5. How does the respiratory system behaves for the production of 2 speaking tasks hierarchically complex in their time duration?

Relevance

- Llitlle information about the effects of WCVT on physiology of speaking voice.
- WCVT improves the strenght of the muscles involved in respiration. This leads to an enlargement of the Maximum phonational frequency range (MPFR) , dynamics and duration of the voice productions for the singing voice.
- Litlle or no evidence that modulation of respiration as effects on vocal rehabilitation.


Methods

Subjects

4 undergraduate voice students enrolled in Western Voice Studio classes - University of Florida's Music Department

Inclusion criteria:

1) ages between 17 and 25 years;

2) native American-English speakers;

3) no history of respiratory /voice disorders;

4) symptom-free of allergies or colds on the days of testing.

Exclusion criteria:

1) smokers;

2) professional singing experience.

Subjects

ID	Sex	Age	Weigh (Kg)	Lenght (cm)	WCVT (sem)	WCVT hours/sem
JP	M	20	73.6	171.5	4	5
AW	F	18	52.3	165.1	4	7
MM	F	20	68.2	165.1	4	11
SG	F	18	52.2	162.6	3	5

Phonatory Tasks

Reading a modified version of the "Rainbow Passage"

Phrase:

"…God shed his grace on thee."

Sentence:

"People look but no one ever finds it unless God shed his grace on thee"

Equipment

Acoustic equipment:

- Microphone, preamplifier, attenuator
- CSL & MDVP - KayPentax
- Sound Blaster 16 Wave Studio

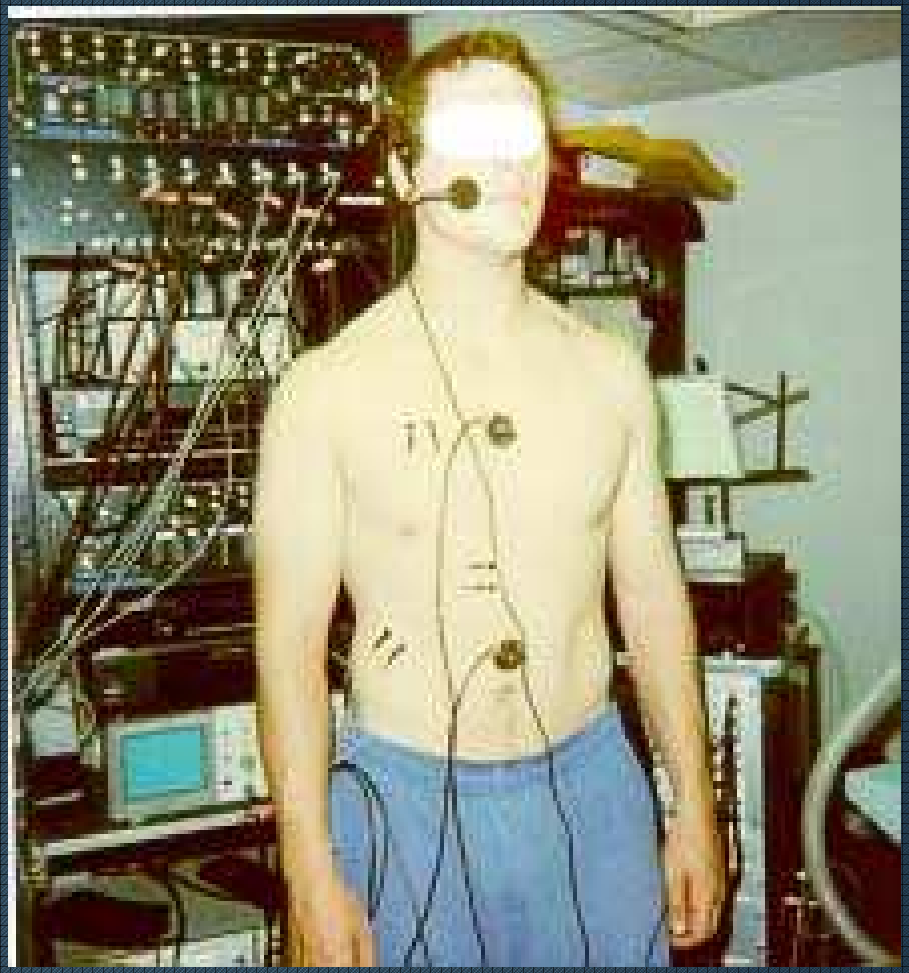
EMG equipment:

- bipolar surface electrodes
- Ampliffier Grass RPS 107

Respiratory kinematics equipment:

- Linearized magnetometers - GMG Scientific Inc.
- 1 pair at the rib cage and other at the abdominal wall

Equipment



Measures

Acoustics:

- F_0
- SPL
- Duration (phrase and sentence)

EMG:

- Burst durantion (BD)
- Peak amplitude (PA)

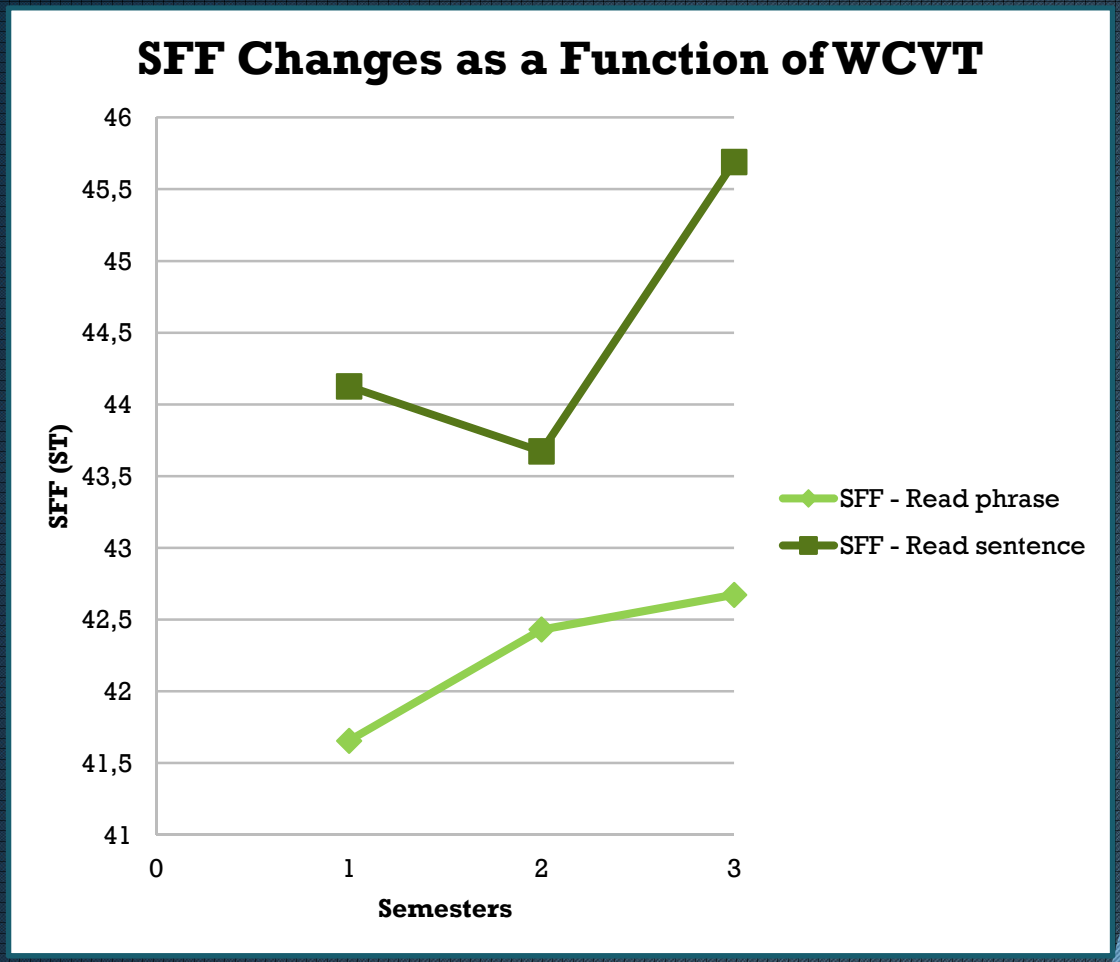
  - Pectoralis major
  - Rectus abdominis
  - External oblique

Respiratory Kinematics:

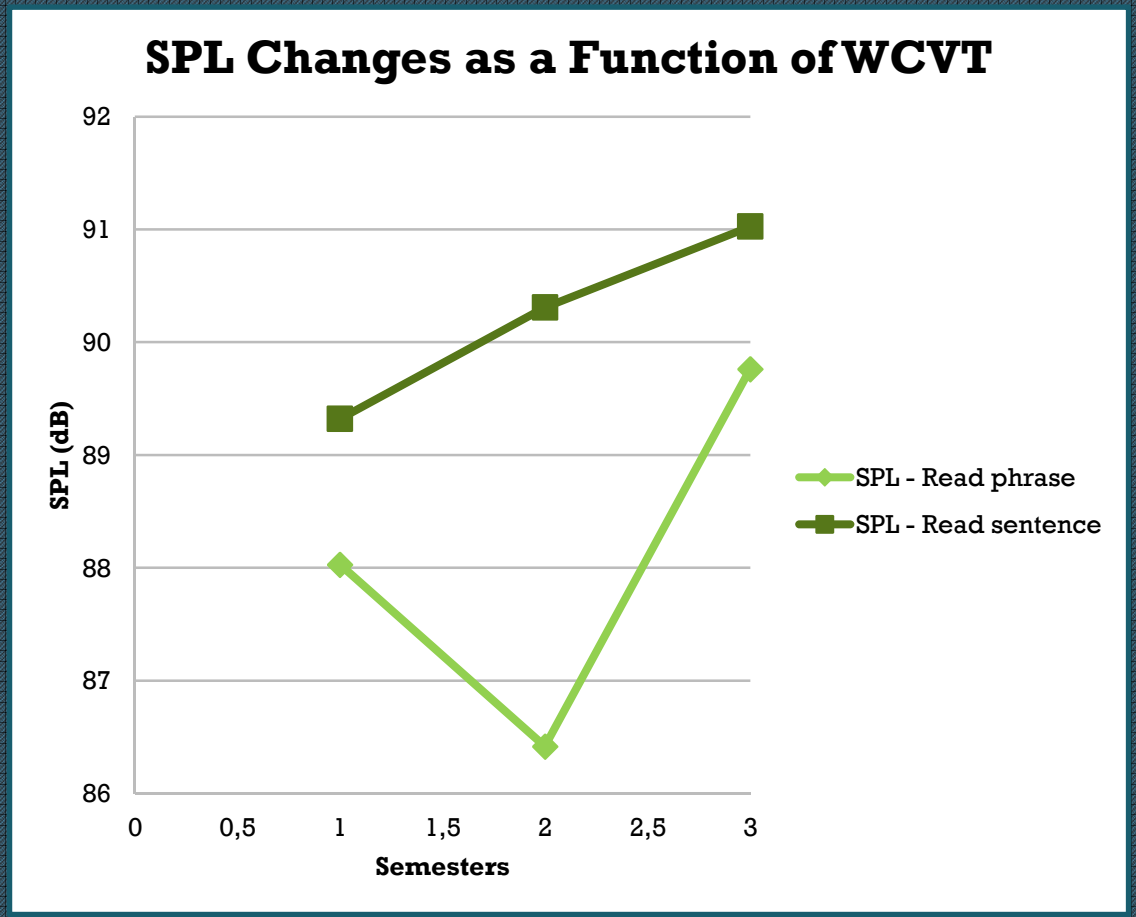
  - Lung volume excursion (LVE)
  - Abdominal excursion (ABE)
  - Rib cage excursion (RCE)

Results

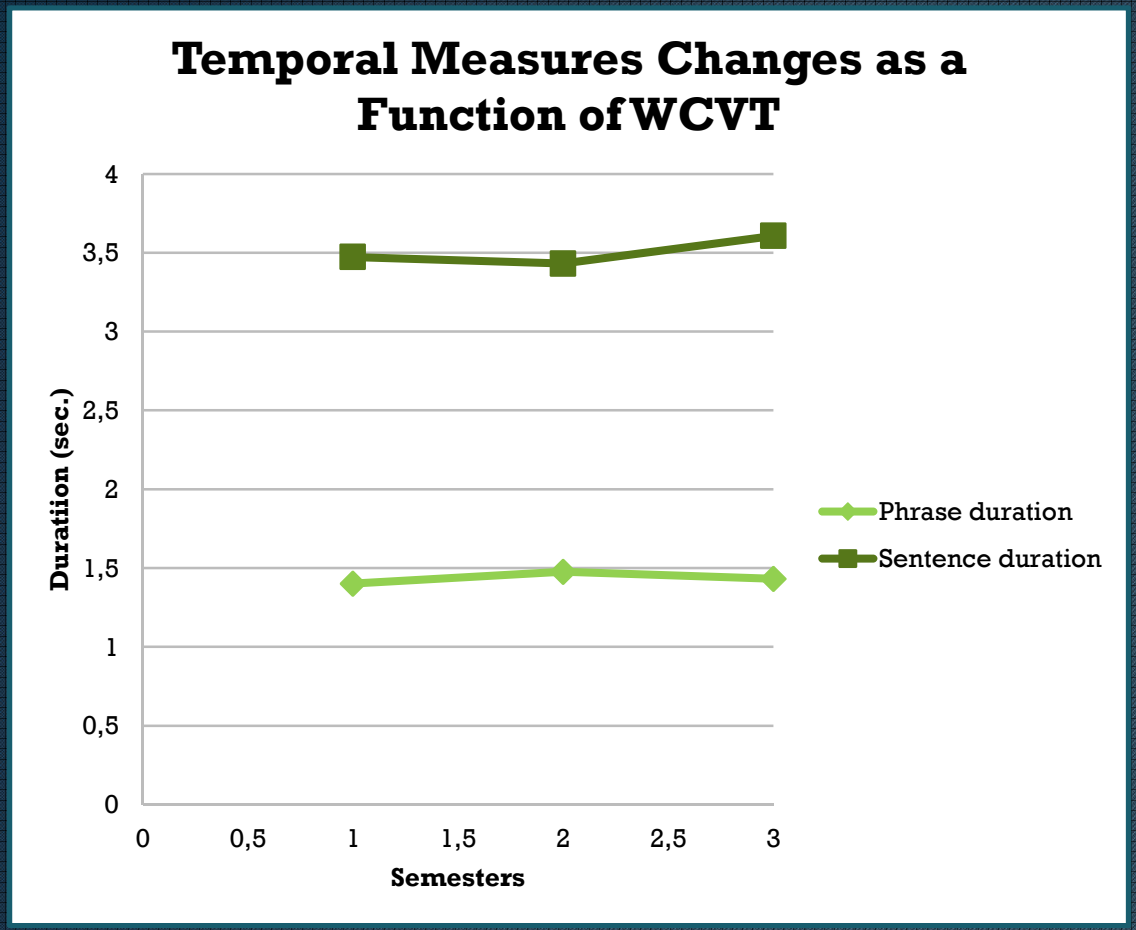
Acoustic Measures



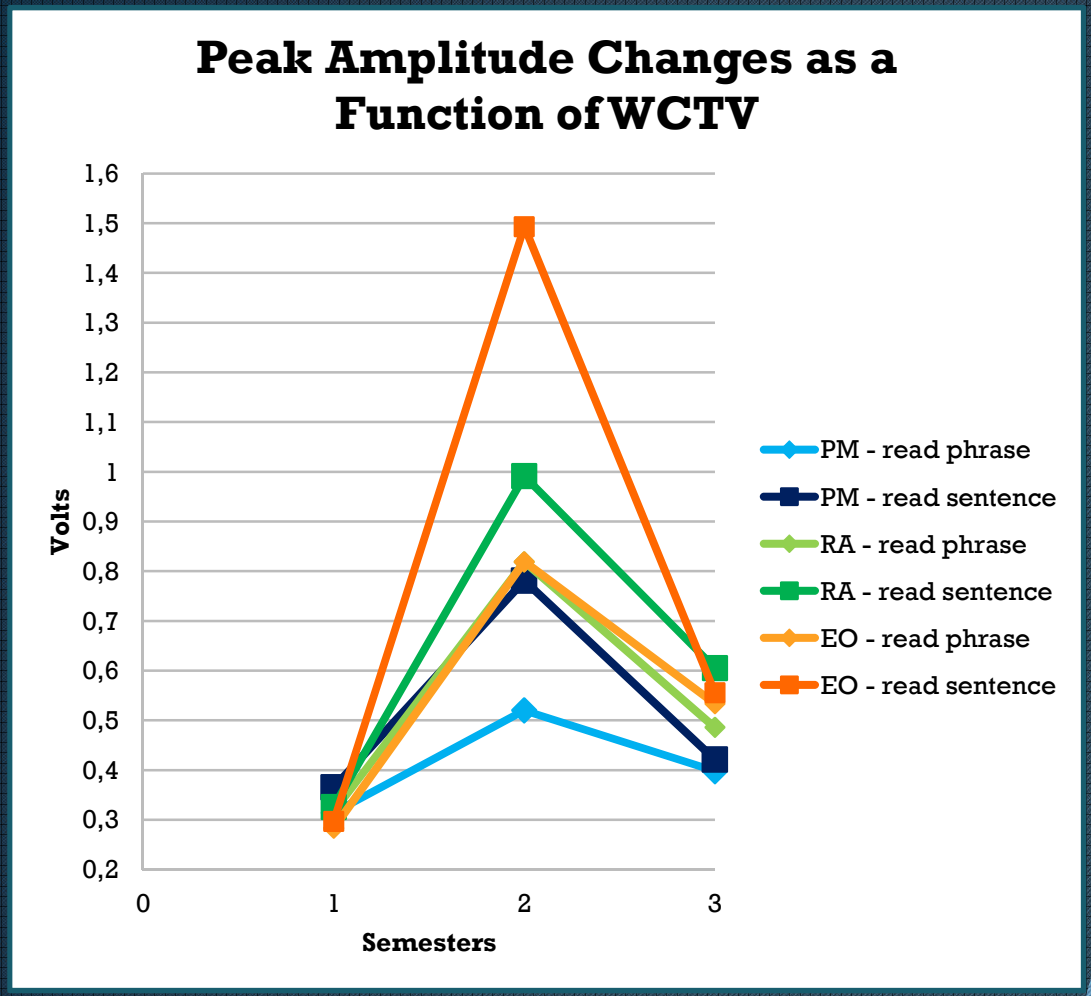
Acoustic Measures



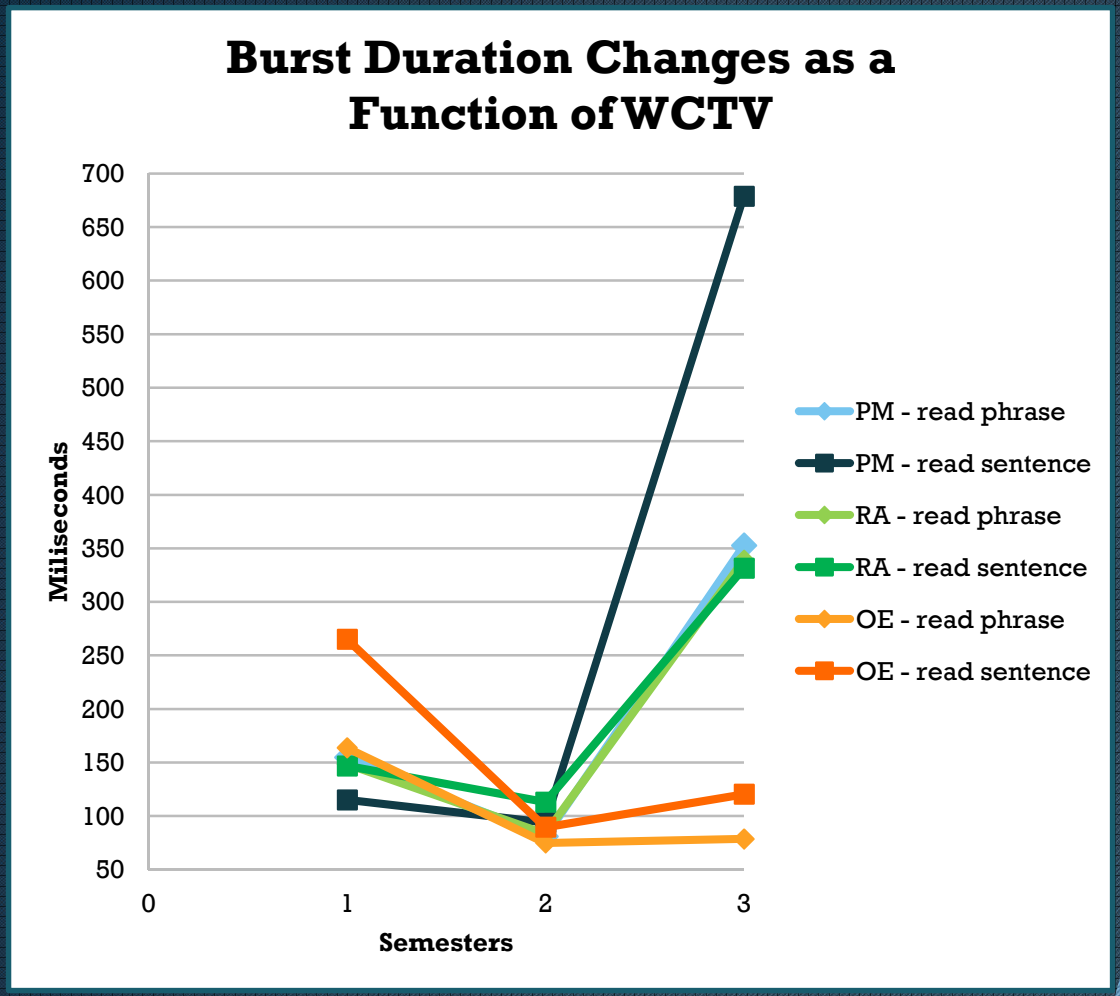
Acoustic Measures



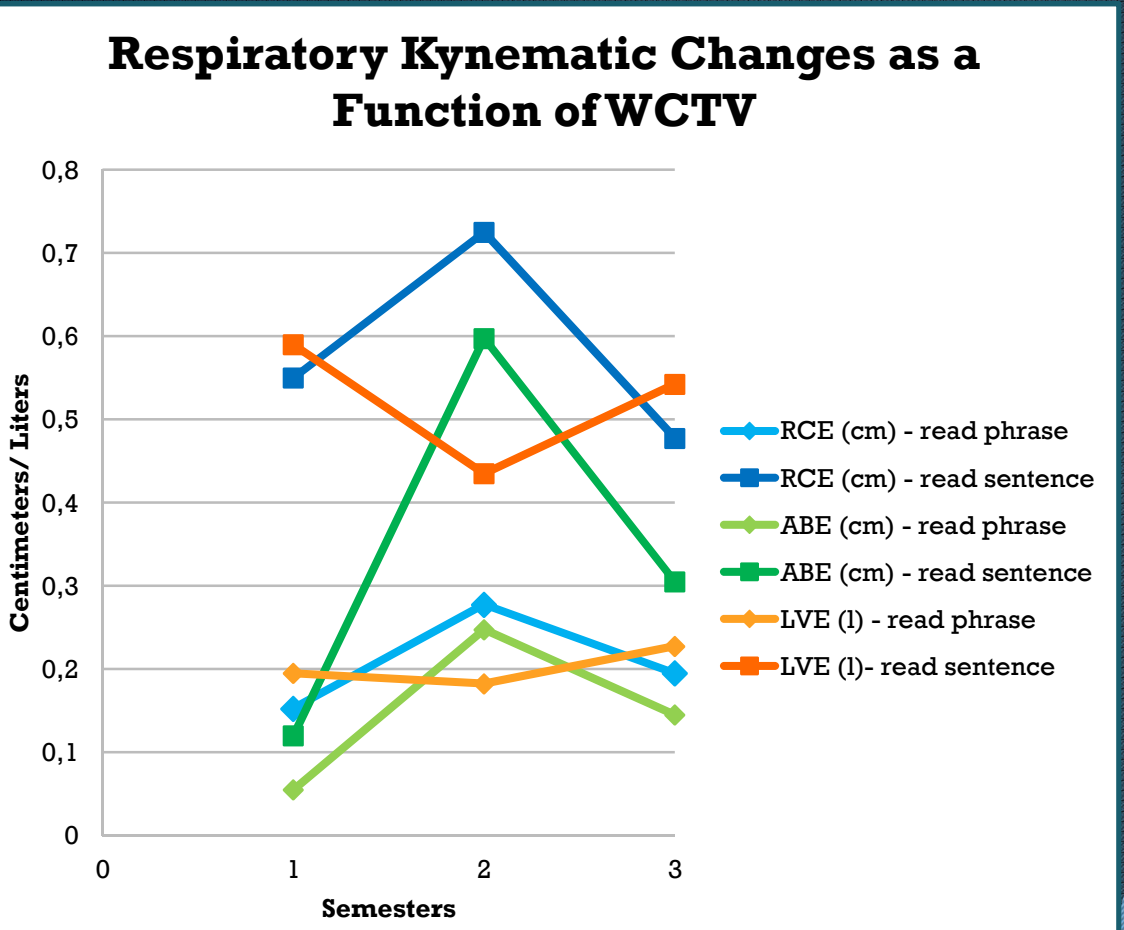
EMG Measures – Peak Amplitude



EMG Measures – Burst Duration



Respiratory Kynematics Measures



Discussion

- 3 semesters of WCVT:
  - Slight increase of RCE and ABE means from 1st to 2nd semester and a decrease from 2nd to 3rd semester, as opposed to LVE.

    Statistically no significative differences.

  - BD means decreased from 1st to 2nd semester and increased from 2nd to 3rd semester, as opposed to PA means.

    Statistically no significative differences.

  - Sentence → higher physiological measures than phrase reading aloud

Discussion

The respiratory system for speaking voice is not modulated by WCVT

WCVT HAD NO EFFECT ON THE RESPIRATORY SYSTEM FOR THE SPEAKING VOICE

“ Washout effect from the summer semester

Limitations

- Sample Reduced (N=4)
- No balance between genders (M 1 / F 3)
- Semesters of WCVT (N = 3)

Future research

Future research will compare the effects of WCVT on both singing and speaking voice.

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Tables

Acoustic Measures - Tables

	F_0			SPL			D		
Phrase	1	2	3	1	2	3	1	2	3
JP	37,42	37,9	37,66	89,38	88,28	85,94	1,3803	1,60917	1,60064
AW	41,04	42,73	42	85,78	84,57	81,65	1,39402	1,35954	1,30204
MM	43	43,86	44,52	95,46	89,99	97,07	1,36272	1,34056	1,43371
SG	45,16	45,23	46,51	81,49	82,82	94,38	1,46601	1,59429	1,39038
M	41,655	42,43	42,6725	88,0275	86,415	89,76	1,40076	1,47589	1,43169
SD	3,28672	3,1883	3,81738	5,91218	3,2958	7,19131	0,04535	0,14564	0,12525
P-value	0,05			0,779			0,779		

	F_0			SPL			D		
Sentence	1	2	3	1	2	3	1	2	3
JP	38,14	37,18	42,82	89,92	92,89	88,28	3,746	3,543	3,574
AW	43,78	44,44	45	90,24	85,73	86,15	3,306	3,342	3,567
MM	46,36	45,31	46,51	94,99	98,2	93,58	3,117	3,104	3,555
SG	48,22	47,76	48,42	82,13	84,41	96,09	3,72	3,734	3,732
M	44,125	43,6725	45,6875	89,32	90,3075	91,025	3,47225	3,43075	3,607
SD	4,38572	4,55085	2,36913	5,32452	6,44709	4,60011	0,311	0,27031	0,0837
P-value		0,039			0,779			0,472	

EMG Measures - Tables

Peak Amplitude	Pectoralis Major			Rectus Abdominis			External Oblique		
Phrase	1	2	3	1	2	3	1	2	3
JP	0,264	0,43	0,474	0,229	0,908		0,264	0,415	0,615
AW	0,566	0,601	0,493	0,215	1,563		0,347	0,796	0,254
MM	0,2559	0,688	0,269	0,142	0,41	0,269	0,2	1,597	0,732
SG	0,171	0,361	0,356	0,679	0,396	0,703	0,322	0,469	
M	0,31423	0,52	0,398	0,31625	0,81925	0,486	0,28325	0,81925	0,53367
SD	0,17304	0,15074	0,10521	0,24482	0,55005	0,30688	0,06549	0,54514	0,24916
P-value	0,105			0,607			0,264		

Peak amplitude	Pectoralis Major			Rectus Abdominis			External Oblique		
Sentence	1	2	3	1	2	3	1	2	3
JP	0,264	0,464	0,474	0,244	0,908		0,264	0,43	0,591
AW	0,566	0,596	0,566	0,225	1,602		0,366	0,801	0,34
MM	0,278	1,709	0,293	0,151	1,045	0,396	0,244	4,229	0,737
SG	0,352	0,356	0,352	0,684	0,41	0,815	0,313	0,513	
M	0,365	0,78125	0,42125	0,326	0,99125	0,6055	0,29675	1,49325	0,556
SD	0,13945	0,62624	0,12245	0,24202	0,49013	0,29628	0,05451	1,83075	0,2008
P-value	0,076			0,607			0,264		

Burst duration	Pectoralis Major			Rectus Abdominis			External Oblique		
Phrase	1	2	3	1	2	3	1	2	3
JP	87,1	49,3	90,5	120,3	111,9		115,9	62,7	110,7
AW	178,3	95,1	93,3	84,7	70,5		159,5	109,5	56,1
MM	71,3	87,7	104,3	71,9	87,7	102,9	254,7	64,1	69,1
SG	282,7	91,5	1121,9	316,6	63,5	575,1	124,3	63,5	
M	154,85	80,9	352,5	148,375	83,4	339	163,6	74,95	78,6333
SD	97,4101	21,2822	512,968	114,004	21,5496	333,896	63,6024	23,0405	28,5211
P-value		0,368			0,223			0,097	

Burst duration	Pectoralis Major			Rectus Abdominis			External Oblique		
Sentence	1	2	3	1	2	3	1	2	3
JP	135,1	73,5	81,9	103,9	192,7		455,1	84,7	97,1
AW	178,3	101,5	66,9	84,7	70,5		75,1	125,1	171,9
MM	71,1	129,9	396,7	88,7	77,9	122,3	265,1	77,9	91,9
SG	75,9	70,7	2169,1	309,7	110,7	540,7	265,1	70,7	
M	115,1	93,9	678,65	146,75	112,95	331,5	265,1	89,6	120,3
SD	51,2083	27,7378	1005,2	108,948	55,9632	295,853	155,134	24,3472	44,7625
P-value	0,472			0,135			0,368		

Respiratory Kinematics - Tables

	RCE			ABE			LVE		
Phrase	1	2	3	1	2	3	1	2	3
JP	0,09	0,22	0,14	0,05	0,82	0,17	0,21	0,21	0,37
AW	0,13	0,2	0,29	0,03	0,07	0,28	0,1	0,15	0,19
MM	0,33	0,57	0,24	0,05	0,04	0,03	0,37	0,29	0,17
SG	0,06	0,12	0,11	0,09	0,06	0,1	0,1	0,08	0,18
M	0,1525	0,2775	0,195	0,055	0,2475	0,145	0,195	0,1825	0,2275
SD	0,12176	0,19973	0,08426	0,02517	0,38187	0,10661	0,12767	0,08921	0,09535
P-value	0,105			0,779			0,761		

	RCE			ABE			LVE		
Sentence	1	2	3	1	2	3	1	2	3
JP	0,3	0,44	0,3	0,23	2,17	0,47	0,79	0,42	0,91
AW	0,95	0,59	0,59	0,04	0,19	0,6	0,63	0,45	0,4
MM	0,52	1,19	0,6	0,07	0,02	0,06	0,57	0,56	0,42
SG	0,43	0,68	0,42	0,14	0,01	0,09	0,37	0,31	0,44
M	0,55	0,725	0,4775	0,12	0,5975	0,305	0,59	0,435	0,5425
SD	0,28154	0,32542	0,14431	0,08446	1,05158	0,27111	0,17359	0,10279	0,24554
P-value		0,223			0,779			0,368	

Respiratory Kinematics - Tables

Temporal Measures of Speaking Voice correlated with physiological measures

			Semesters	1		2		3	
			Duration of the phonatory task	Phrase	Sentence	Phrase	Sentence	Phrase	Sentence
		EMG	Kinematics						
Inspiratory muscle	Pectoralis major	BD	RCE	-,645	,608	,081	,834	-,669	-,191
			ABE	,632	-,111	-,985*	-,484	-,290	-,649
			LVE	-,881	,601	-,069	,914	-,723	-,338
		PA	RCE	,006	,932	,809	,926	,098	-,091
			ABE	-,824	-,654	-,411	-,359	,935	,981*
			LVE	-,821	-,104	,408	,886	,512	,239
Expiratory muscles	Rectus abdominis	BD	RCE	,141	-,753	,291	-,608	NA	
			ABE	,930	,232	,869	,930		
			LVE	-,357	-,806	,337	-,344		
		PA	RCE	-,635	-,282	-,351	-,016		
			ABE	,895	,244	,132	-,045		
			LVE	-,843	-,759	-,987	,594		
	External oblique	BD	RCE	,985*	-,943	-,242	-,336	-,995	,422
			ABE	-,310	,918	-,331	-,056	-,160	,727
			LVE	,746	,376	-,807	,201	,949	-,480
		PA	RCE	-,777	,771	,723	,648	-,581	-,122
			ABE	,056	-,447	-,517	-,414	-,937	-,904
			LVE	-,984	-,222	,723	,833	,194	,185

Temporal Measures of Speaking Voice correlated with physiological measures

	Semesters	1		2		3	
	Duration of the phonatory task	Phrase	Sentence	Phrase	Sentence	Phrase	Sentence
		Duration measures					
Respiratory Kinematics	RCE	,998	-,586	,657	-,703	-,747	-,337
	ABE	-,405	,839	,586	,262	-,215	-,461
	LVE	,844	,004	,791	-,981	,928	-,209
Pectoralis major	BD	-,686	,019	-,698	-,968	,006	,971
	PA	,041	-,257	,304	-,889	,146	-,310
Rectus abdominis	BD	-,670	,586	,903	,518	NA	
	PA	-,682	,643	-,274	-,648		
External oblique	BD	-,779	,578	-,535	-,284	,998	,207
	PA	,976	,045	,371	-,841	,547	-,499

F0 Acoustic Measures of Speaking Voice correlated with physiological measures

		Semesters	1		2		3	
		Duration of the phonatory task	Phrase	Sentence	Phrase	Sentence	Phrase	Sentence
			F0					
	Respiratory Kinematics	RCE	,161	,216	,011	,523	-,032	,366
		ABE	,615	-,594	-,950	-,966	-,492	-,760
		LVE	,444	-,944	,259	-,141	-,961	-,766
Inspiratory muscle	Pectoralis major	BD	,633	-,594	,918	,270	,678	-,905
		PA	-,306	,157	,157	,199	-,701	,825
Expiratory muscles	Rectus abdominis	BD	,574	,569	-,886	-,807	NA	
		PA	,608	,503	-,370	-,191		
	External oblique	BD	,302	-,525	,083	-,112	-,824	,924
		PA	,102	,168	,375	,274	,085	-,760

SPL Acoustic Measures of Speaking Voice correlated with physiological measures

	Semesters	1		2		3	
	Duration of the phonatory task	Phrase	Sentence	Phrase	Sentence	Phrase	Sentence
		SPL					
Respiratory Kinematics	RCE	,875	,203	,834	,606	-,343	-,020
	ABE	-,485	-,322	,352	,238	-,973	-,964
	LVE	,999	,586	,958	,813	-,335	-,338
Pectoralis major	BD	-,927	,125	-,470	,622	,438	,836
	PA	-,043	-,124	,574	,814	-,968	-,627
Rectus abdominis	BD	-,773	-,910	,769	,126	NA	
	PA	-,819	-,959	-,211	,089		
External oblique	BD	,779	-,025	-,370	-,331	-,021	,046
	PA	-,897	-,427	,618	,785	,859	,264