Quantifying Vocal Repertoire Tessituras Through Real-Time Measures

Matthew Schloneger, PhD, MM, Friends University

Eric J. Hunter, PhD, Dept of Communicative Sciences and Disorders, Michigan State University

Lynn Maxfield, PhD, National Center for Voice and Speech

Selecting Appropriate Student Repertoire

Voice teachers use experience and anecdotal evidence when selecting repertoire for students:

- Range
- Tessitura
- Passaggio points
- “Weight”
- “Color”
- Pedagogical goals

Tessitura, however, is something that has until recently remained un-quantified by scientific methods.

The acquisition of singer Voice Range Profiles combined with the quantification of repertoire tessituras could help voice teachers scientifically choose repertoire that is a good “fit” for individual voices

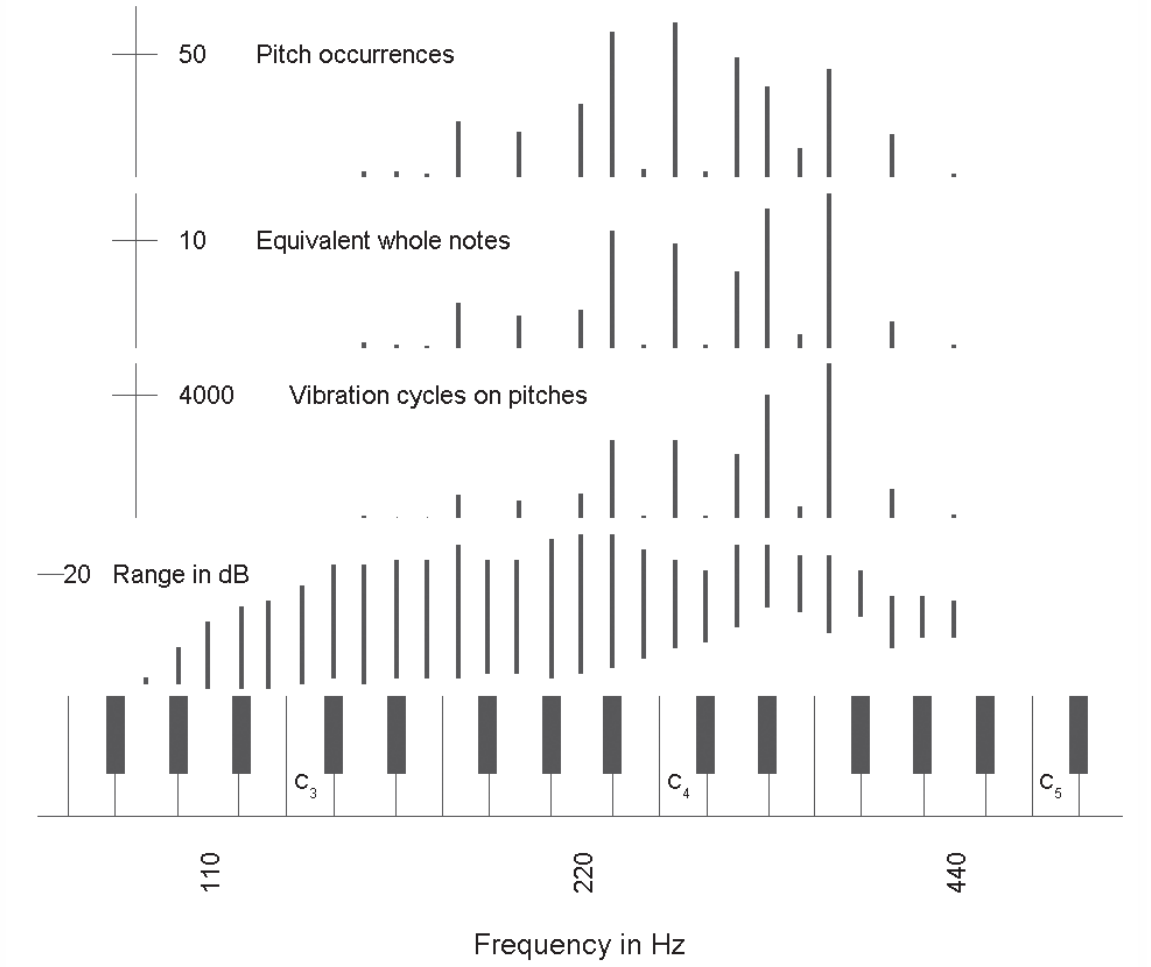
Previous Studies

Titze, Ingo, "Quantifying Tessitura in a Song." *Journal of Singing,* 65:1 (September 2008), 59–61.

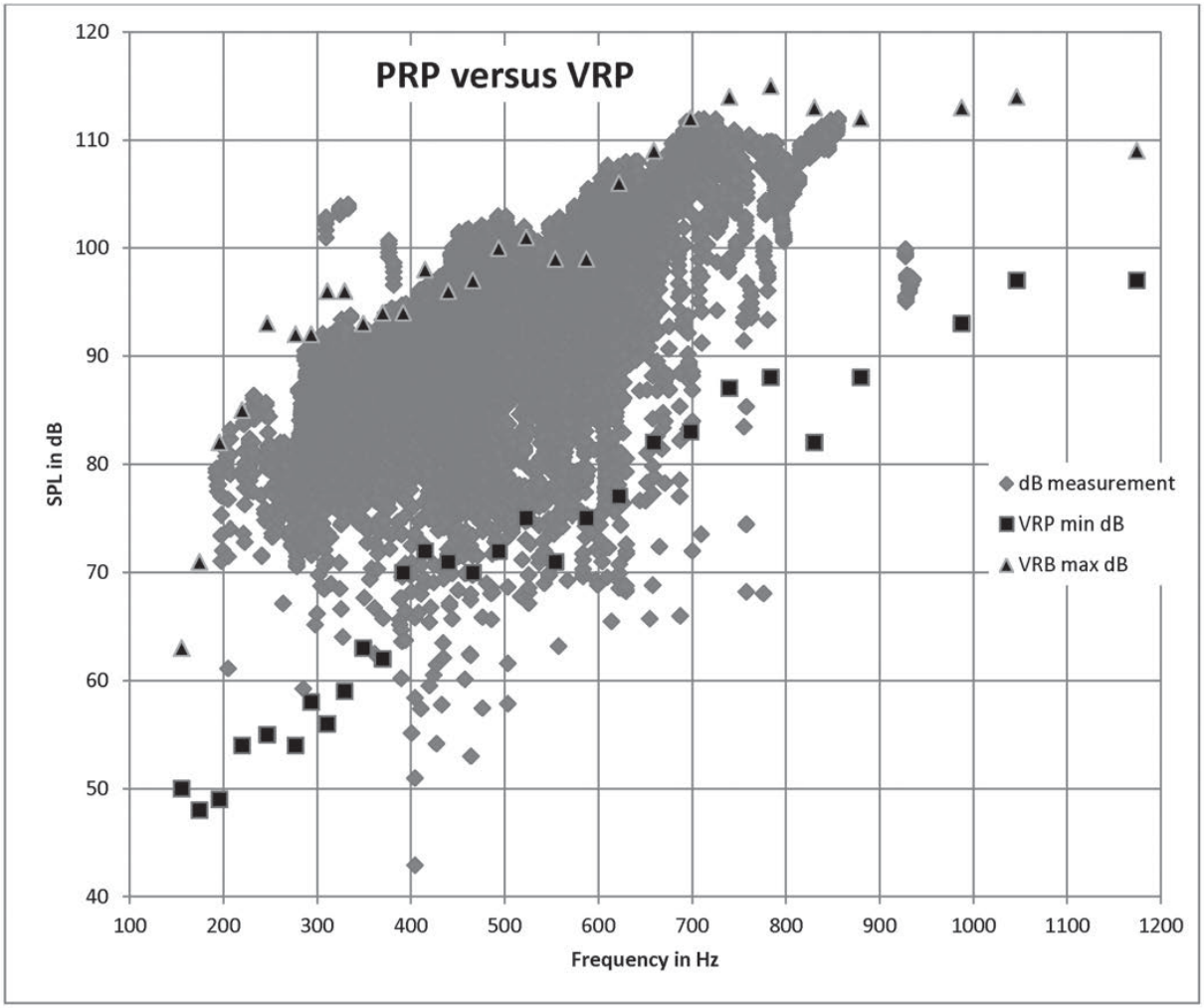
Hanrahan, Kevin. "Use of the Voice Range Profile in Assigning Repertoire: An Evaluation." NATS National Conference, Salt Lake City, UT, July 2010 (Best Poster Award)

Nix, John, "Measuring Mozart: A Pilot Study Testing the Accuracy of Objective Methods for Matching a Song to a Singer." *Journal of Singing,* 70:5 (June 2014), 561-572

Titze – Tessituragram of "Il mio tesoro" from *Don Giovanni*- Mozart



Nix – VRP overlaying Tessituragram



Purpose Statement

The purpose of this study was be to examine the use of dosimetry-derived tessituragrams and Voice Range Profiles (VRPs) in selecting appropriate voice repertoire for singing students.

Research Questions

1. How do dosimetry-derived tessituragrams compare to score-derived tessituragrams of the same selection in the same key?
2. How do dosimetry-derived tessituragrams of the same vocal selection (“Il mio bel foco…Quella fiamma” by Benedetto Marcello) compare when performed in three different keys each by four different female singers?;
3. How do singer VRPs compare with their tessituragrams of three performances of this aria, each sung in a different key?;
4. How do singer and expert panel perceptions of the aria’s “fit” in three different keys align with the overlay of singer VRPs with tessituragrams?

Methods

Each singer (*N=4)* completed the following:

Demographic profile

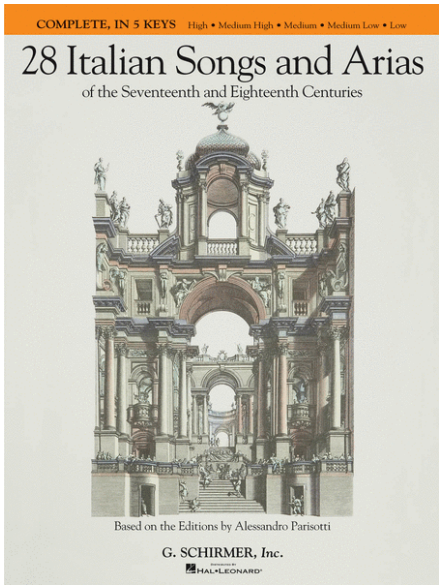
Voice Range Profile –Voice Dosimeter

Aria recording

– Recorded with Voice Dosimeter and Hall Microphone

--Three repetitions in random order of “Quella fiamma” (Schimer Complete 28 Italian Songs and Arias in 5 Keys, Ed. Parisotti)

1. Singer’s accustomed key
2. Adjacent higher key
3. Adjacent lower key



Singer Perception Questionnaire

Expert Panel Questionnaire (*N=5)*

- Random order listening

Ambulator Monitoring - Voice Dosimeter

- **Sonovox AB VoxLog™ portable voice analyzer collar**
- **Standard digital recorder**

Recording

Arias were recorded simultaneously with the voice dosimeter and a hall microphone

The Hall microphone recorded .wav audio files of the choir using a ZOOM H6 device (XY microphone attachment, 90 degree angle) at a 44.1 kHz sampling rate (16 bits).

Singer Perceptual Survey

Each singer responded to the following questions on a separate page following each song repetition:

When in singing the selection, I perceived (mark a tic on the scale):

My overall ease in singing:

Easy |----------| Difficult

High notes:

Easy |----------| Difficult

Low notes:

Easy |----------| Difficult

Register transitions:

Easy |----------| Difficult

Overall “weight” of the selection:

Easy |----------| Difficult

Participants

1. 17-year old soprano, college freshman, 3 years voice lessons, 4 years choir
2. 18-year old soprano, college freshman, 1 year of voice lessons, 13 years choral experience
3. 21-year-old mezzo-soprano, college senior, 3 years of voice lessons, 16 years choral experience
4. 37-year-old soprano, professional singer, 10 years of voice lessons, 10 years choral experience

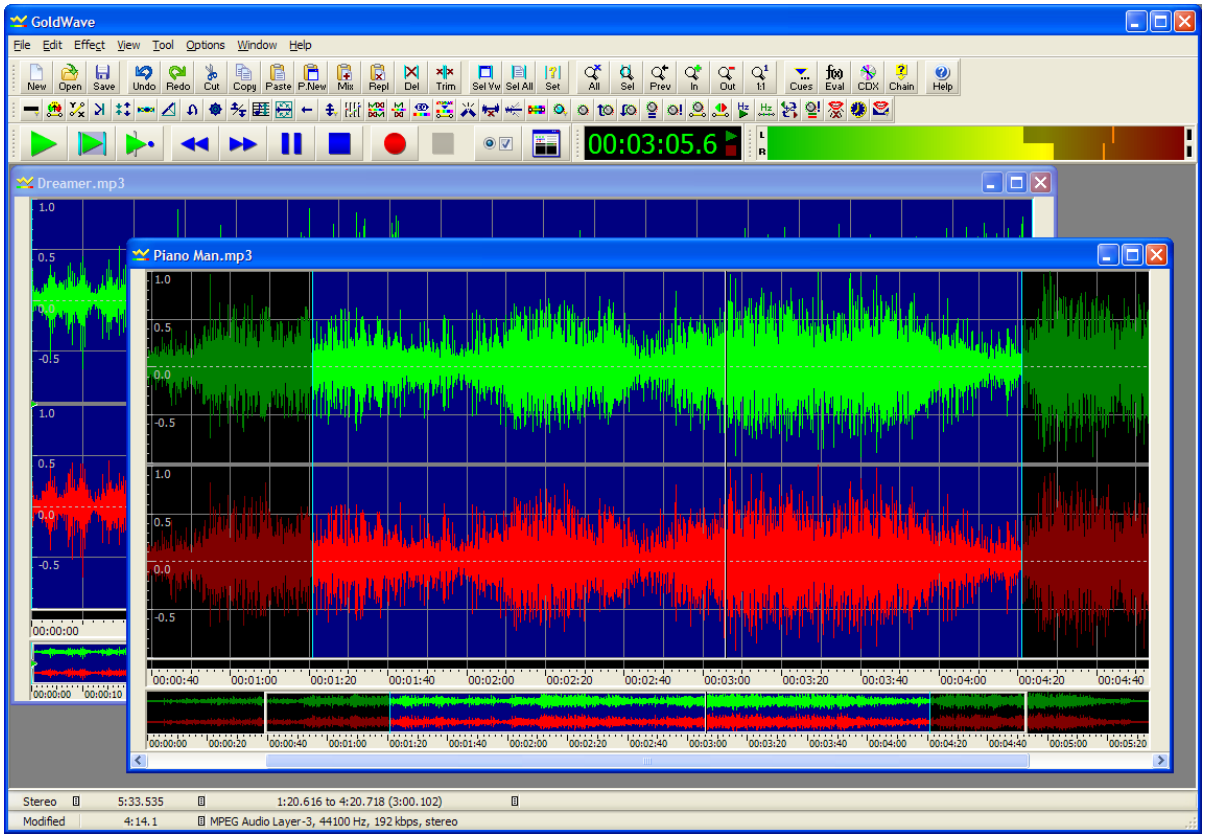
None of the singers reported current vocal pathologies or a history of vocal pathologies

VoxLog Data Processing

Initial data processed using Goldwave v5.70 digital audio editing software (normalizing volume, splitting files, etc)

Accel

Audio



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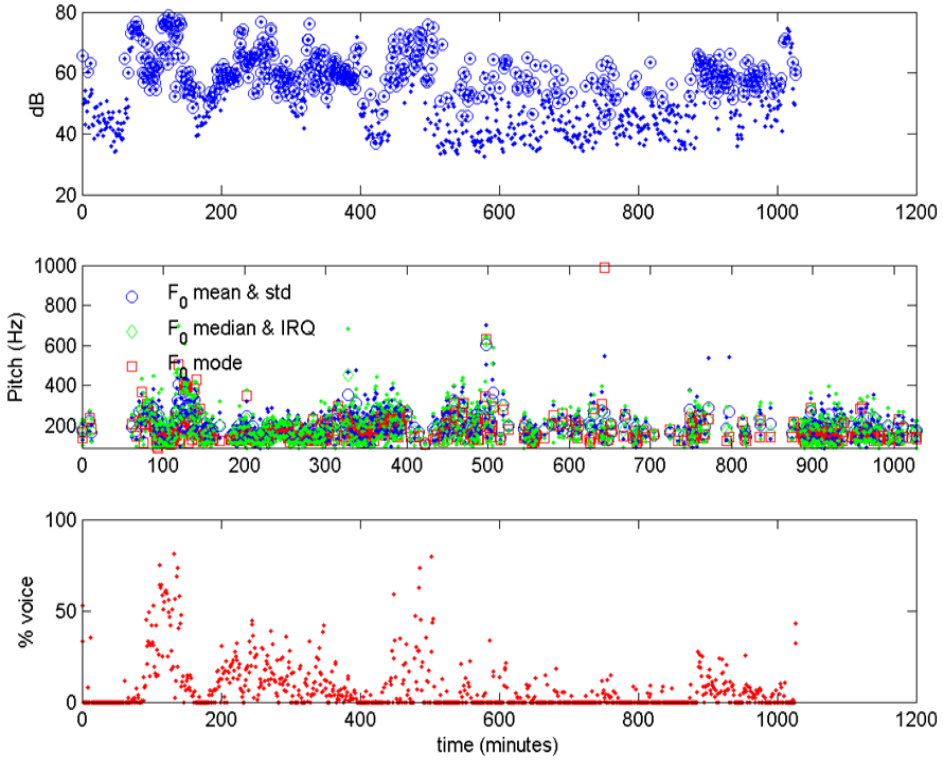
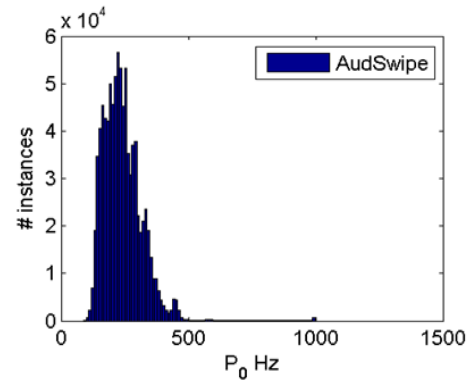
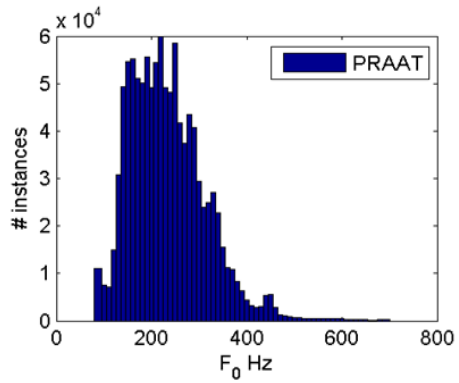
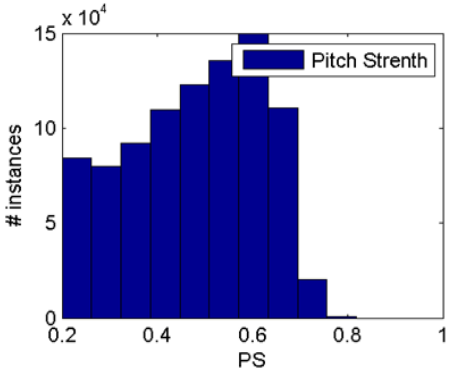
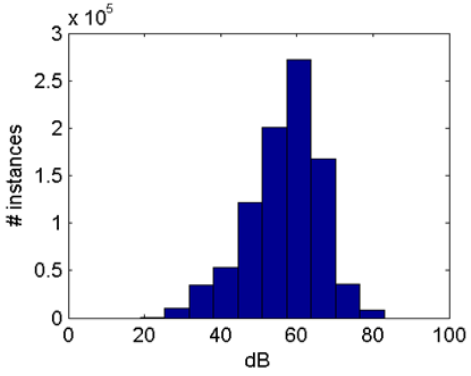
MATLAB Dosimeter Analysis











Expert Panel

Five (5) experienced vocal pedagogues listened to all 12 excerpts in random order and responded to a series of 5 questions regarding the efficiency of vocal production

Mark with a vertical line on the scale:

Overall ease in singing:
Free/Efficient |_____| Strained/Inefficient

High notes:
Free/Efficient |_____| Strained/Inefficient

Low notes:
Free/Efficient |_____| Strained/Inefficient

Register transitions:
Free/Efficient |_____| Strained/Inefficient

Overall "weight" of the selection
Free/Efficient |_____| Strained/Inefficient

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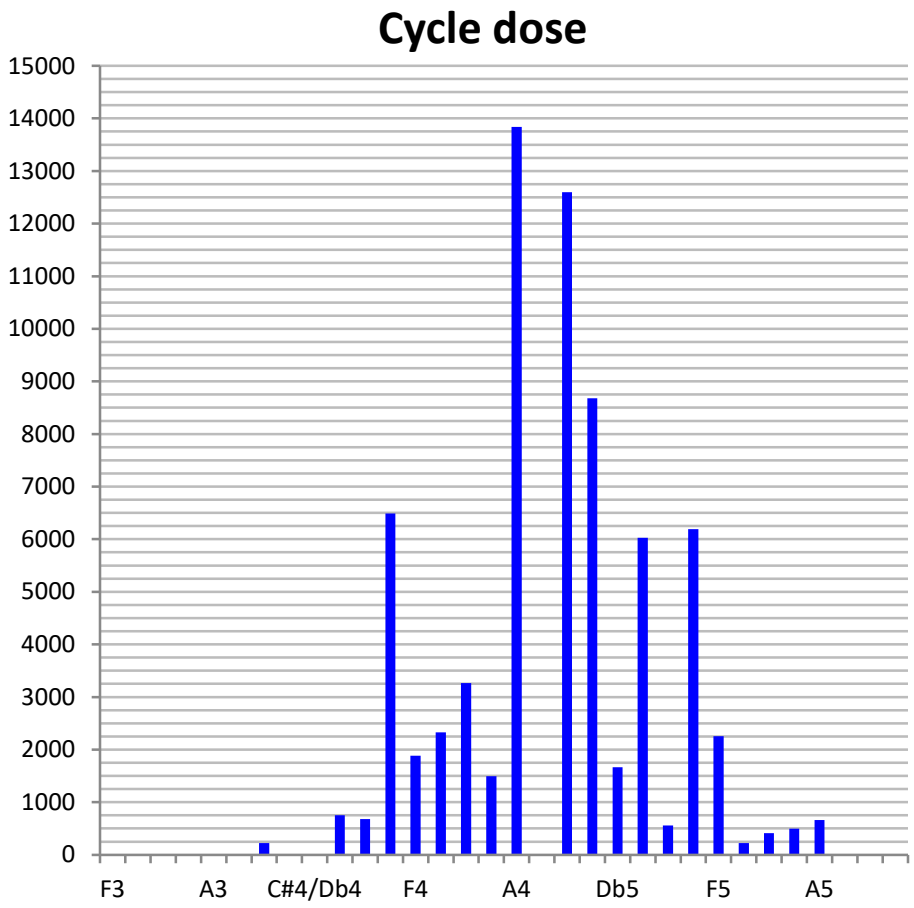
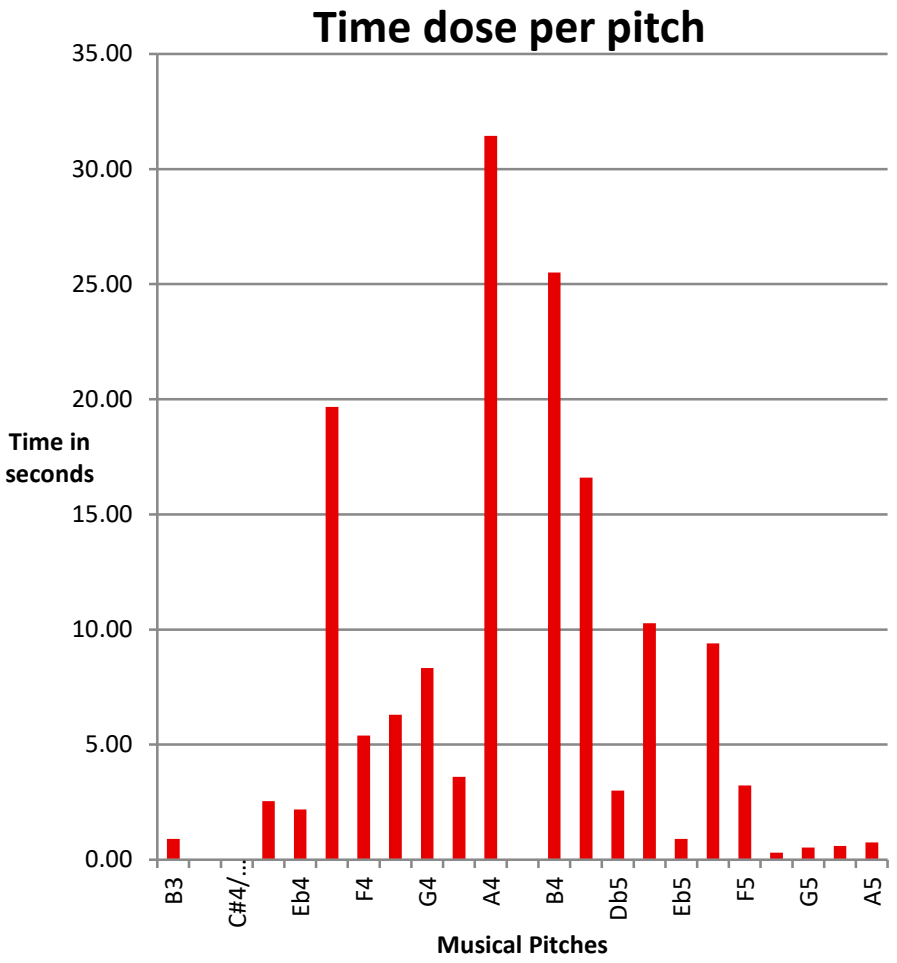
Results

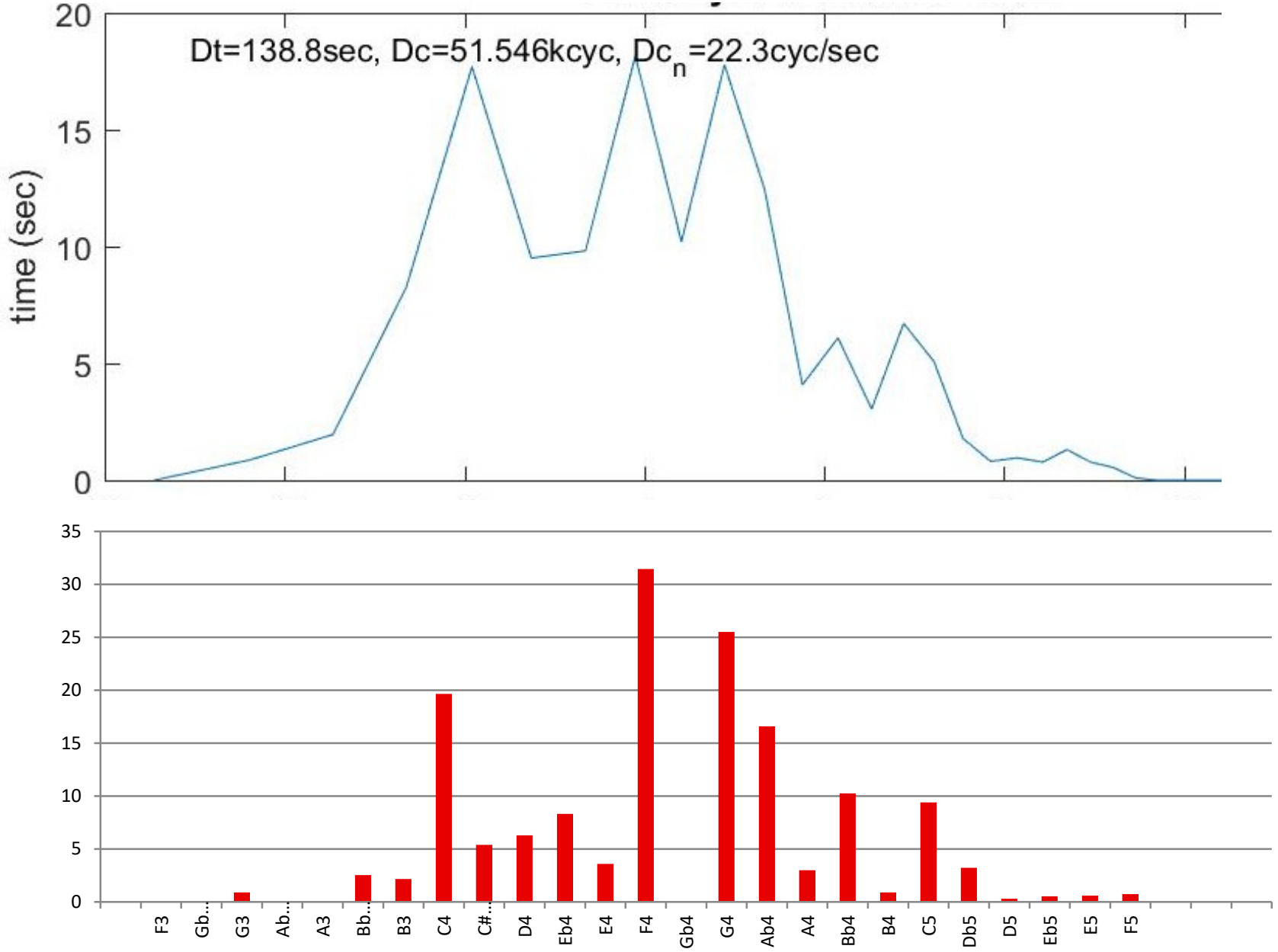
Score-Based Tessituragram
Quella fiamma-Medium High (Key of Am)

Recit: 55 bpm; Aria: 100 bpm





Tessituragram (Dose Time) – Score compared to Dosimeter



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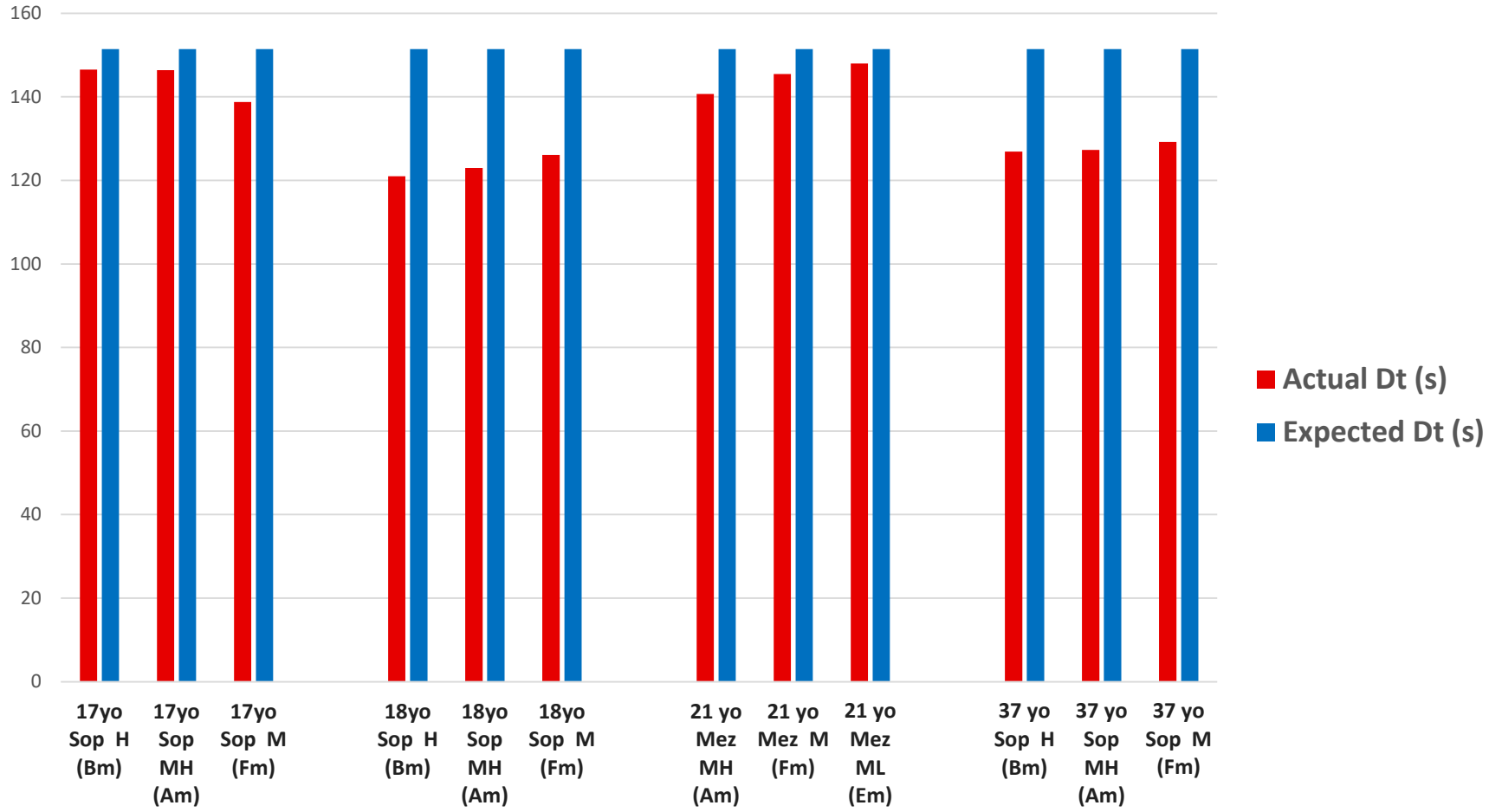
Dose Time - Score-based estimate vs Dosimeter Reading



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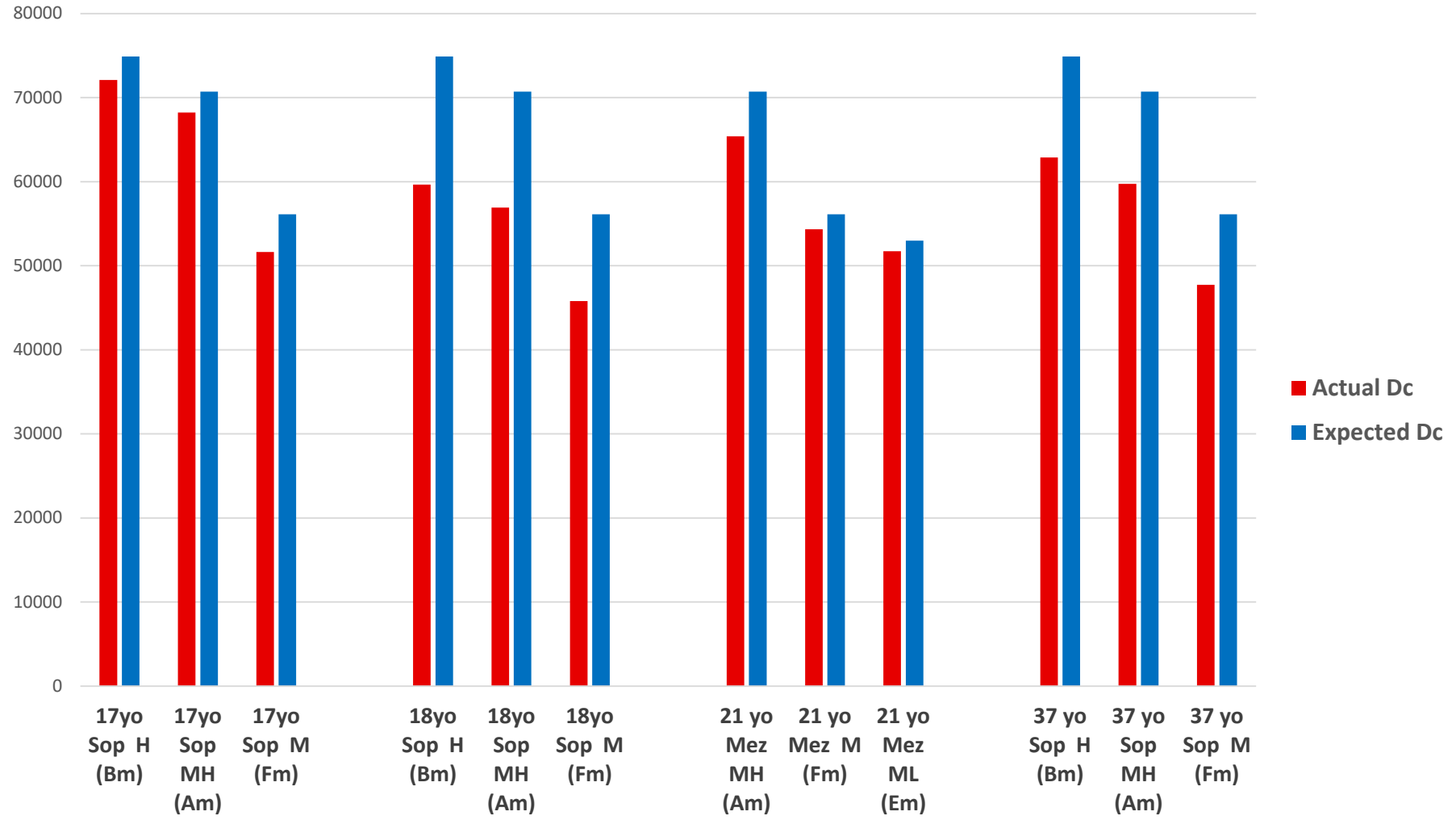
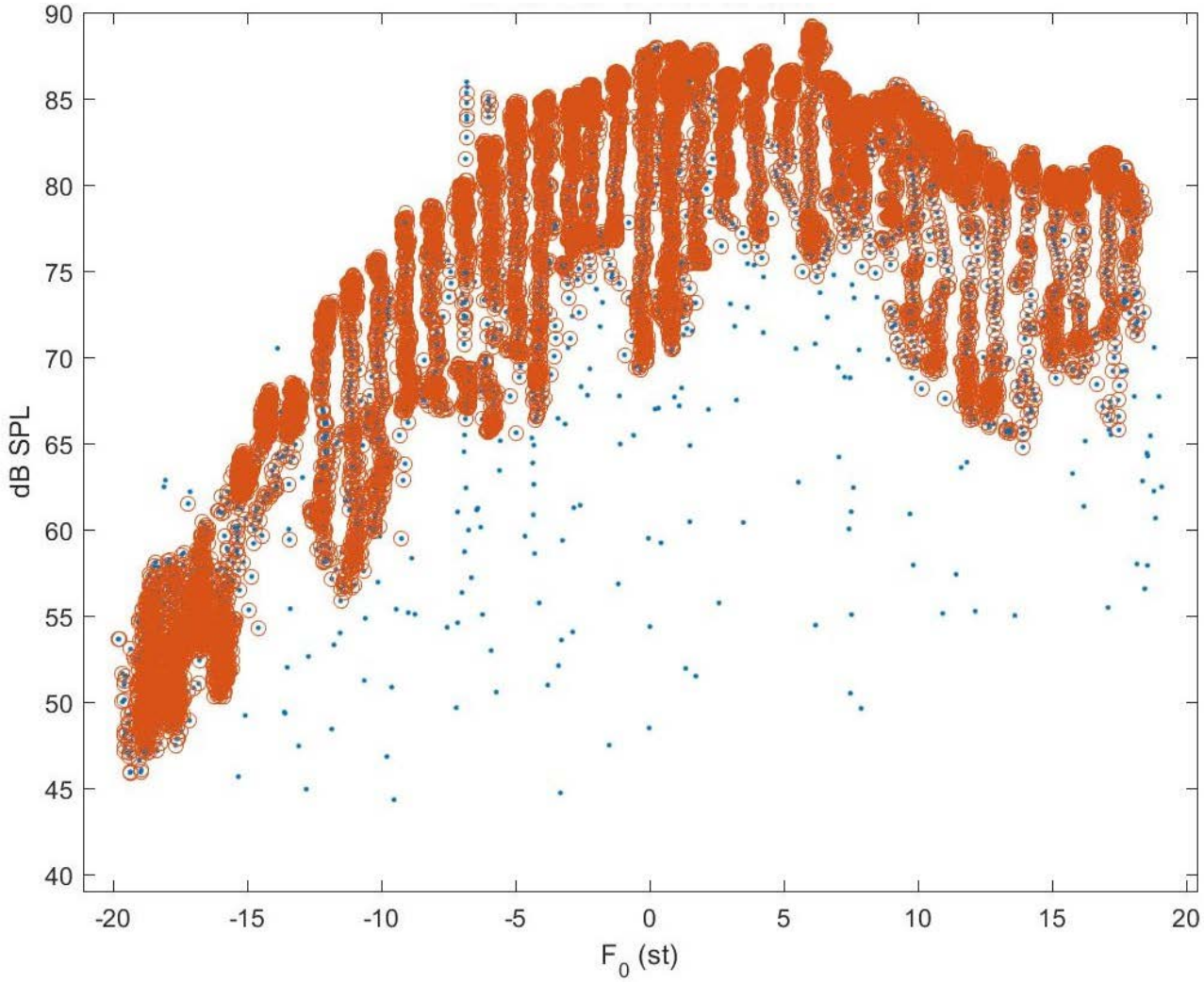
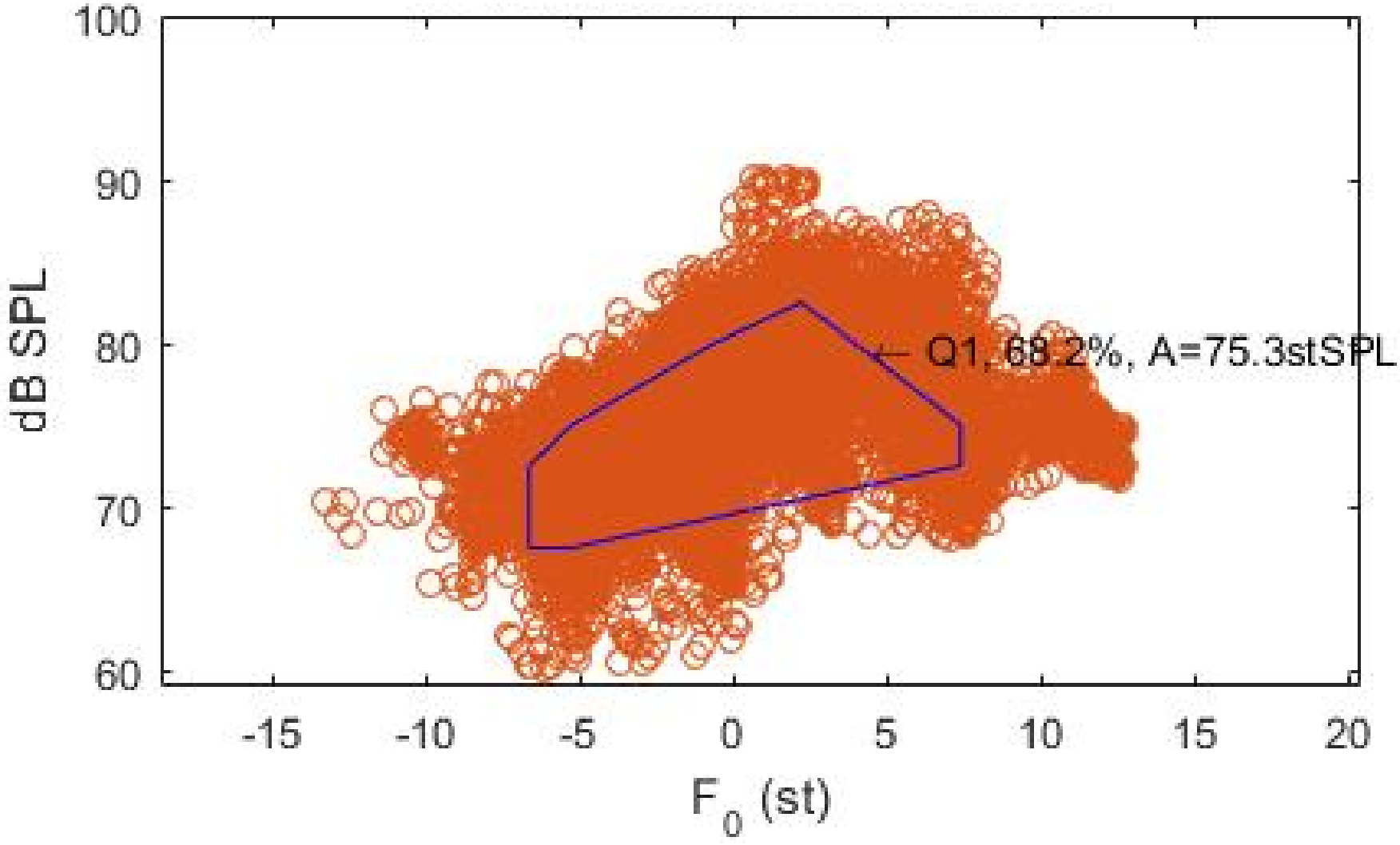
Cyce Dose (Dc) - Score-Based estimate vs. Dosimeter Reading



Voice Range Profiles



Song Range Profile/Tessituragram

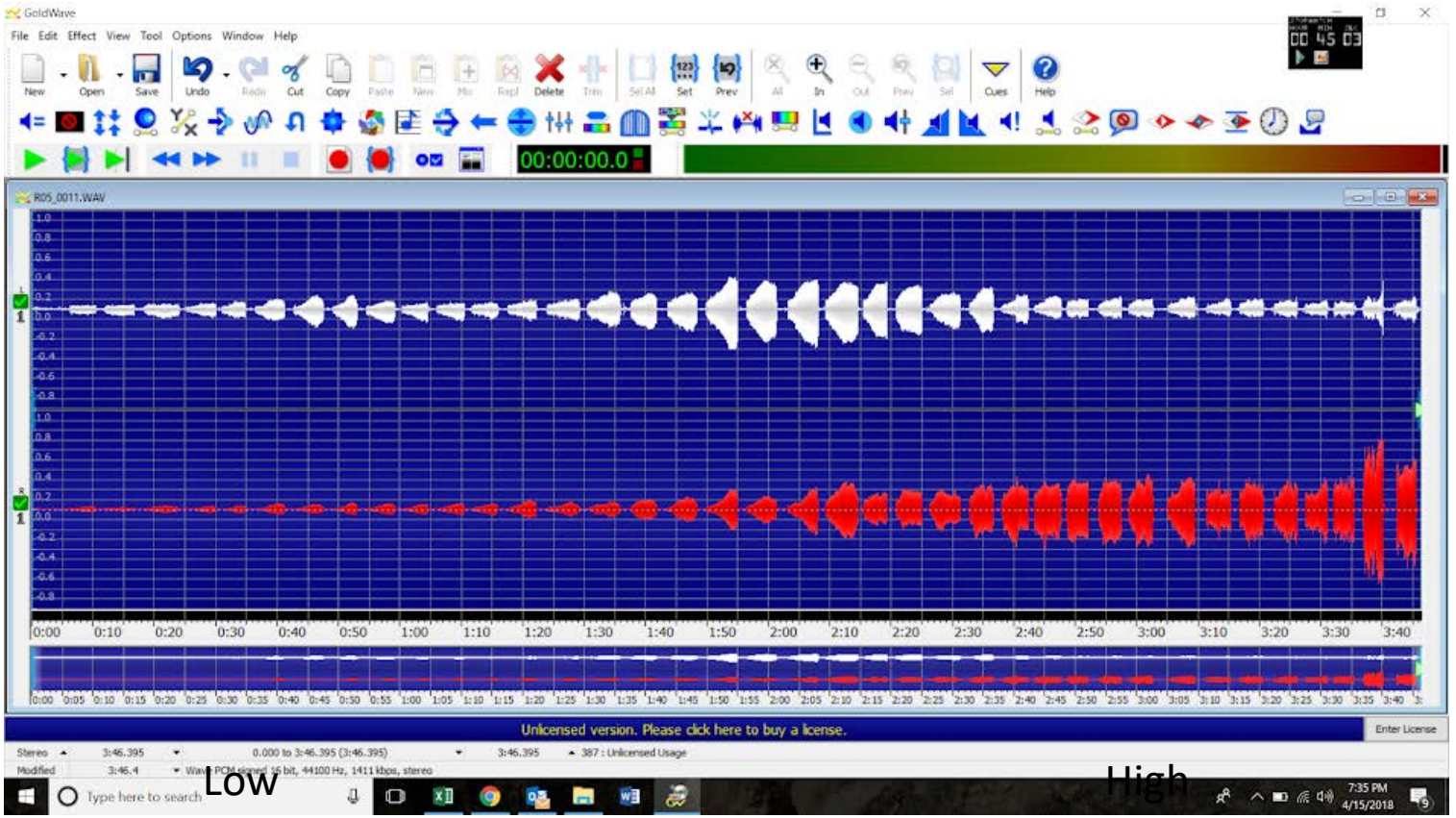


Voice Range Profile

Accelerometer (Voice Source) vs. Audio (Source + Filter)

Accel.

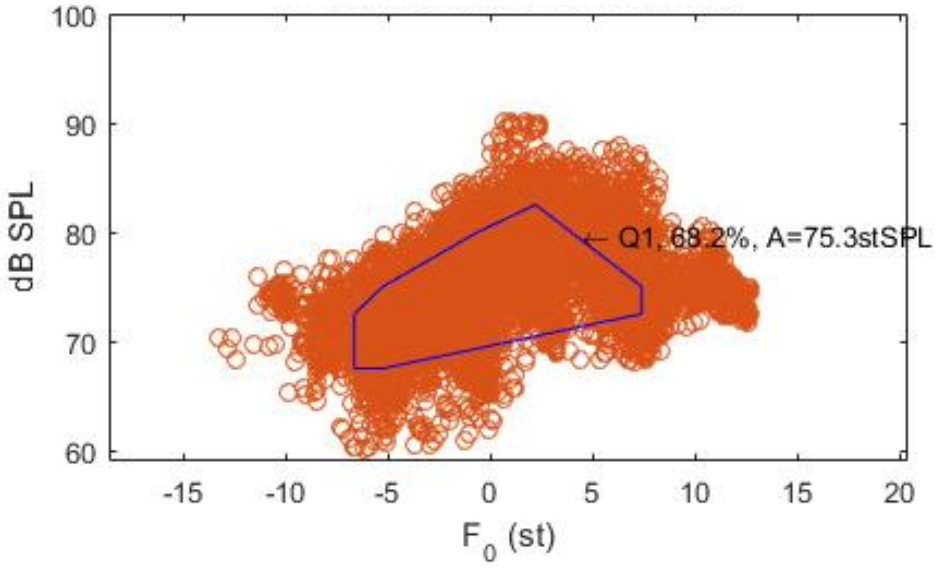
Audio

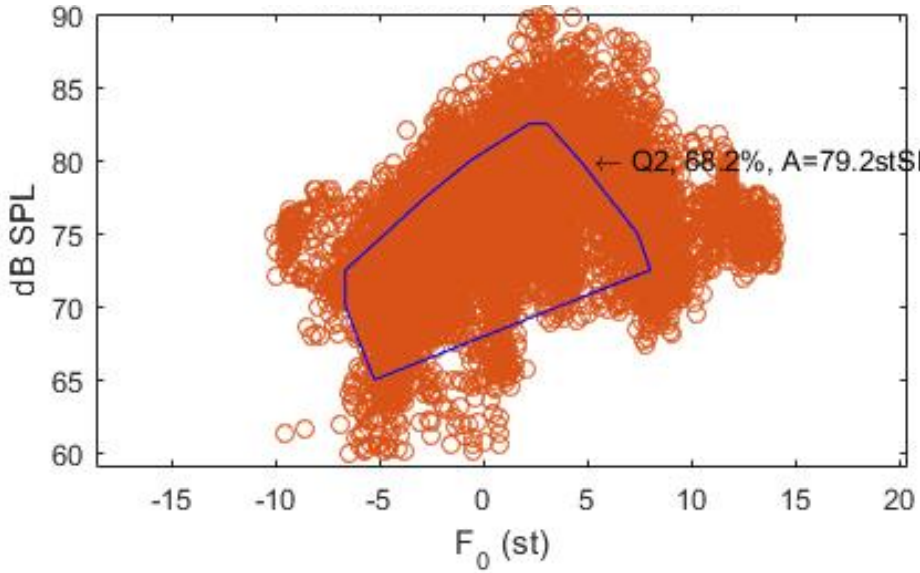


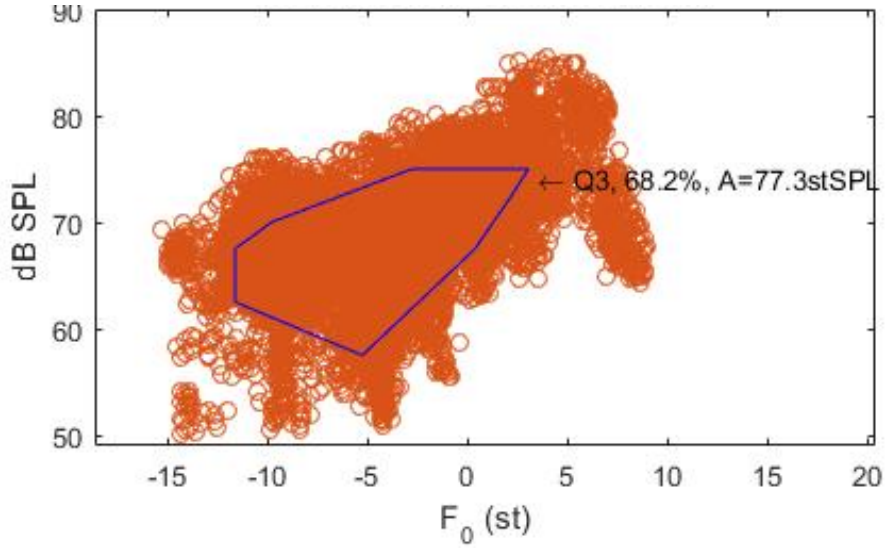
Low

High

Song Tessituragrams (SRP) – Three Keys



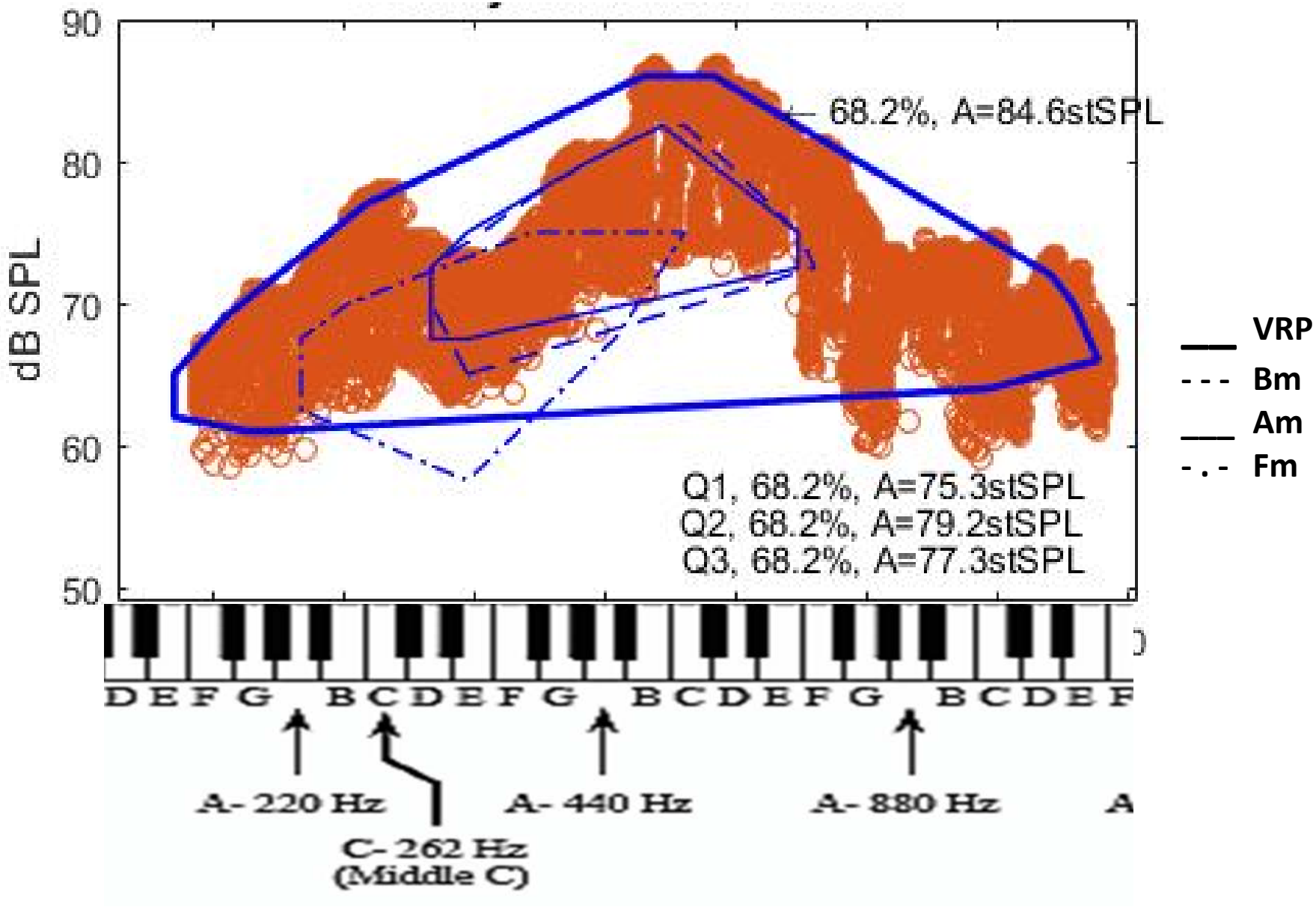




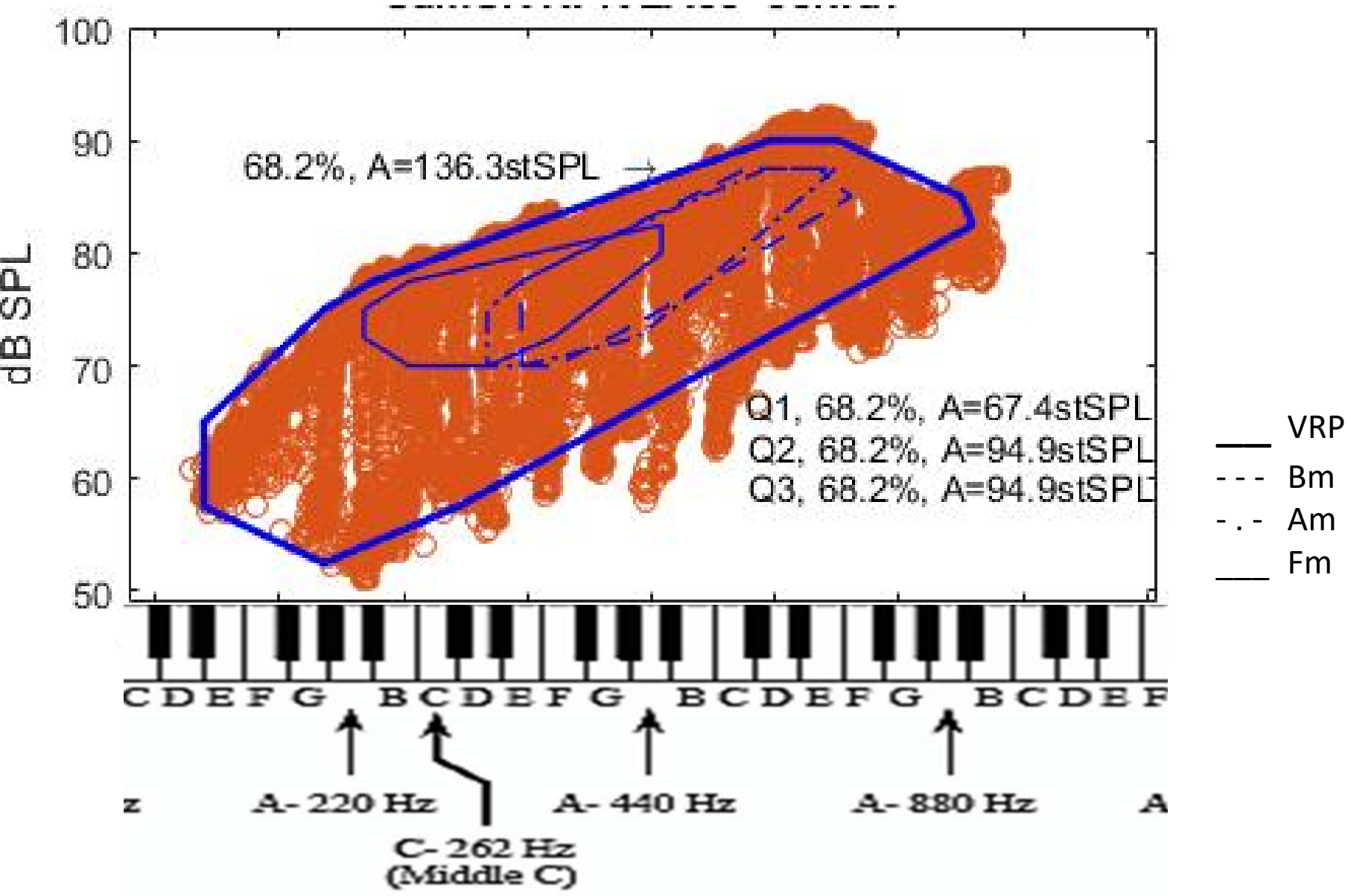
Song Range Profile (SRP) boxed areas equal 68.2% of all voicing – A visualization of tessitura

A larger area means a greater dynamic range was used in performance

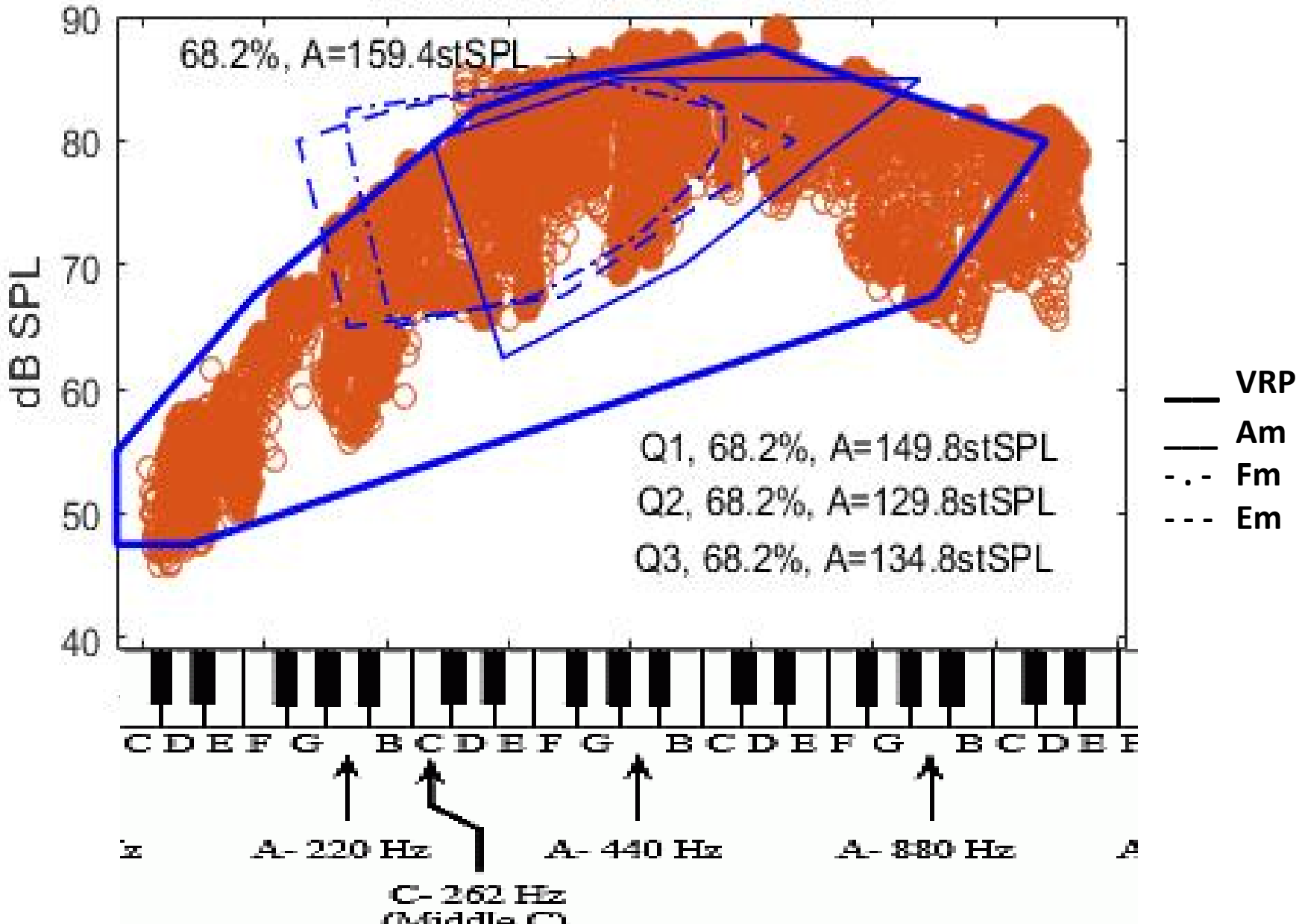
Singer 1 – VRP Area overlayed with SRP Areas



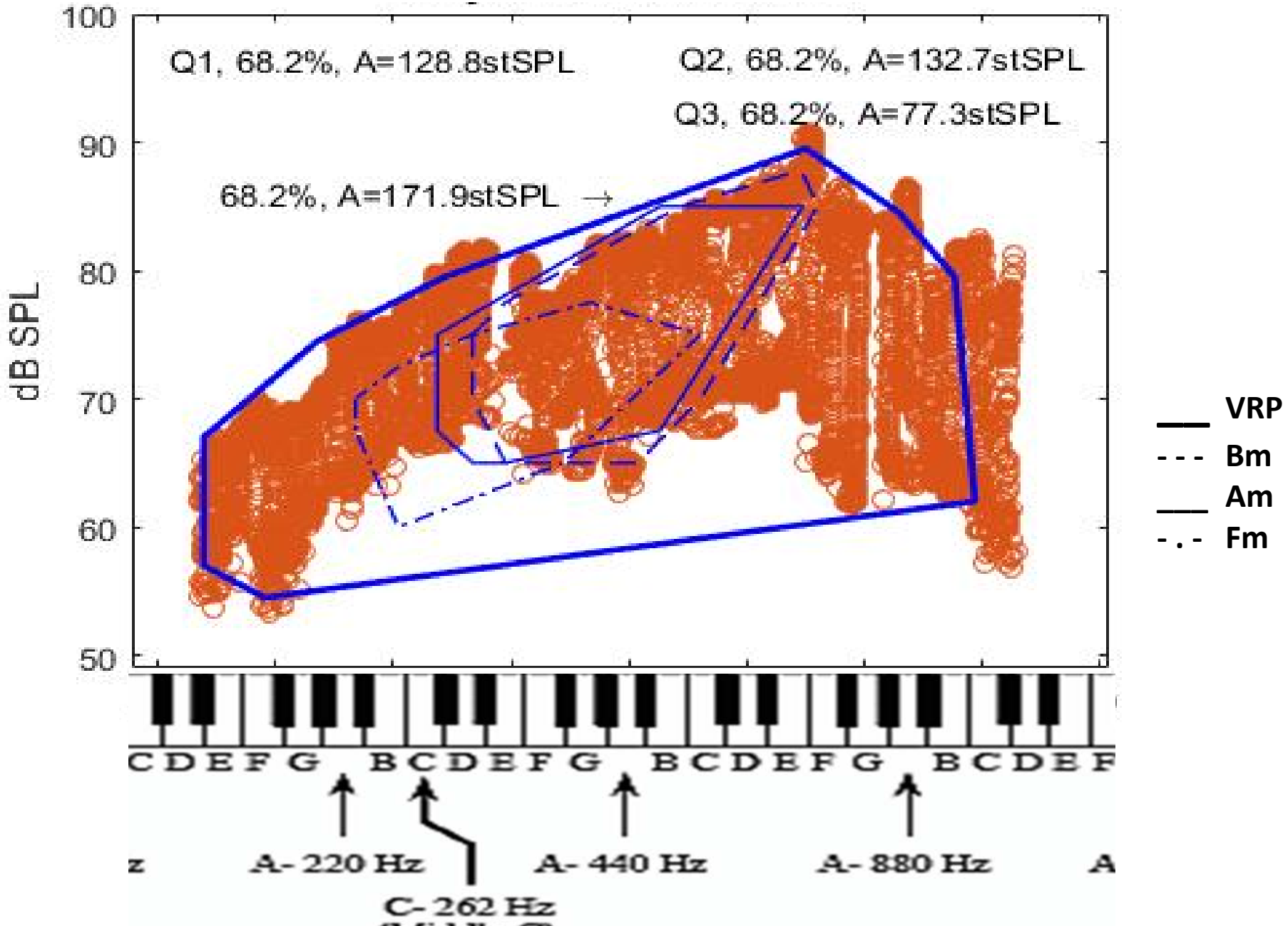
Singer 2 – VRP Area overlayed with SRP Areas



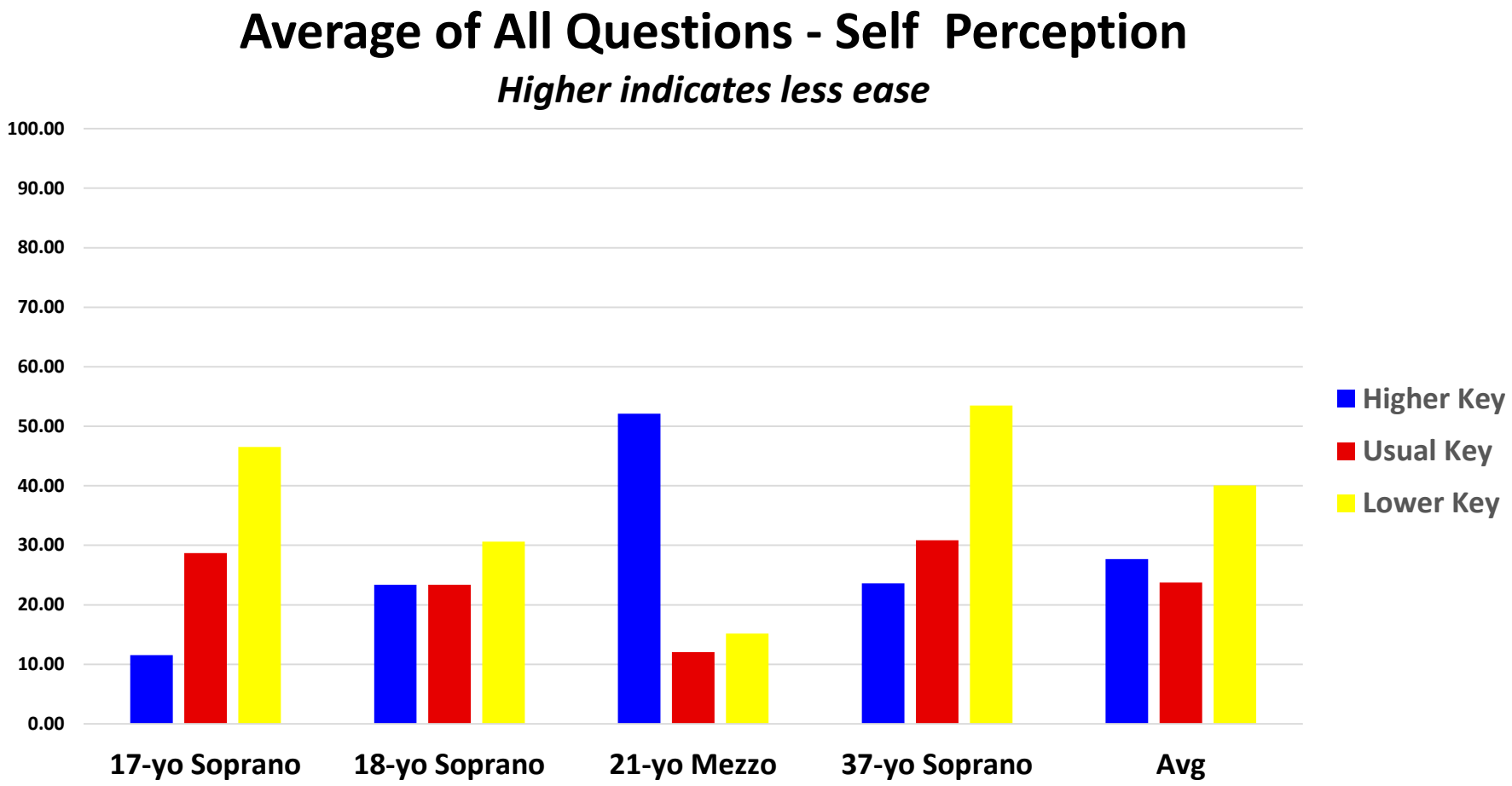
Singer 3 – VRP Area overlayed with SRP Areas



Singer 4 – VRP Area overlayed with SRP Areas



Singer Perception



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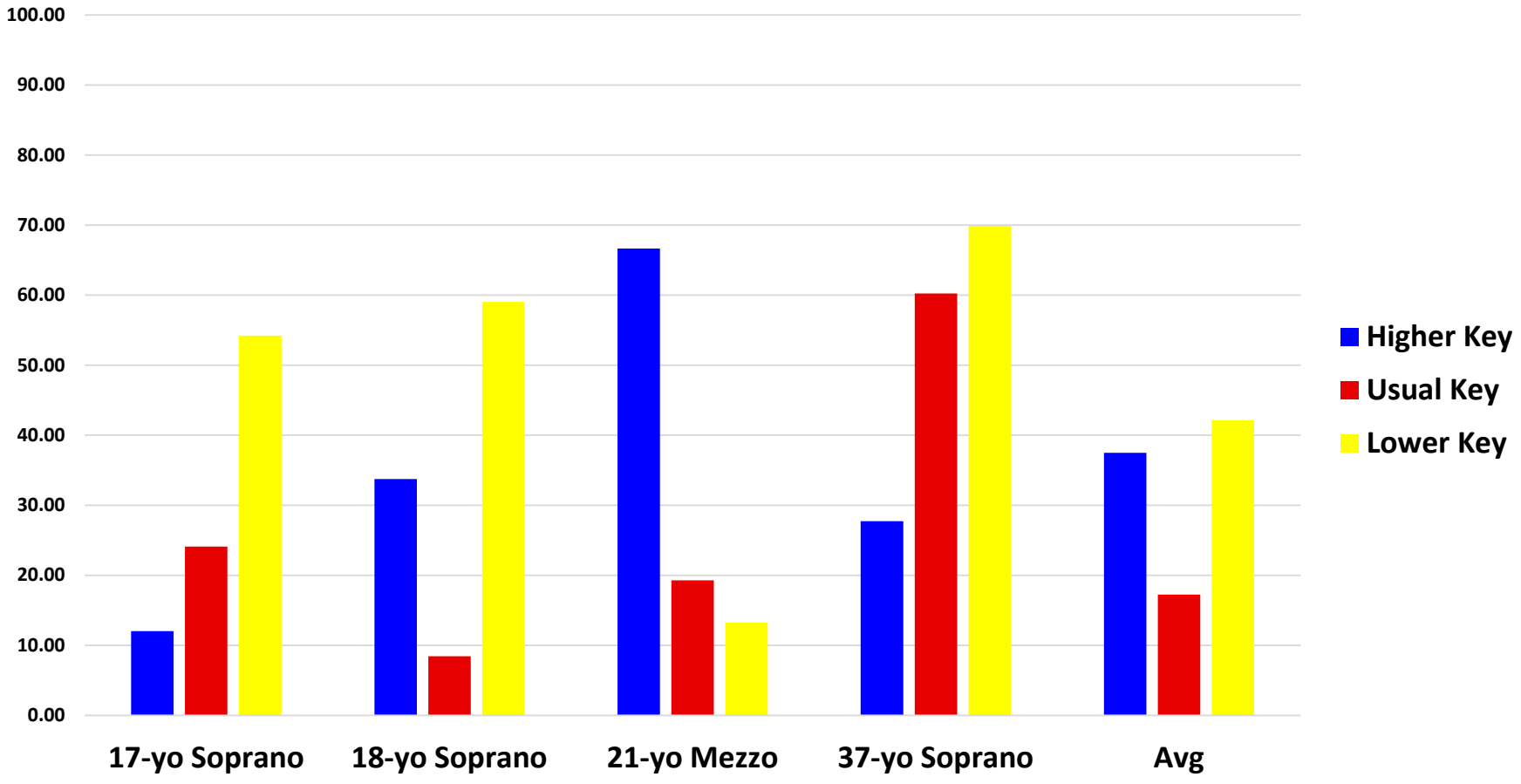
Overall Ease in Singing - Self Perception

Higher indicates less ease



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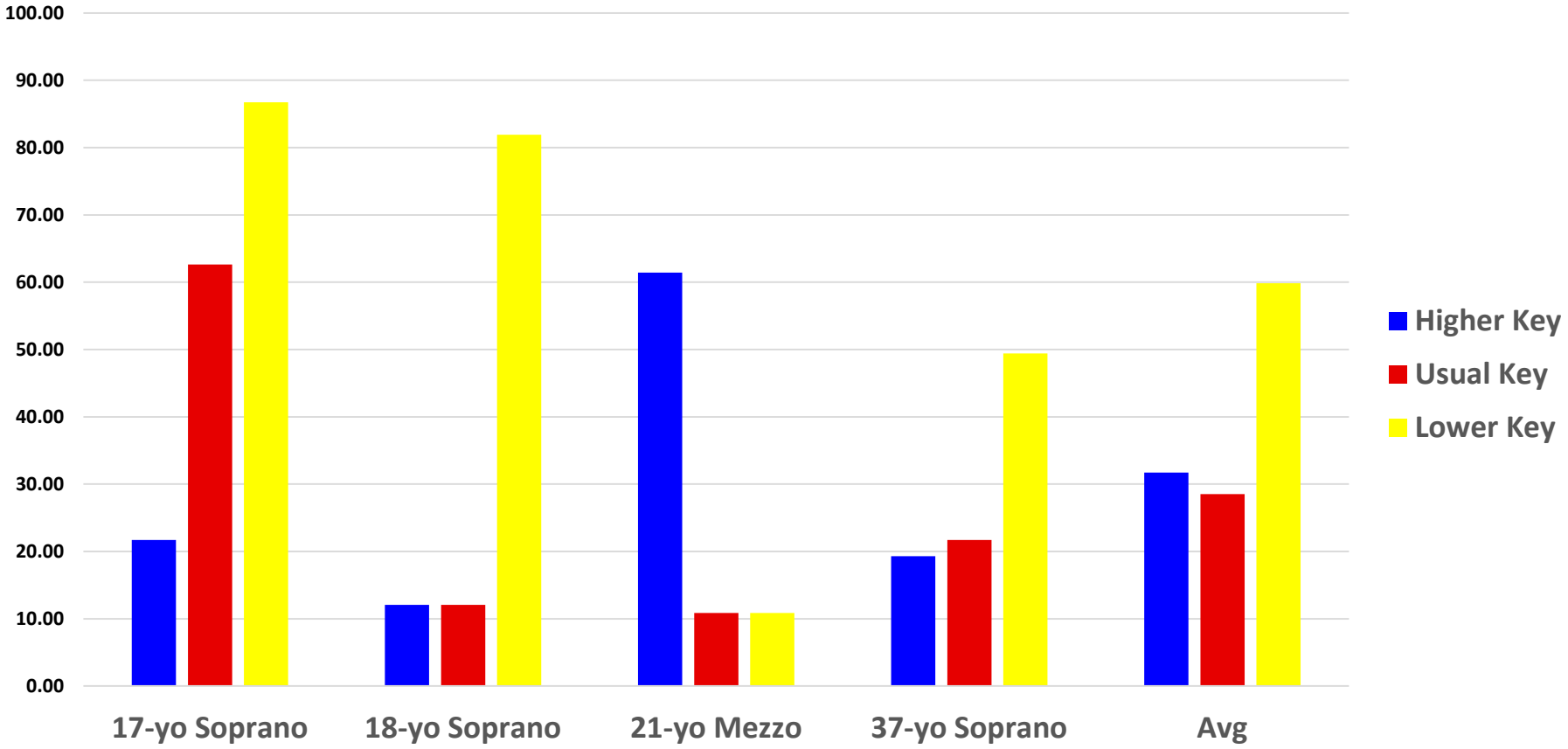
Register Transitions - Self Perception

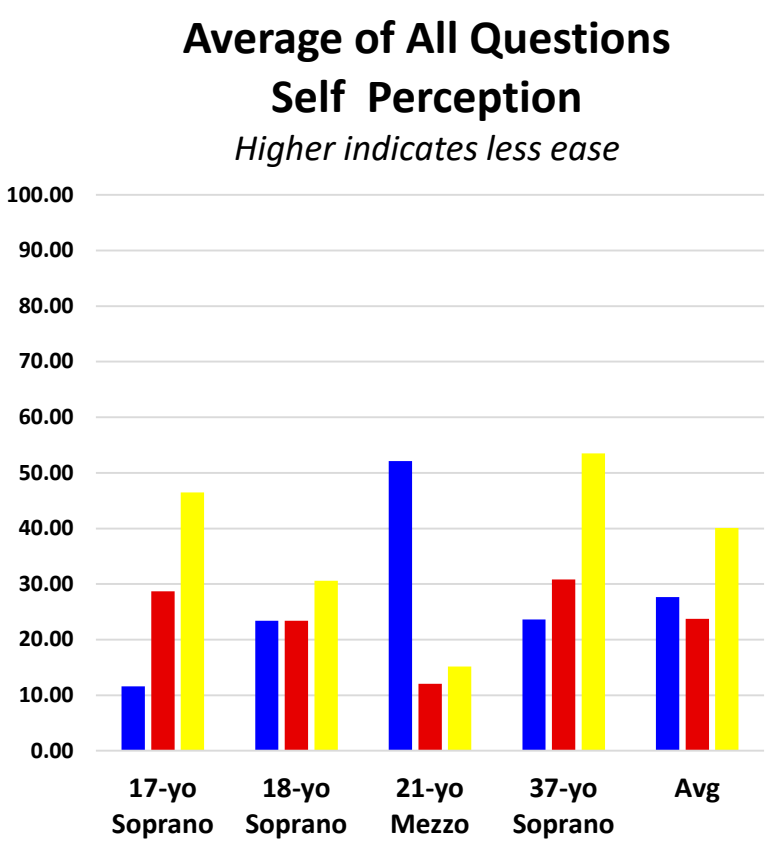
Higher indicates less ease

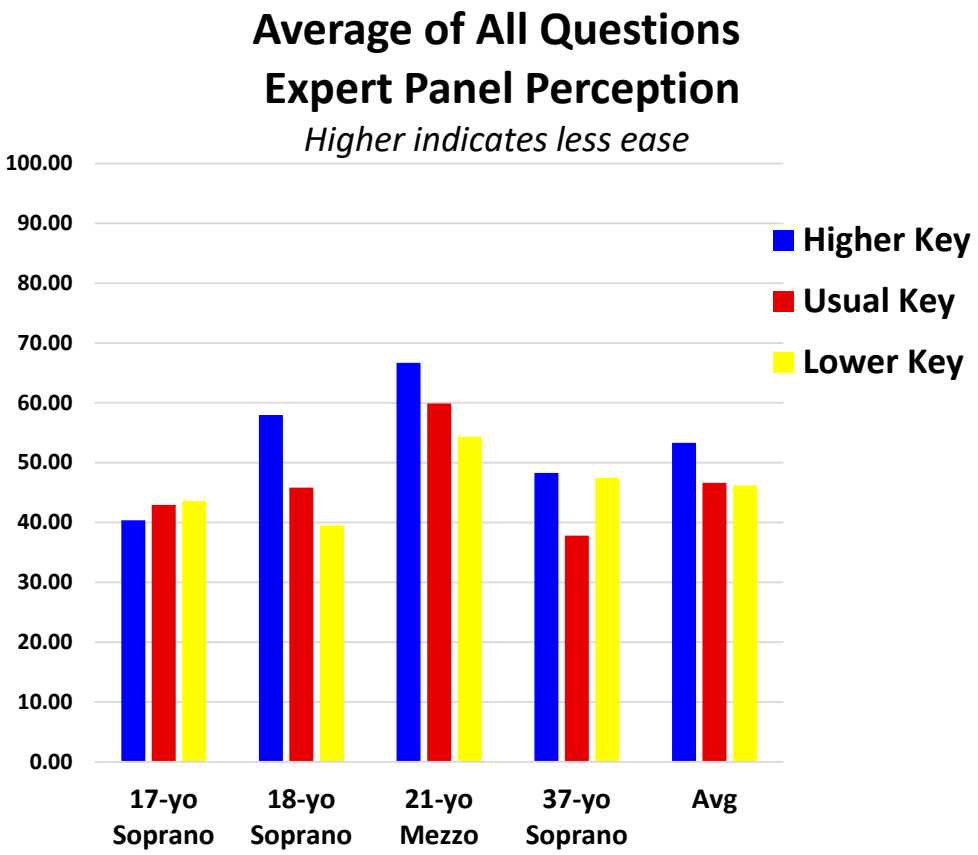


Expert Panel Inter-Rater Reliability

	Intraclass Correlation/ Cronbach's Alpha	95% Confidence Interval		F Test		
		Lower Bound	Upper Bound	Value	df1	df2
Overall Ease of singing	.612	.108	.873	2.579	11	44
High Notes	.736	.391	.913	3.782	11	44
Low Notes	.392	-.400	.800	1.644	11	44
Register Transitions	.239	-.752	.750	1.314	11	44
Weight	.598	.075	.868	2.487	11	44
Average	.473	.228	.658	1.898	59	236

Singer Perception vs Panel Perception





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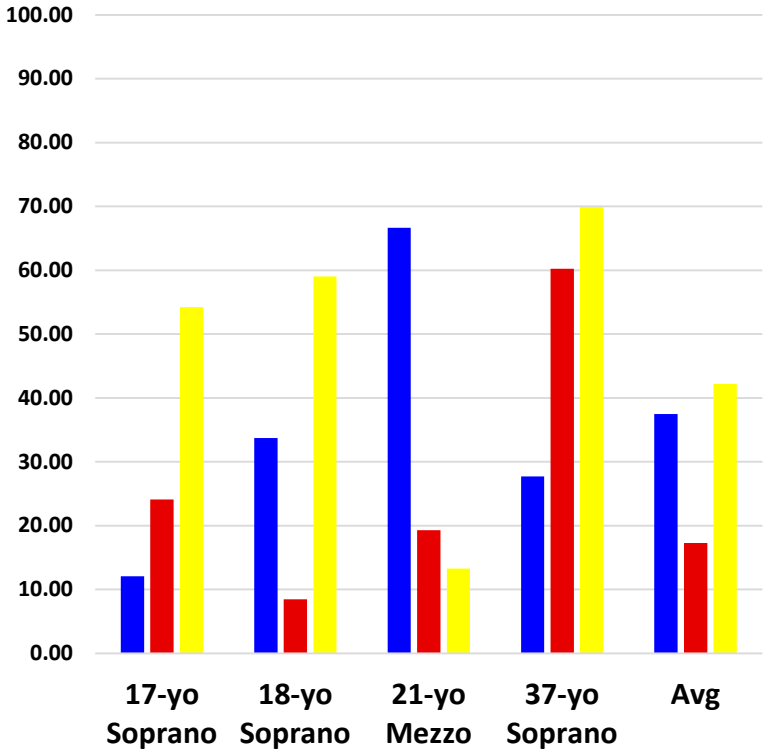
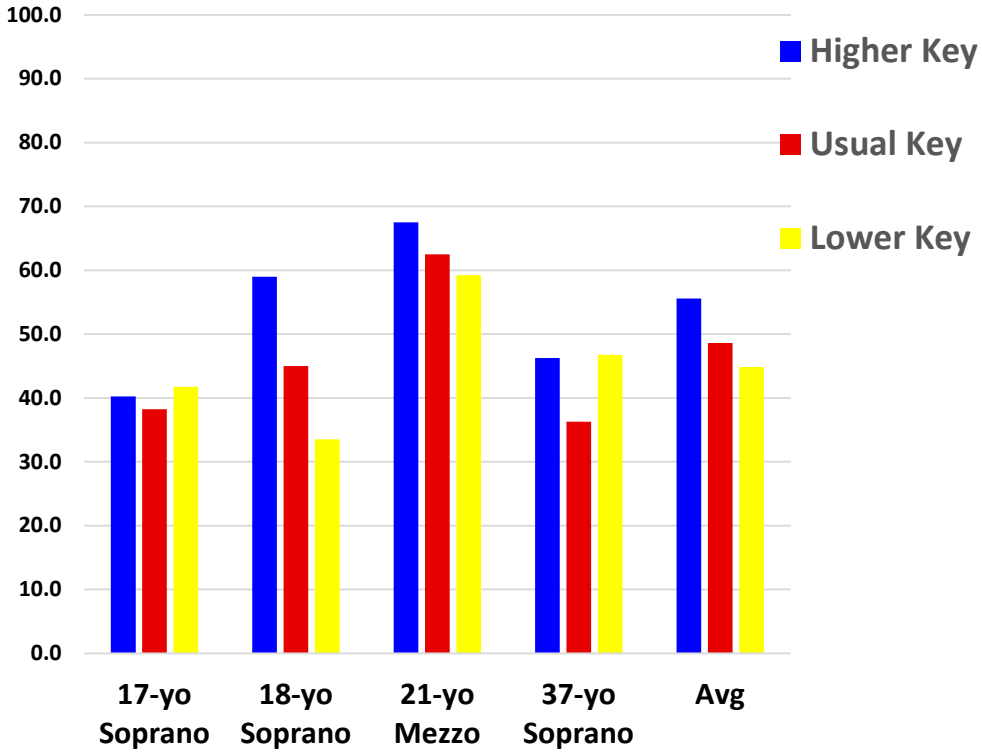
Overall Ease in Singing
Self Perception

Higher indicates less ease



Overall Ease in Singing
Expert Panel Perception

Higher indicates less ease



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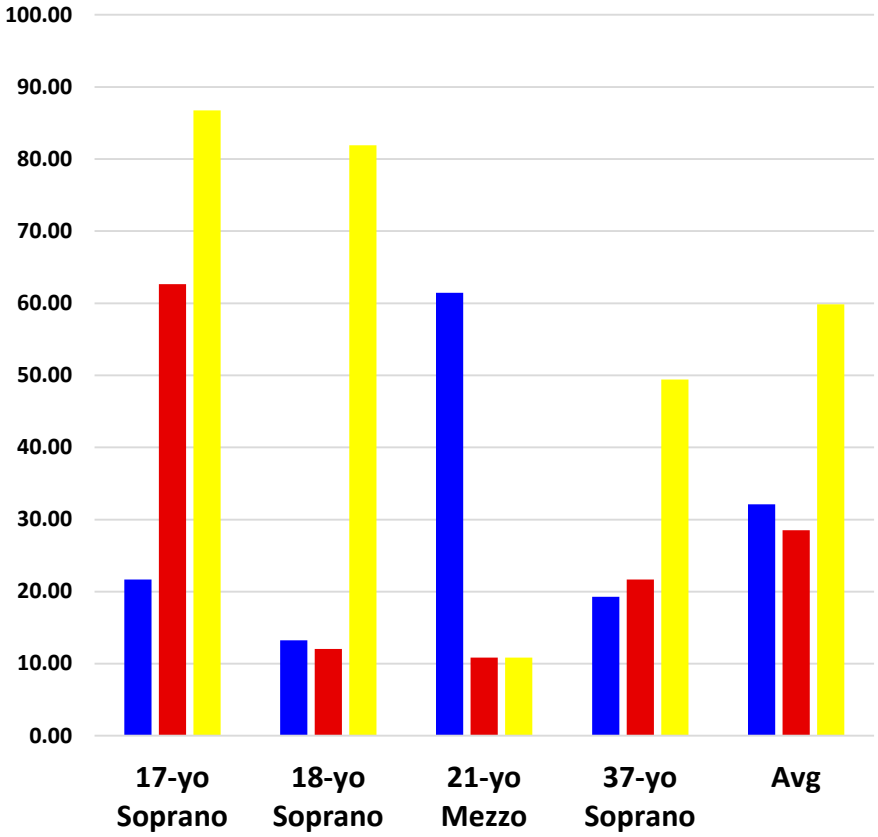
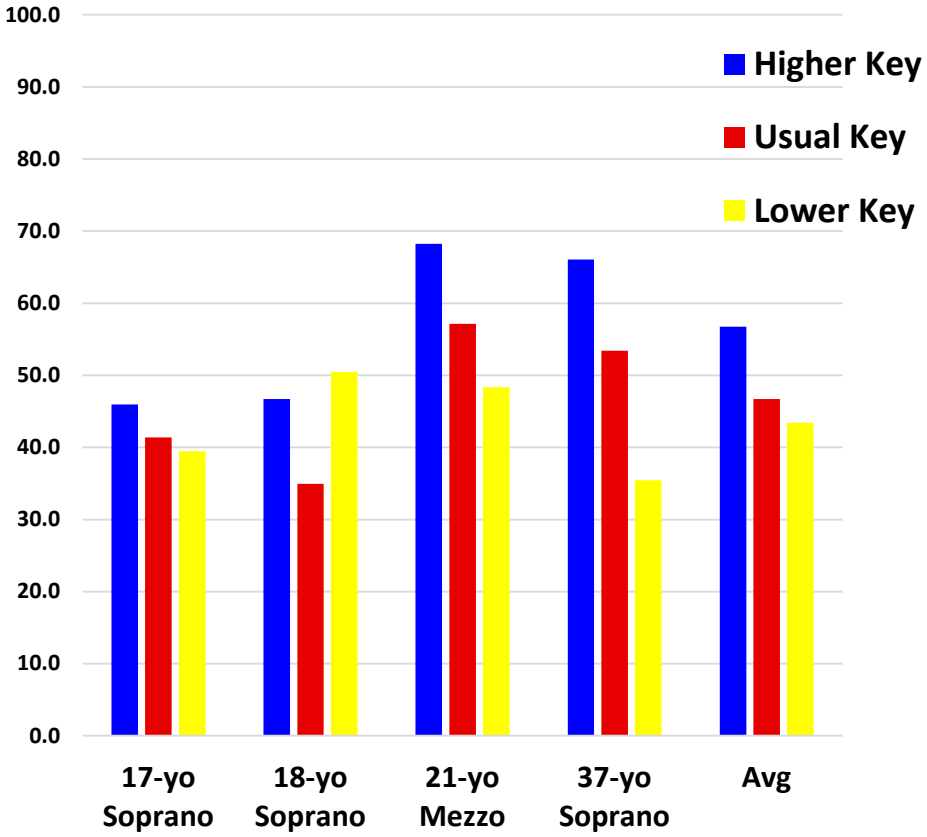
Register Transitions
Self Perception

Higher indicates less ease

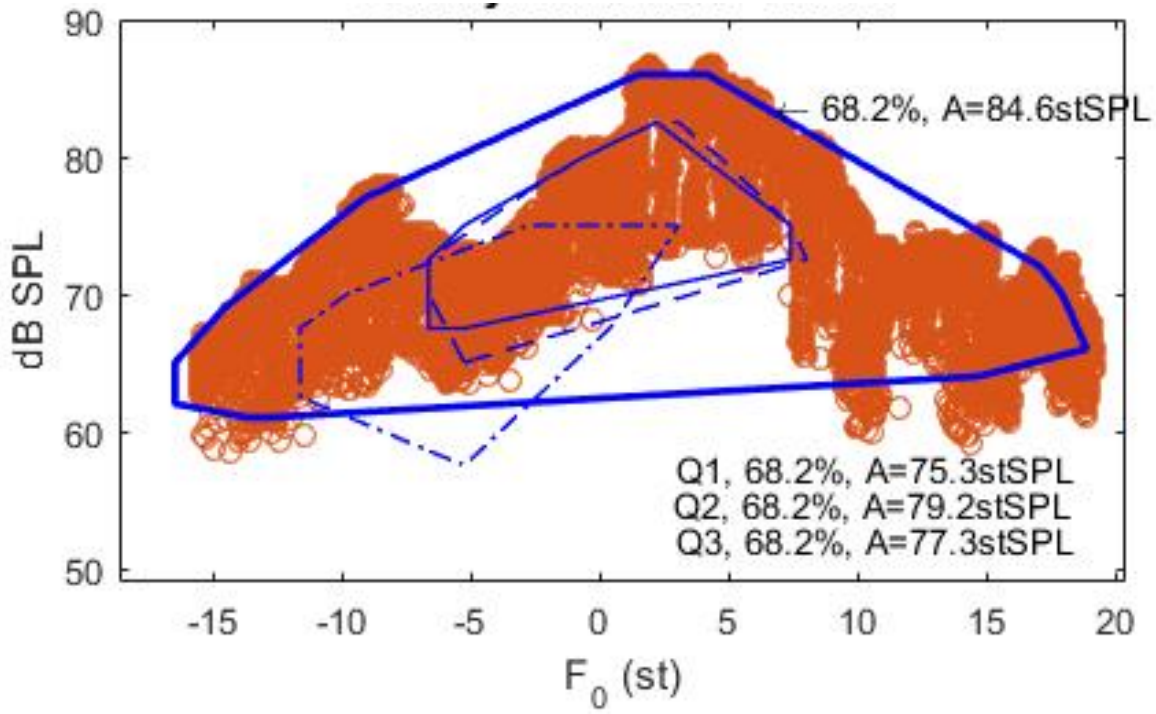


Register Transitions
Expert Panel Perceptions

Higher indicates less ease

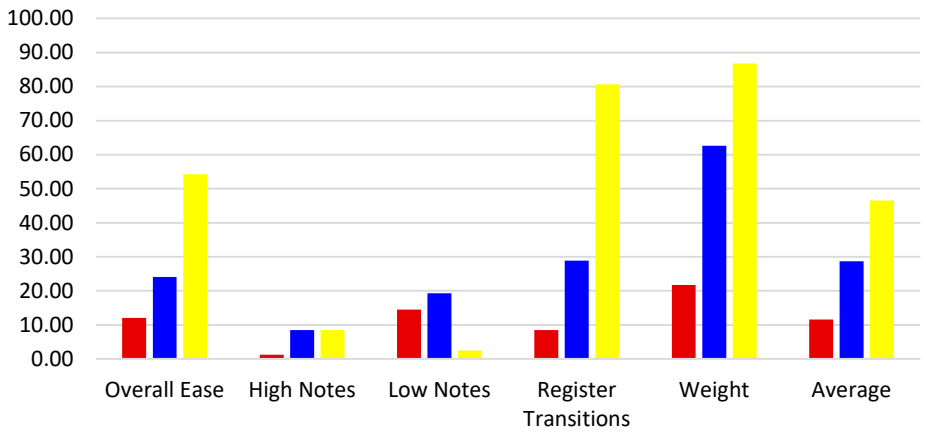


Singer 1 (17yo Soprano) – VRP/SRP Areas vs Perception

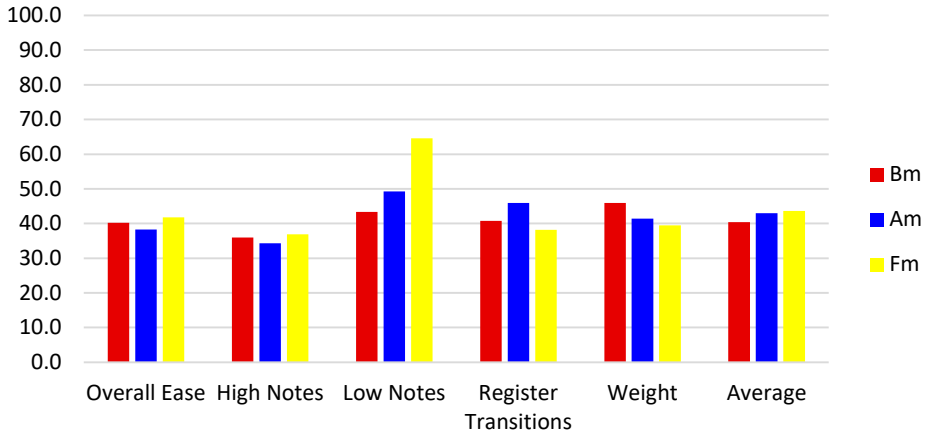


VRP
Bm
Am
Fm

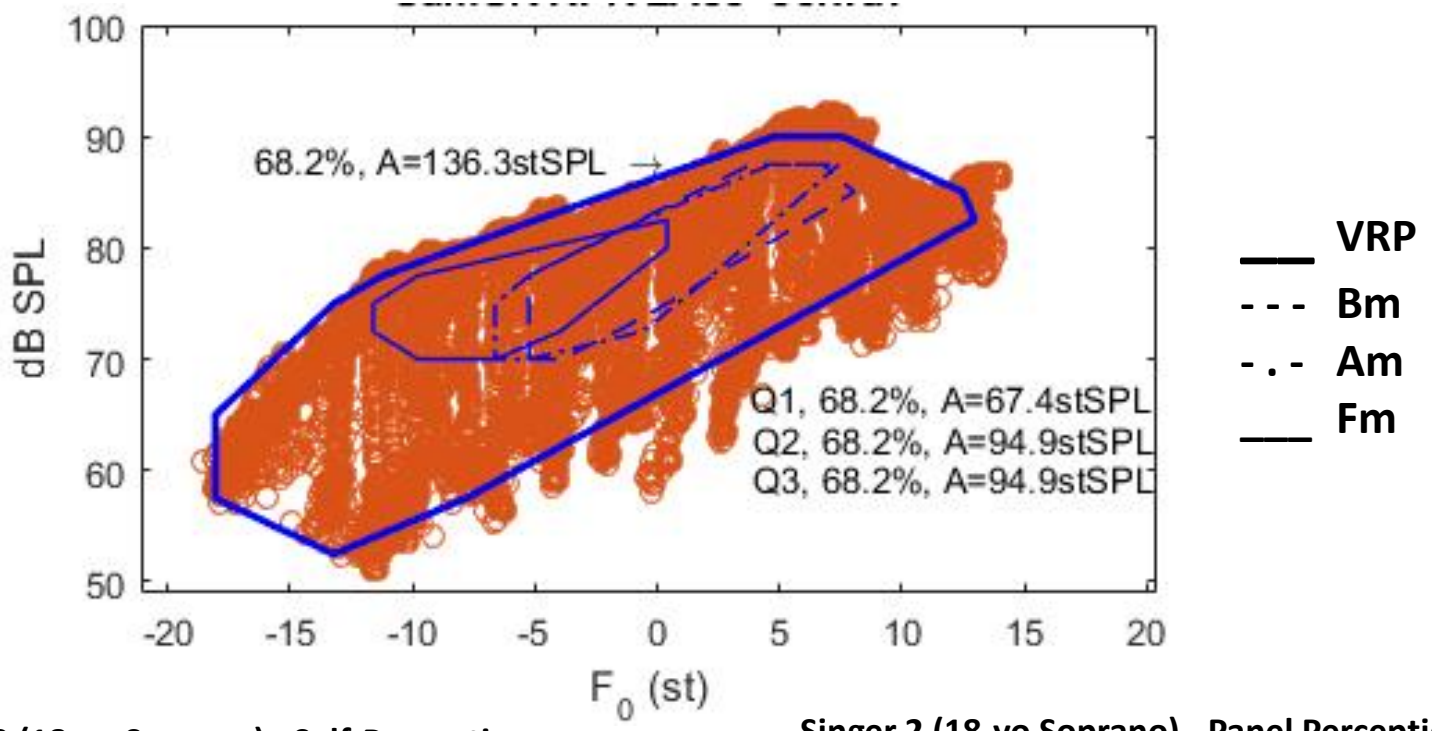
Singer 1 (17-yo Soprano) - Self-Perception
Hgher indicates less ease in singing



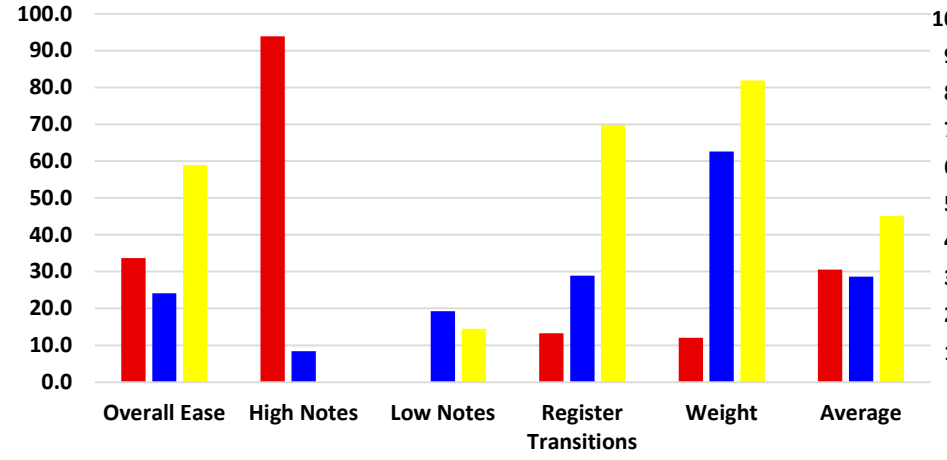
Singer 1 (17-yo Soprano) - Panel Perception
Hgher indicates less ease in singing



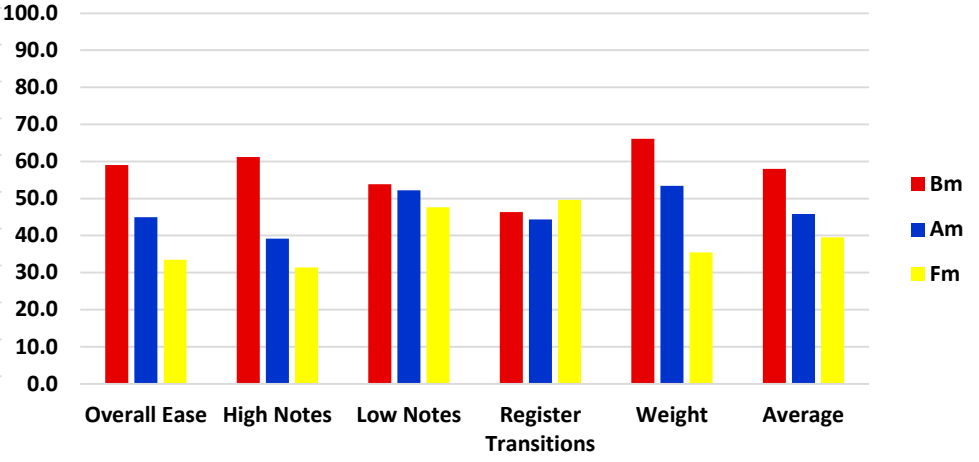
Singer 2 (18-yo Soprano) - VRP/SRP Areas vs Perception



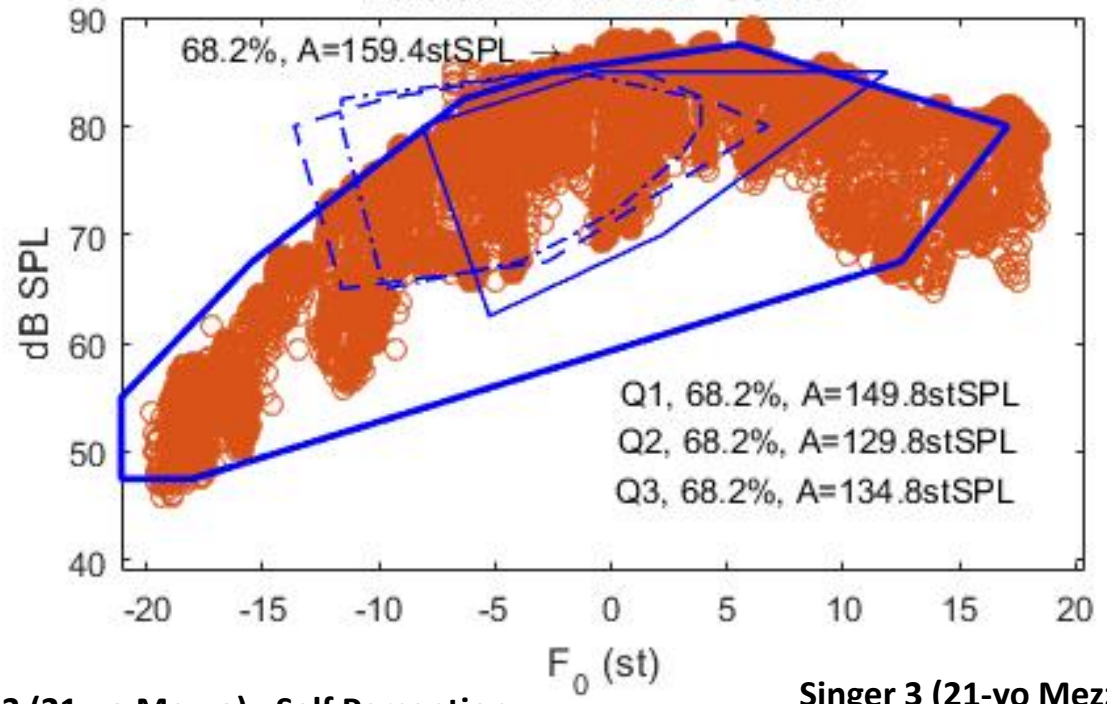
Singer 2 (18-yo Soprano) - Self-Perception
Higher indicates less ease in singing



Singer 2 (18-yo Soprano) - Panel Perception
Higher indicates less ease in singing

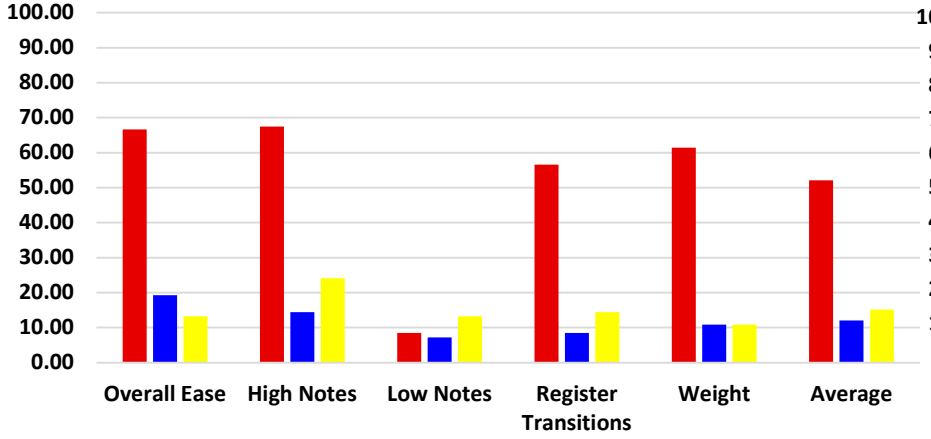


Singer 3 (21-yo mezzo) – VRP/SRP Areas vs Perception

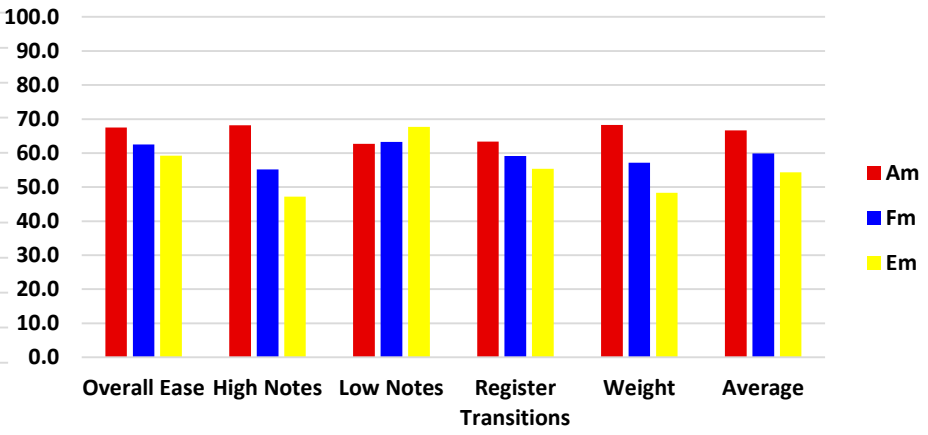


VRP
Am
Fm
Em

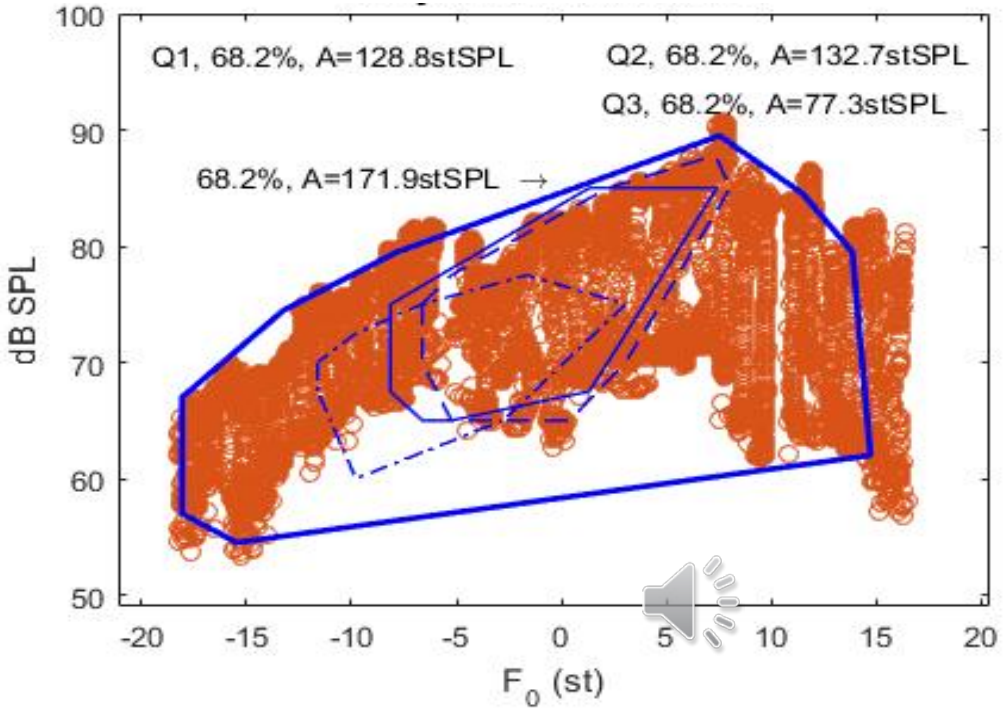
Singer 3 (21-yo Mezzo) - Self Perception
Higher indicates less ease in singing



Singer 3 (21-yo Mezzo) - Self-Perception
Higher indicates less ease in singing

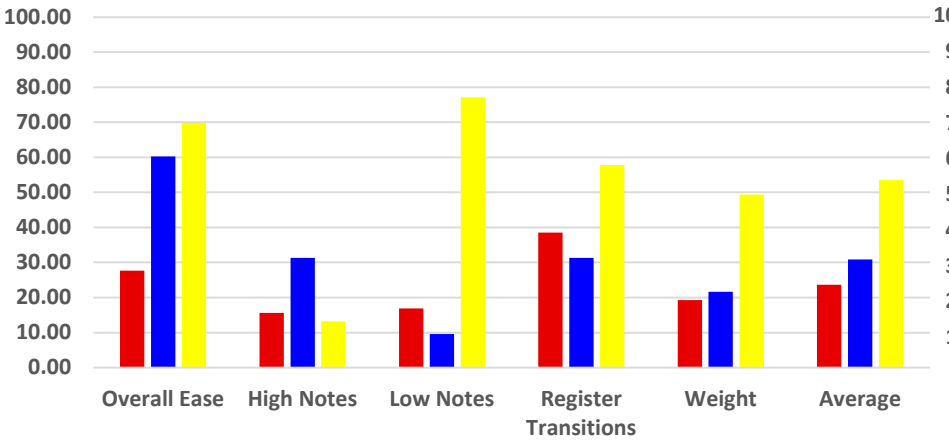


Singer 4 (37-yo Soprano) – VRP/SRP Areas vs Perception

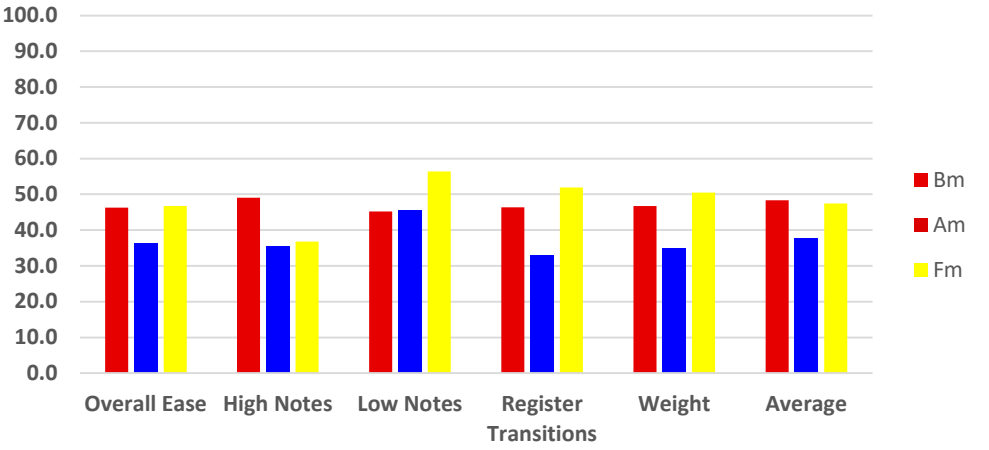


VRP
Bm
Am
Fm

Singer 4 (37-yo Soprano) - Self-Perception
Higher indicates less ease in singing



Singer 4 -(37-yo Soprano) - Panel Perception
Higher indicates less ease in singing



Limitations

Small number of participants & small expert panel – no statistical validity

Dosimeter may have missed a small amount of voicing activity

More investigation on the relationship between vocal fold contact measurement (dosimeter) and acoustic measurement (audio) is needed

Discussion

Score-based tessituragram aligned well with dosimetry-based tessituragram – Score-based tessituragrams do have a practical application

Singer Self-Perception aligned well with the VRP/SRP Comparisons

Expert Panel Perception showed little inter-rater reliability or alignment with singer perceptions or VRP/SRP comparisons

Score-based tessituragrams aligned with singer VRP's show promise in repertoire selection

Disclosure

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Lynn Maxfield and Ingo Titze

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