

**Acoustic and Perceptual Impacts of Straw Phonation Exercises on
Barbershop Quartets:
A Pilot Study**

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Module 6 Project Presentation
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Introduction

Background

- My area of voice pedagogy practice/research interest is barbershop ensemble singing
- Previous research has shown that straw phonation (SP) may improve vocal economy in both speech and singing, including choral ensemble singing (Manternach and Clark, 2018; Manternach and Daugherty, 2019; Manternach, Kotsonis, and Mann, 2022; Manternach, Schloneger, and Maxfield, 2019).
- Only one previous study researched SP in the context of barbershop chorus (BC) singing (Manternach and Clark, 2018), and no known research to date has studied the impact of SP on barbershop quartet (BQ) singing.



VOCAL
CONFLUENCE

Introduction (cont.)

Background (cont.)

- Most barbershoppers are avocational singers who lack substantial vocal training outside of their barbershop experience (Gongaware, 2025)
 - Barbershop singers in general may substantially benefit from improving their baseline vocal efficiency, and therefore potentially from practicing SP
- BQ singers anecdotally may benefit even more from improved vocal efficiency than BC singers:

BC Singers

- Typically one of multiple voices in a section (Barbershop Harmony Society Contest and Judging Committee, 2025)
- May practice stagger breathing throughout a song and strategically opt out of notes that are in uncomfortable parts of their voices

BQ Singers

- Only individual in ensemble singing their voice part
- Must sustain every note in the arrangements they perform, and therefore must approach breathing in a way that permits this (Barbershop Harmony Society Contest and Judging Committee, 2025)

Introduction (cont.)

Aims and Objectives

Aims

1. To generate pilot data on the impact of SP on various aspects of BQ singing including the following:
 - Singers' perceptions of their individual vocal effort (VE) level
 - Singers' perceptions of the feeling and sound of their individual singing
 - Singers' perceptions of their quartet's sound
 - Long-term average spectrum of BQ sound
 - BHS Singing score awarded to a BQ performance
2. To investigate how the impact of straw phonation on BQs may vary based on the following potential factors:
 - Quartet Classification (Men's, Mixed Harmony, and Women's)
 - Barbershop Voice Part (Tenor, Lead, Baritone, and Bass)
 - Previous SP experience
 - Use of semi-occluded vocal tract exercises (SOVTEs) in vocal warm up

Objectives

1. Identify potential benefits of SP for BQ singers to justify its use as a vocal exercise in BQ settings
2. Identify how SP impacts may vary across different groups of barbershop singers and BQs
3. Identify potential future research opportunities to build on this study's findings

Methodology/Methods

Philosophical Foundation

- The definition of vocology - “the science and practice of voice habilitation” (Titze and Verdolini Abbott, 2012, p. 11) - implicitly acknowledges that voice training is not an objective science.
- The artistic nature of barbershop singing voice adds an additional layer of subjectivity to my practice and research.
- Pragmatism is well-suited for practice-based research on barbershop voice pedagogy, as it prioritizes research that helps improve pedagogical practice and acknowledges value in both quantitative and qualitative research methods (Denscombe, 2010).
- Given this blend of art and science in my practice and research, this study is also grounded in a constructivist epistemology, valuing both objective measures of and subjective interpretations of reality (Pretorius, 2024).

Methodology/Methods

Inclusion Criteria

Quartet Participants (n = 20)*

- Established BQs
- All participants at least 18 years old
- All participants attest they are vocally healthy and not experiencing any vocal pain or discomfort

*5 quartets with non-overlapping membership participated, for a total of 20 singers

- One Men's
- Two Mixed Harmony
- Two Women's



Expert Listener Participants (n = 6)

- Certified Barbershop Harmony Society (BHS) Singing judges
- All participants at least 18 years old



Methodology/Methods (cont.)

Research Questions and Methods

This study approached the following research questions:

What impact does a brief straw phonation regimen have on...

- ...BQ singers' perceptions of their individual VE level?
- ...BQ singers' perceptions of the feeling and sound of their individual singing?
- ...BQ singers' perceptions of their quartet's sound?
- ...long-term average spectrum (LTAS) of BQ sound?
- ...the BHS Singing score awarded to a BQ performance?

To answer these questions, I conducted a mixed-methods study consisting of the following methods:

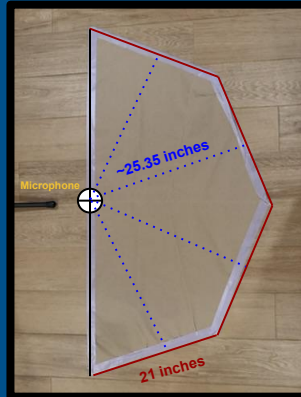
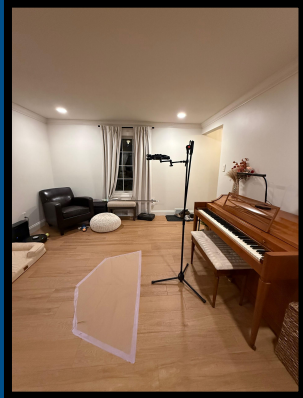
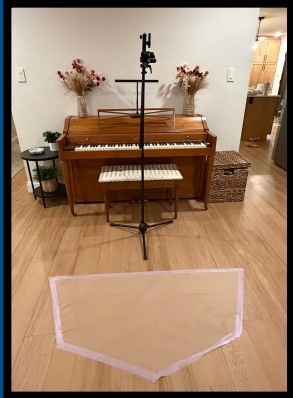
- Literature Review
- Quasi-Experiment
- Survey



Data Collection

Quartet Experimental Protocol

- Quartet participants were given 15-minutes to warm up while I set up my equipment
 - ZOOM H6 Studio recording device with 19.4 mm large diameter stereo X-Y microphones (for audio recording)
 - Triplet SLM600 sound level meter (for SPL calibration)
 - Spacing markers based on standard BHS contest microphone setup (Brooks, 2026)

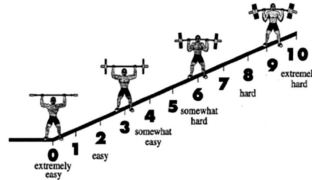


Data Collection (cont.)

Quartet Experimental Protocol (cont.)

- Quartets stood with standard spacing and sang one entire barbershop song from their repertoire, which I audio-recorded.
- Each quartet singer answered a two-question survey on their experience to that point in the experiment:

1. Based on the scale below, circle the number (0-10) that indicates how much effort, strain, discomfort, and/or fatigue you perceived when using your voice during your first performance?



2. Please describe how you warmed up before your first performance.

Data Collection (cont.)

Quartet Experimental Protocol (cont.)

- I demonstrated a 4.5-5 minute long SP protocol similar to that outlined in Titze (2010):
 - Six vocal glides from low to high to low range and then high to low range, without accents
 - Five vocal glides from low to high to low range and then high to low range, with increasing number of accents
 - Perform 'The Star-Spangled Banner' through straw in the key of A-major
- Key Difference: All participants used a standard drinking straw (7.625 in./19.37 cm length, 0.25 in./6 mm diameter)
 - Previous studies instead used a narrower stirring straw
 - I chose to use a standard drinking straw based on its relatively moderate level of back-pressure as observed in Maxfield *et al.* (2014) and supporting anecdotal evidence.

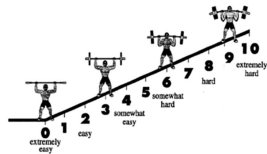


Data Collection (cont.)

Quartet Experimental Protocol (cont.)

- After completing the straw phonation protocol, quartets again sang the same repertoire song from the same standing positions.
- Following the post-straw phonation performance, each quartet singer completed another survey on their experience
 - VE Rating scale chosen was OMNI Vocal Effort Scale (OMNIVES) (Shoffel-Havakuk, 2018) based on demonstrated effectiveness in measuring VE, as well as simplicity

3. Based on the scale below, circle the number (0-10) that indicates how much effort, strain, discomfort, and/or fatigue you perceived when using your voice during your second performance?



4. In terms of overall quartet sound, how do you think your first performance compared to your second performance? Circle your response below.

- The overall quartet sound was better during the first performance than during the second performance.
- The overall quartet sound was better during the second performance than during the first performance.
- I did not notice a difference in the overall quartet sound between the first and second performances.

5. Did you observe any differences between your first and second performances? If so, please explain what you observed and what you think may have contributed to these differences.

6. Please rate how much you think the straw exercise regimen impacted each of the following:

	Not at all ←————→ Very much										
The overall quartet sound	0	1	2	3	4	5	6	7	8	9	10
The sound of your individual singing	0	1	2	3	4	5	6	7	8	9	10
The feeling of your individual singing	0	1	2	3	4	5	6	7	8	9	10

7. If you perceived changes in the overall quartet sound after the straw exercise regimen, please describe the changes you perceived.

8. If you perceived changes in your individual singing after the straw exercise regimen, please describe the changes you perceived.

9. Have you done straw-based vocal exercises before participating in this experiment? Circle your response below.

- Yes
- No
- I am not sure

Data Collection (cont.)

Expert Listener Ratings

- Following quartet data collection, I sent quartet recordings to expert listeners for their review
 - Recordings were pseudonymized and were not attributed to any quartet or individual singers
 - Each quartet's pre-SP recording and post-SP recording were included (10 total recordings), but expert listeners were not told which was which
 - The presentation order of the recordings was the same for each expert listener, but was randomized
- Each expert listener participant reviewed each recording and submitted a Singing Score (0 - 100) (BHS Society Contest and Judging Committee, 2025)

SINGING

Song 1: _____

10 20 30 40 50 60 70 80 90 100

D C B A

Not in tune Impure vocal quality Not a unit No expression	Rarely in tune Deficient vocal quality Rarely a unit Rare expression	Sometimes in tune Satisfactory vocal quality Sometimes a unit Some expression	Frequently in tune Pleasing vocal quality Frequently a unit Frequent expression	Consistently in tune Excellent vocal quality Consistently a unit Consistent expression
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Information

includes (1/4) _____ # / % _____

Vocal Quality

support _____

flow _____

accent _____

staying _____

vibrato/tremolo _____

bright, vibrant, cool _____

soft/low, dark, husky _____

theory, over-sung _____

timbre _____

suitable to performer _____

Style

single voices _____

word sound match _____

balance _____

ensemble _____

ding/expiration _____

attack, release _____

articulation _____

flow _____

pronunciation _____

articulation _____

Vocal Expression

emotion _____

word sounds _____

tone color _____

inflection _____

believable emotion _____

Penalty or forfeiture: _____ Amount: _____

Song 1 Score: _____

Strengths: _____ Areas to Improve: _____

CJ-25 08/26/25

Ethical Considerations

Standard Research Ethics Considerations

- University of Wales Trinity Saint David provided ethical approval before I contacted potential participants
- All participants provided informed consent before participating
- I only collected data related to the study's research questions
- Raw data are stored in password-protected locations accessible only to me and will be deleted upon project completion
- To protect quartet participant privacy, recordings were pseudonymized before sharing securely with expert listeners
- All instructions and survey questions were worded neutrally to avoid influencing participant responses
- I critically analyzed each phase of the study and identify factors that may have influenced the results, as well as areas of improvement for potential future studies.

Ethical Considerations (cont.)

Insider Research Considerations

- I have relationships with all participants that predate the study, including working with many as a chorus director, coach, and/or judge which could create an unintentional power dynamic or the desire for participants to provide answers
- I ensured participants that they were under no obligation to answer every question, participate in every task, or even participate in the study at all if they were uncomfortable doing so.
- I asked each participant to answer each question candidly and honestly, and did not discuss any hypotheses or prior expectations I had with participants before data collection
- I attempted to put aside any expectations or assumptions I had about what the results would look like going into the experiment and rather let the data speak for themselves.

Findings/Discussion

Self-Perceived Vocal Effort Level

Figure 1: QP Perceived SP Impact - Quantitative Summary

	n	Mean Pre-SP Vocal Effort	Mean Post-SP Vocal Effort	Mean Pre-to-Post SP Change	p-value ^a	% Post-SP Performance > Pre-SP Performance	SP Impact on Quartet Sound	SP Impact on Individual Sound	SP Impact on Individual Feeling
Overall									
Overall	20	5.55	3.70	-1.85	0.000***	95.00%	6.45	6.35	7.45
Voice Part									
Tenor	5	5.40	4.80	-0.60		100.00%	6.40	6.40	6.80
Lead	5	5.80	3.20	-2.60		100.00%	7.60	8.00	9.00
Baritone	5	6.60	3.80	-2.80		100.00%	7.20	6.80	7.40
Bass	5	4.40	3.00	-1.40		80.00%	4.60	4.20	6.60
Voicing									
Women's	4	5.00	3.50	-1.50		100.00%	6.00	6.25	7.25
Mixed Harmony	8	5.75	3.88	-1.88		100.00%	6.25	6.50	7.75
Men's	8	5.62	3.62	-2.00		87.50%	6.88	6.25	7.25
Previous Experience with SP									
Yes	16	5.75	3.50	-2.25		100.00%	6.62	6.56	7.62
No/Not Sure	4	4.75	4.50	-0.25		75.00%	5.75	5.50	6.75
Did SOVTE in Warmup									
Yes	9	5.22	3.22	-2.00		100.00%	6.11	5.78	7.56
No	11	5.82	4.09	-1.73		90.91%	6.73	6.82	7.36

^a***p < 0.001 (Overall Paired t-test) – t-tests not done within subgroups due to small sample size

- SP may reduce VE in BQ singers, with 85% of QPs (n = 17) reporting such a decline in their OMNIVES between their pre-SP and post-SP performances, as well as freer and easier singing with lower levels of effort being a common theme in QPs' open-ended comments.

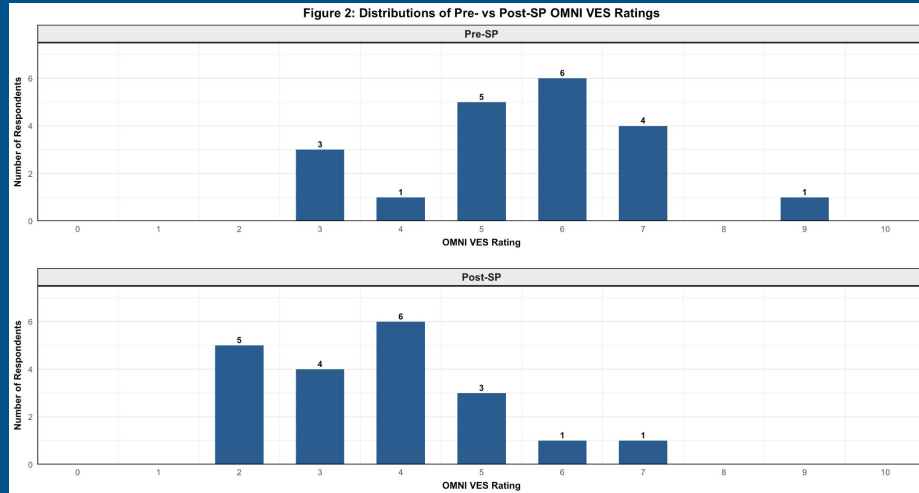
"I felt less vocal strain and sang more relaxed during the second performance..."

"I actually had to pay attention more because the ease of singing kept distracting me."

- Those with previous SP experience (n = 16) may perceive a larger VE decrease, than those without prior SP experience (n = 4).
 - Possibly due to biases influenced by previous knowledge or education on SOVTEs and their potential benefits
- SP with a drinking straw may reduce VE level regardless of the singer's quartet voicing and whether they include SOVTEs in their vocal warm up routine, pointing to a broad potential impact.

Findings/Discussion (cont.)

Self-Perceived Vocal Effort Level (cont.)



Leftward shift in OMNIVES distribution demonstrates average decline in VE from pre-SP to post-SP

- Middle voices ($n = 10$) - reported the largest average OMNIVES decreases, and all non-tenors ($n = 15$) reported a decreases in their OMNIVES pre-SP to post-SP, while 60% of tenors ($n = 3$) reported increases.
- The higher impact for inner voices aligns with my anecdotal experience as I have seen SP and other SOVTEs be particularly impactful for singers experiencing vocal inconsistency through register transitions.
 - Baritones and leads in barbershop are more often singing in a part of their range that requires transitioning between registers than basses or tenors
- Standard drinking straws may be more likely to increase effort in BQ singers who sing in higher ranges and/or who primarily utilize lighter vocal mechanisms like falsetto than in singers who sing in lower ranges and/or primarily utilize heavier vocal mechanisms like chest/modal voice.

Findings/Discussion (cont.)

Perceived Differences from Pre-SP to Post-SP

95% of respondents (n = 19) felt their quartet's post-SP performance was better than their pre-SP performance

- Most respondents (n = 11) mentioned a sense of freer and easier singing and/or lower VE post-SP
- Many (n = 8) also mentioned a sense of more unified quartet vowels/resonance and a greater sense of chord ringing
- One quarter (n = 5) mentioned a sense of improved breath management/support
- Perceived differences were mostly but not unanimously positive

"I felt less vocal strain and sang more relaxed during the second performance..."

"I actually had to pay attention more because the ease of singing kept distracting me."

"A lot more chords were locking in the second half of the song during the second run as compared to the first"

"The second run felt louder, even though I'm not sure it was. Our resonance was much more unified."

"I exerted much less vocal effort in my throat the second performance and felt less like I was running out of breath"

"I felt more in control of my breath and it felt like it was easier to manage my breath through the end of the phrase"

"Initially I felt myself working harder...soft took a little more effort than louds."

"...The straw exercises...caused a bit of muscle fatigue."

Findings/Discussion (cont.)

Perceived Impact of SP on Quartet Sound (cont.)

- Most respondents felt their quartet had improved resonance and vowel unity across the quartet and/or more chord ringing (n = 12) after SP.
- Nearly half (n = 9) noted that the post-SP quartet sound felt freer, easier and/or less effortful.
- 20% of respondents (n = 4) also felt their quartet's intonation improved post-SP.
- Some reported observations were neutral or negative in sentiment.

"The blend felt better, ringier."

"I felt that it was more locked in as a unit after the straw exercise. Overall better."

"We...sounded less labored and more relaxed after the straw exercises."

"I perceived voices sounding smoother and seemingly requiring less effort."

"We barely dipped in pitch, which is often a major hurdle for us."

"Focused on my sound."

"It felt like we...weren't as unified as we typically are."

"Our sound became slightly harder to control in the beginning because we were used to working harder than we needed to. As we adjusted, the sound rang/tuned better."

Findings/Discussion (cont.)

Perceived Impact of SP on Individual Voice (cont.)

- Most singers felt their own singing was freer and easier singing with lower VE after SP (n = 12).
- One fifth (n = 4) noted that transitioning between different parts of their vocal range and/or between different pitches was easier in their post-SP performance.
- Not all observations were strictly positive, with some singers reporting neutral or negative observations.

"I used less effort and was more relaxed throughout the performance."

"I felt like I was singing more efficiently (i.e. more vocal fold closure with less tension)."

"Felt a little smoother from top to bottom off range, fewer 'bumps'"

"Easier transition between notes, especially from chest to head tone."

"I felt that overall vocal production was more difficult for me...slightly more difficult but not significant."

"It made me aware of the muscles being used."

"I didn't notice much of a difference in the feeling of my own singing."

"I struggled between singing more smoothly, losing stamina, breathing."

Findings/Discussion (cont.)

LTAS

Figure 8: LTAS t-Testing Data

Quartet	Frequency Range (kHz)	dB SPL Difference (Post-SP vs. Pre-SP)	p-value	Significance [†]
Quartet 1	0 - 10	0.97267	0.00000	***
Quartet 1	2 - 4	1.07067	0.01264	
Quartet 2	0 - 10	0.34898	0.20173	
Quartet 2	2 - 4	-0.86909	0.03847	
Quartet 3	0 - 10	-1.41303	0.00000	***
Quartet 3	2 - 4	-0.9621	0.03881	
Quartet 4	0 - 10	-1.78314	0.00000	***
Quartet 4	2 - 4	-2.33842	0.00000	***
Quartet 5	0 - 10	-0.6551	0.00000	***
Quartet 5	2 - 4	-1.18194	0.00074	***

[†] ***p < 0.001 (0.01 Significance Level with Bonferroni adjustment for 10 simultaneous t-tests)

- Like similar previous studies such as Manternach and Clark (2008), I analyzed LTAS data for each quartet recording in the 0-10 kHz and 2-4 kHz frequency ranges.
- LTAS differences between pre-SP and post-SP performances were variable across quartets.
 - In the 0 - 10 kHz range, four quartets had average dB SPL changes that were statistically significant (three decreases and one increase)
 - In the 2 - 4 kHz range, two quartets experienced dB SPL decreases that were statistically significant
- Variability likely due to choice of drinking straw (more moderate level of oral pressure) vs. stirring straw used in predecessor studies (more extreme level of oral pressure) (Maxfield *et al.*, 2014)

A Contradiction?

Quartet Perceptual Data vs. LTAS

Some members of Q2, Q3, and Q4 felt their sound was overall louder and/or ringier, which seemingly contradicts their quartets' LTAS results which showed lower intensity levels across wide frequency ranges that were likely perceptible.

- Raises questions:
 - Do quartet singers may have a fundamentally different perception of their quartet's sound in-the-moment from outside listeners?
 - Is in-the-moment self perception of ensemble sound a meaningful outcome to consider in future research?
- In a contest setting, quartet singers' perception of their own ensemble sound is certainly less practically relevant than others studied, since in a contest setting only the Singing Judge's perception of a quartet sound impacts the Singing score (BHSSCJC, 2025).



Findings/Discussion (cont.)

BHS Singing Scores (cont.)

Figure 9: ELP Singing Scores by Quartet

Pre-SP vs. Post-SP

Quartet Name	Pre-SP Mean Score	Post-SP Mean Score	Mean Score Difference
Quartet 1	66.00	67.67	1.67
Quartet 2	68.83	65.67	-3.17
Quartet 3	72.17	73.83	1.67
Quartet 4	70.67	68.17	-2.50
Quartet 5	75.00	76.50	1.50

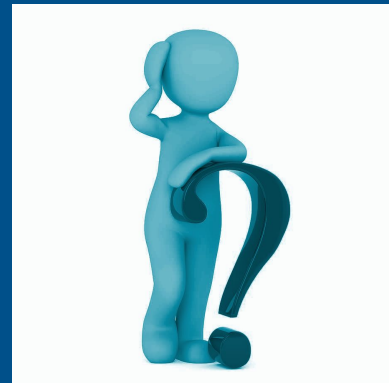
- BHS Singing Score changes from pre-post SP were also mixed, with three quartets seeing a mean score improvement and two seeing a mean score decline
- The increases (1.50-1.67 points) were relatively modest compared to the declines (2.5-3.17 points)
- The ELPs showed a fair amount of disagreement within the panel, only achieving unanimous agreement in the score change direction from pre-SP to post-SP for one quartet (Q2).
 - Can be impacted heavily by the listening device the listener is using, so some inconsistency is expected.

Findings/Discussion (cont.)

LTAS and BHS Singing Scores

There was no clear relationship between LTAS results and ELP Singing scores.

- One possible sufficient but not necessary condition to increase BHS Singing Score is to create noticeably more spectral between 2 - 4 kHz due to the perception of more expansion of sound.
 - Quartets 1 and 3 (score increase) had such an increase in part of the 2 - 4 kHz range
 - Quartets 2 and 4 (score decrease) did not have such an increase in any part of the 2 - 4 kHz range
 - Exception is Quartet 5, whose score increased without having such an increase in spectral energy
- Singing scores are influenced by more than just spectral energy, so there are many other factors that may have changed between performances that are not captured in LTAS measurements



Another Contradiction?

Quartet Perceptual Data vs. BHS Singing Scores

Quartet 2 and 4 had lower singing BHS Singing scores from the expert listeners in their post-SP performance, which the singers' unanimously felt sounded better

- Expert listeners did not provide rationale for their scores.
- BHS Singing score can be impacted by myriad different technical and artistic aspects of a performance
- Some quartet singers' opinions of which performance sounded better may change if they could listen back to a recording of both performances



Limitations

This study has a number of key limitations, including the following:

- Both participant samples are non-random, convenience samples
- Quartet data collection sessions did not occur in spaces that were designed for recording.
- Some QPs' standing positions may have shifted slightly throughout or between performances, altering their position relative to the microphone.
- BQs self-direct (i.e. no conductor), so the BQs studied may have consciously or unconsciously changed their approach to performing from pre-SP to post-SP
- Expert listeners were not given any instructions or restrictions on what type of listening devices they should use.
- Only quartets scoring in the B-range of the Singing Category, with average scores in this study ranging from 65.67 to 76.50 (BHSSCJC, 2025), were included.
- Only BHS-affiliated quartets participated and only the BHS scoring system was tested.
- Insider researcher considerations previously addressed



Recommendations/ Outstanding Questions

- SP with a drinking straw may be effective for lowering VE in BQ singers, especially for leads and baritones
 - This may not be an optimal level of pressure for basses or tenors, who should experiment with other SOVTEs to find one that is effective in their voice
- Research testing a variety of straw sizes and types, as well as other SOVTEs, could provide barbershop voice practitioners valuable insights that could inform their exercise recommendations in different scenarios.
- A separate line of research could be opened to more identify key acoustic drivers of BHS Singing score, which could provide BHS ensemble coaches and quartet singers who are interested in improving their Singing scores more objective acoustic targets to work toward.
 - This would potentially also provide more information on relationship between LTAS and BHS Singing Score
- Some lower-priority possible future research questions/topics include:
 - How reliable are ensemble singers' in-the-moment perceptions of their sound compared to expert listeners?
 - Additional research into the immediate impact of SP on BHS Singing Score



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