

What are the Acoustic Strategies of High Belt and are they voice type or gender dependent?

An acoustical study into High Belting across different voice types and genders

Research Objectives

- Investigate the possible acoustic strategies for producing high-belt.
- Identify possible trends and exploring potential hypotheses.
- Explore results of this research and its application to pedagogy.
- Link the singer's subjective experience to measurable outcomes.

Context and Rationale

- *Only sopranos can do high belt* (Roll, 2016) This is a sometimes given general claim.
- My experience contrasts this.
- Limited research in high-belting.
- No research in high-belt has included lower-voices.
- Implications for current pedagogy within CCM.
- Assumptions around singers' abilities based on voice-type and gender.

Definition of terms

Belting

A loud, intense, bright, brassy, yell-like voice quality heard across musical styles and genres (Lebowitz and Baken, 2011; Sundberg, Thalén and Popeil, 2012; Salidas et al., 2019)

High Belting

A belt quality produced on pitches above C5.

CCM

Contemporary Commercial Music (pop, rock, soul, rnb, jazz, contemporary musical theatre)

Harmonic (H)

An integer multiple of a fundamental frequency. (e.g. if $H1 = 220\text{Hz}$ $H2 = 440\text{Hz}$, $H3 = 660\text{Hz}$ etc)

Formant (f)

A resonant frequency of the vocal tract.

Upper Partial

Harmonics in the higher end of the spectrum (in this study H4-H8)

Ethics

Procedural Requirements

- Ethical approval provided by UWTSD - and code of practice followed
- Informed consent was received from all participants
- Consent forms/study information provided in advance
- Data protection informed by GDPR.

Vocal Health Considerations:

- Belt is an intense, high effort quality therefore vocal health had to be considered.
- Due to limited research in high-belt, this is somewhat uncharted territory.
- Researcher's background within CCM singing and teaching belt/high-belt.
- Experienced and qualified within Voice Health and assessing vocal function (Vocal Health First Aider - VHE; certified Estill Master Trainer)

Insider Research Considerations:

- Identifying and mitigating biases
- Thorough design to avoid skewing results
- Awareness of existing interpersonal dynamics

Where does the literature agree?

- A variety of strategies are possible and employed in high belt (Lebowitz and Baken, 2011; Roll, 2016; Flynn, Trudeau and Johnson, 2018)
- F1 is used to boost H2 (Sundberg et al 2012; Flynn, Trudeau and Johnson, 2018)
- H1 cannot be the most intense harmonic - usually H2 is most intense (Sundberg 2012) *sometimes H3 is most intense* (Flynn, Trudeau and Johnson, 2018)
- A change in strategy often happens between traditional belt and high-belt. (Lebowitz and Baken, 2011; Roll, 2016; Flynn, Trudeau and Johnson, 2018)
- This may not be a necessity for all singers (Flynn, Trudeau and Johnson, 2018)

Where does the literature disagree?

- In some cases H1 is the most intense harmonic (Lebowitz et al, 2014)
- F1 to H1 tracking is sometimes observed (Guzman et al, 2014)
- In some cases H1 is the most intense harmonic (Lebowitz et al, 2014)
- It's possible not all singers *need* to change strategy (Flynn, Trudeau and Johnson, 2018)

What about lower-voices?

Similar observations have been found in the “reinforced falsetto” of male amateur rock singers.

- Relatively weak H1
- A boosting of 2kHz-4kHz *singer's formant*
- Boosting of H2 - *not always with f1*
- Larger mouth opening
- Higher larynx position

(Guzman et al, 2014)

My Methodological Approach

- Mixed-methods approach
- Connecting quantitative and qualitative data
- Pragmatist research paradigm
- Interview responses viewed through post-positivist lens

Recruitment Information

Recruitment via social media, the researchers network, and the local community of singers.

Inclusion Criteria	Exclusion Criteria
Already able to produce belt quality in the high belt range	All participants had to be 18+
Able to attend an in-person research session in central Manchester	Zero history of voice pathology

Recruitment and Population

$\frac{3}{8}$ Subjects had been trained by the researcher, an important consideration to Insider Research.

<u>Singer</u>	<u>Voice type</u>	<u>Age</u>	<u>Gender</u>	<u>Years singing</u>	<u>Experience Level</u>
Subject 1	Mezzo-soprano	23	Cis-female	17	Amateur
Subject 2	Counter-tenor	31	Cis-male	15	Professional
Subject 3	Tenor	26	Cis-male	10	Amateur
Subject 4	Baritone	38	Non-binary (AMAB)	30	Professional
Subject 5	Mezzo-soprano	28	Cis-female	25	Semi-professional
Subject 6	Soprano	32	Cis-female	28	Professional
Subject 7	Tenor	32	Cis-male	20	Semi-professional
Subject 8	Soprano	43	Cis-female	25	Professional

Recording and Analysis Method

- RODE NT1-A Condenser microphone
- Focusrite ScarlettSolo Interface via a standard XLR cable (connecting to an iMac via USB cable)
- Distance from microphone remained the same.
- Audio samples were recorded directly into the Estill Voiceprint program.
- Any acoustic information below a D5 was disregarded.
- Praat software was used to calculate the Centre of Gravity (Central Spectroid) as Estill Voiceprint does not give this information.

Coaching Protocol

- Vocal health was monitored and prioritised.
- Each session began with a voice health check-in.
- A warm-up was included, led by the participant and facilitated by the researcher.
- Instructions related to physiological co-ordinations were avoided.
- Prompts such as “make the sound brighter” or “make the sound more yell-like” we instead used

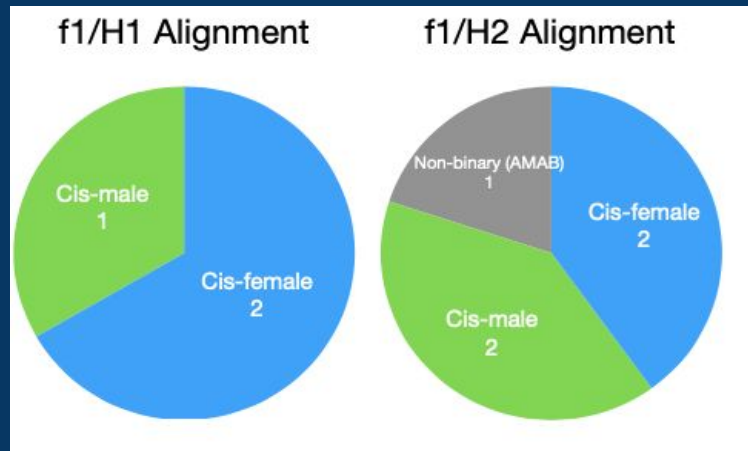
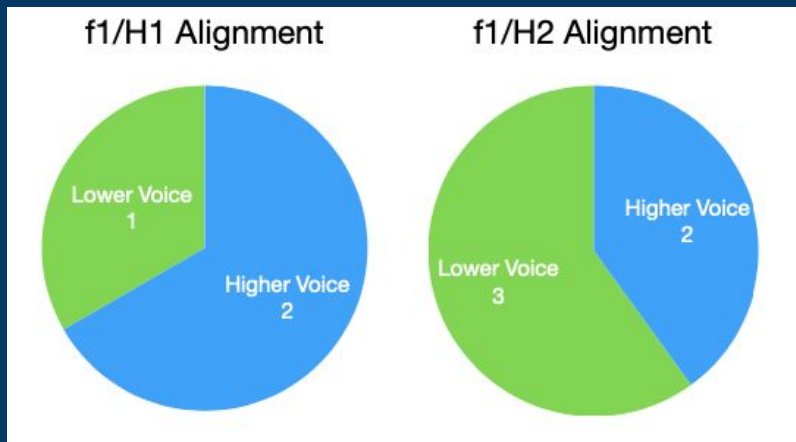
Interview

- Semi-structured interview, which was recorded then transcribed with subjects' consent.
- Member checking was offered.
- Qualitative data from responses were analysed using frequency coding.
- This task was included to further explore the research question. The main focus was on acoustic analysis.

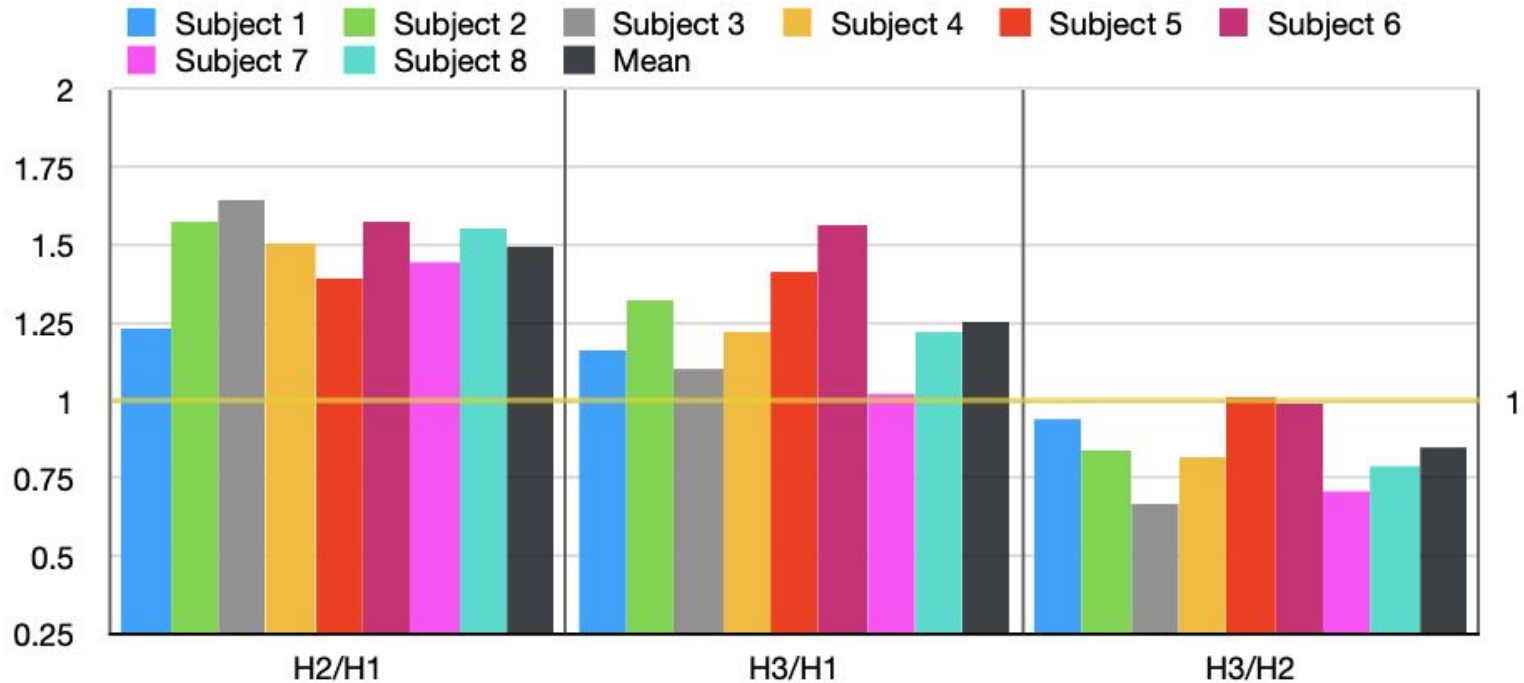
Singer	Torso/Body	Mouth/Throat Space	Breath	Vocal fold/larynx specific	Mindset	Effort/Engagement	Sound Quality	Miscellaneous
Subject 1	Whole body tensing. Diaphragm engaged.	Open back of throat. High soft palate	Very little breath			Engagement. Quite high effort		
Subject 2	"Tighten the corset". Soft tummy. Anchoring the torso. Shoulder blades down.	Small space at the back of the mouth. Into the back of the head and front of the mouth at the same time. Like a 120 degree angle.		High larynx.	Let the voice lock into place, then keep everything almost still to allow it to stay there.		Let it be yelly and don't worry about it sounding pretty or nice.	Feels like raising the ears.
Subject 3	Engage a lot of abdominal support.		Less airflow despite more pressure.	Quite thin folds. Larynx rising pretty high. Using vocal folds as resistors more so than at a lower pitch.			Masky sort of sound. Twang helps.	
Subject 4	Felt like nothing was coming from the diaphragm.	Manipulating the mouth and tongue in different ways.			The less in my head I was the more successfully I was.	Felt like was forcing it out too much.	Hearing the bell and feeling the bell quality at that note.	Sliding up helped.
Subject 5	Anchoring	Creating it in the head and neck. Be aware of the velum. Wide and up/down.			Don't think about it too much. Trust that it will just do it based on what I've learned and worked on.	Anchoring/Head and neck Anchoring	Start thinking about shouting it out and add from there. Couldn't tell if it was getting a bit nasally.	Singing to the back wall behind.
Subject 6	Stand straight up, legs apart. It's flexible. But for me my relaxed is standing upright but apart.	Opened mouth more to make it sound nicer. It would sound strained if I didn't open the mouth more. Elongating your mouth.		Naturally I'd use my head voice (referring to when not doing this specific more chesty belt sound)			The vowel didn't want to sound nice. Make it strong and powerful.	Climbing on top of the note, especially if sliding.
Subject 7	Sustained by the chest.	Try not to close the throat too much. Middle ground between the classical sound and a more natural sound. Avoid closing or opening too much, and then keep that balance. Keeping the space big enough that it remains controlled, but not so big it no longer has a natural tone.	Try to "push more air out". Having enough air to go through.	Full voice up there feels like a balloon hiss, falsetto feels bigger space/ yawny - try to find a middle ground between the two. Feels like chest voice if I get it right.	Try not to worry. If I worry the throat closes up.		Taking full voice higher. Try to not make it sound too stretched or just doing a head voice that sounds like a bell.	Easier to go up slower rather than jumping straight up.
Subject 8	Right from the core.		Put a good breath behind it. A deep breath. Belly air. It looks like "gestures to belly expanding".		Clear my mind in a split second and just go for it with a good breath behind.			

Acoustic Analysis Results

- Aligning of f1/H2 vs f1/H1 as a strategy varied, but was not predictable based on gender.
- All sopranos aligned f1/H2 whereas all mezzos aligned f1/H1.
- Lower voices more consistently aligned f1/H2 ($\frac{3}{4}$ subjects).



Ratio of energy across H1-H3



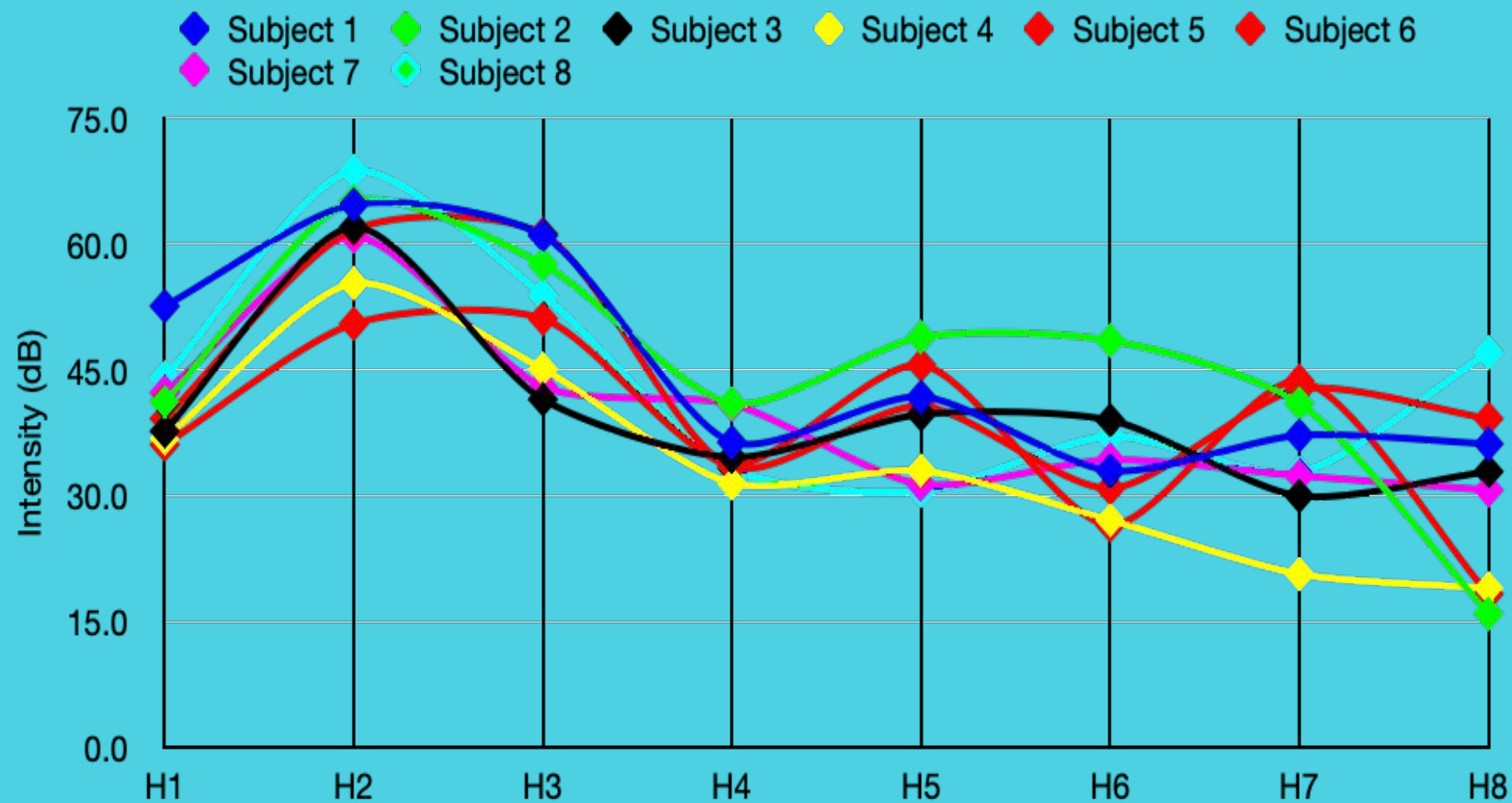
Results - Upper Partial

A number of strategies in boosting the Upper Partial (H4-H8) were investigated.

Some subjects appeared to “group” resonances and boost consecutive harmonics, whereas others seemed to employ a “one-on, one-off” strategy.

Discussion of Acoustic Strategies Identified

- In no example was H1 the loudest harmonic.
- A number of strategies appeared that make high belt possible.
- Lower voices were more likely to “bunch” resonances and boosted consecutive harmonics.
- One subject showed no apparent strategy for the upper partials. This subject was the only baritone in the study - however relevance of this cannot be drawn due to small sample.
- One subject boosted three consecutive harmonics - the only countertenor in the study.



	H1	H2	H3	H4	H5	H6	H7	H8
Subject 1								
Subject 2								
Subject 3								
Subject 4								
Subject 5								
Subject 6								
Subject 7								
Subject 8								

Discussion

- Due to the small sample size more research with a larger population is required to draw any concrete conclusions.
- How important is voice type in the context of High Belting and additionally in the concept of the wider implications of CCM voice teaching?
- Is it possible as teachers we are limiting the potential of our clients and students by assigning voice types based on what we first hear?

Application to Practice

- Perhaps all voice-types can produce high-belt.
- Perhaps issues found in singers who struggle are related to coordination rather than physiology.
- Physiology/morphology may play a role in the most efficient strategy, but it is unclear how this relates to voice-type/gender.
- Perhaps in CCM teaching we need to be cautious of “typing” our clients, and potentially limiting their vocal development.

Study Limitations

- Small Sample size.
- The room was not soundproofed/acoustically treated.
- Voice-type was self-reported.
- The earlier interviews were less “thorough”.
- Three of the subjects had been trained by the researcher - this may be significant due to the small sample size.

Personal/Professional Reflection

- Time/project management
- Interview skills - later interviews were more thorough than earlier ones.
- Deeper critical thinking into the “why” of existing theories and my own existing ideas.
- Reflection of looking at the same phenomena from different perspectives.

Conclusion

- In this sample, a variety of voice-types and genders were capable of producing a belt sound in the high-belt range.
- Further research is needed with a larger population.
- There appeared to be more variation from singer to singer, compared to from voice type to voice type.
- A repeat experiment with a perception test would be hugely beneficial.
- Could there be more research into the countertenor voice within CCM singing?

References

- Echternach, M., Popeil, L., Traser, L., Wienhausen, S. and Richter, B. (2014). Vocal Tract Shapes in Different Singing Functions Used in Musical Theater Singing—A Pilot Study. *Journal of Voice*, [online] 28(5), pp.653.e1–653.e7. doi:<https://doi.org/10.1016/j.jvoice.2014.01.011>.
- Flynn, A., Trudeau, J. and Johnson, A.M. (2018). Acoustic Comparison of Lower and Higher Belt Ranges in Professional Broadway Actresses. *Journal of Voice*, 34(3). doi:<https://doi.org/10.1016/j.jvoice.2018.10.006>.
- Guzman, M., Acevedo, K., Leiva, F., Ortiz, V., Hormazabal, N. and Quezada, C. (2019). Aerodynamic Characteristics of Growl Voice and Reinforced Falsetto in Metal Singing. *Journal of Voice*, 33(5), pp.803.e7–803.e13. doi:<https://doi.org/10.1016/j.jvoice.2018.04.022>.
- Guzman, M., Barros, M., Espinoza, F., Herrera, A., Parra, D. and Lloyd, A. (2014). Resonance Strategies Revealed in Rock Singers during Production of High Notes. *Journal of Singing*, 71(2), p.183.
- Lebowitz, A. and Baken, R.J. (2011). Correlates of the Belt Voice: A Broader Examination. *Journal of Voice*, 25(2), pp.159–165. doi:<https://doi.org/10.1016/j.jvoice.2009.10.014>.
- Roll, C. (2016). The Evolution of the Female Broadway Belt Voice: Implications for Teachers and Singers. *Journal of Voice*, 30(5), pp.639.e1–639.e9. doi:<https://doi.org/10.1016/j.jvoice.2015.07.008>.
- Saldias, M., Guzman, M., Miranda, G. and Laukkanen, A.-M. (2019). A Computerized Tomography Study of Vocal Tract Setting in Hyperfunctional Dysphonia and in Belting. *Journal of Voice*, 33(4), pp.412–419. doi:<https://doi.org/10.1016/j.jvoice.2018.02.001>.
- Sundberg, J., Thalén, M. and Popeil, L. (2012). Substyles of Belting: Phonatory and Resonatory Characteristics. *Journal of Voice*, 26(1), pp.44–50. doi:<https://doi.org/10.1016/j.jvoice.2010.10.007>.