

Module 3
BMPF7008

Working and Learning: An introduction to Work-Based Higher
Education

Can changes in facial expression serve as a tool to improving tuning
competency in novice singers?

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Project proposal

1. Project title

Can changes in facial expression serve as a tool to improving tuning competency in novice singers?

2. The context

Historically, within a pedagogical setting, there is evidence to suggest that facial expression was considered an important contributor to overall voice quality, known as 'timbre' in music (Lamperti, 1877; Tosi, 1723). The advent of spectrographic technology in the 20th century has made it possible to analyse graphically, the harmonic features of a singer's voice and, as such, scientifically verify that facial musculature can alter the spectra of the voice (Bozeman, 2019; Miller, 1996, 2004; Nair, 1999). While the significance of facial expression on timbre is highlighted in pedagogical texts and research (Appelman, 1967; Chapman, 1981, Titze, 1981), there is limited evidence to suggest that it was specifically employed as a tool to improving tuning.

3. The justification

'Tuneful' singing is considered a foundational singing skill (Bunch-Dame, 2006). However, this often presents as a major challenge to improvement for beginner singers (Numminen et al., 2015). Therefore, evidence for techniques and tools that may improve tuning accuracy, could expedite learning. Within the context of the researcher's area of professional practice, one-to-one adult singing lessons, the historical verbal instruction (Mancini, 1774) to 'lift the cheekbones' or 'smile' has been observed to produce a perceptual improvement in tuning. This study aims to explore this observation within the context of existing research and by using spectrographic technology to capture and analyse the vocal spectra of individual singers while they are directed in changes in facial expression.

4. The intended impact

Rather than providing conclusive evidence, the research aims to improve understanding and provide transferable findings (Lincoln and Guba, 1985). These might include identifying language and methods that can be employed in the studio beyond the research setting and which may also hold value for the wider community of teachers.

5. The outlined intention

As singing involves a multitude of variables that are difficult to separate or conclusively measure (Herbst, 2016; Zhang, 2016), a pragmatic approach to allow for necessary flexibility will be undertaken. This mixed methodologies study will measure quantifiable changes in spectrographic outputs while singers employ varying facial expressions and solicit qualitative participant feedback in the form of a short interview.

The study will use a purposive convenience sample of 6-10 consenting adults at the early stages of learning.

The research will be undertaken between April to June 2024 and carried out in the researcher's private studio.

Methods

- A literature review of existing research relating to the impact of facial expression on tone and on spectrographic analysis of the singing voice along with research on poor pitch singing.
- Using Voce Vista software and a condenser microphone, the participant will record melodic patterns while using three prescribed facial postures.
- Participant feedback about the experience will be drawn from short semi-structured interviews, which may identify emergent themes and insights.
- Spectrographic analysis of the recorded pitch relative to the target pitch will be measured. Analytics per participant, per facial expression will be followed by comparisons of the effects of facial expression on each exercise and finally, statistics will be recorded between each facial expression over the whole experiment. The metric to be used is cents, with 100 cents representing 1/2 musical tone.

6. Ethics and insider research

Social situatedness is a key facet of insider research and will seek to mitigate unintentional bias by highlighting the role of the researcher as an interpreter of emerging information (Easterby-Smith et al., 2018; Lave and Wenger, 1991). Additionally, the insider researcher will actively seek to diminish any implied pressure, or make assumptions about participation, in line with ethical principles laid out by UWSTD (appendix #). They will present the aims, processes and level of participation in unambiguous language that seeks to reassure and mitigate uncertainty. The participant can be assured that through a structured consent protocol (appendix), their names and identity will remain anonymous throughout and after the research. Additionally, that any research materials generated through their participation will be destroyed following the end of the research. The collaborative nature of working with an institution, such as UWSTD, will allow for ongoing feedback and scrutiny by experienced tutors, throughout the planning, execution and analysis phases of the project (Costley et al, 2010) thus providing a framework for accountability.

7. Personal learning outcomes

- An improved understanding of spectrography
- An improved understanding of the reasons and manifestations of poor pitch singing
- An improved understanding of the role of facial expression in singing
- The gaining of skills and knowledge in undertaking and presenting research

- The gaining of an introduction to statistical data analysis

The Report

Can changes in facial expression serve as a tool to improving tuning competency in novice singers?

Introduction

Historically, within a vocal pedagogical setting, facial expression was widely considered an important contributor to overall voice quality, known as 'timbre' in music (Lamperti, 1877; Tosi, 1723). The advent of spectrographic technology in the 20th century allows contemporary pedagogues to graphically analyse the impact of facial musculature, including lip shape and flaring the nostrils, on the spectra of the voice (Bozeman, 2019; Miller, 1996, 2004; Nair, 1999; Obert, 2023). As a result, the acoustic effects of facial expression on the voice, is now evidenced in contemporary texts and research (Appelman, 1967; Chapman, 1981, Miller, Titze, 1981). However, although the use of spectrographic technology is now a commonplace feature in singing training, there is currently limited research that explores its use as a tool in analysing the impact of facial expression on tuning. 'Tuneful' singing, (i.e., the ability to match accurately the written notes of a melody) is considered a foundational singing skill (Bunch-Dame, 2006, Dalla Bella, 2009; Edmonds et.al, 2023; Pfordresher and Brown, 2007), but, within the context of the author's area of professional practice, one-to-one adult singing lessons, it often presents as the major challenge to improvement for beginner singers. This lack of perceived innate ability can lead learners to self-report as tone-deaf or conclude that natural talent is an essential ingredient to successful singing (Pfordresher and Brown, 2007; Wise and Sloboda 2008). However, the historical verbal instructions to 'lift the cheekbones' or 'smile' (Mancini, 1774), or the more contemporaneous iteration to adopt the 'Nashville squint' which requires upper lip lift, teeth showing and scrunched nose (Obert; 2023), have been observed to assist in improving tuning, particularly in the higher ranges. This mixed methods study (Denzin, 1978; Patton, 1999) explores the perceived relationship between tuning and facial expression, which may provide the basis for devising remedial strategies. This study aims to explore this observation within the context of existing research and by using spectrographic technology to capture and analyse the vocal spectra, particularly the fundamental frequency (called a 'note' or 'pitch' in music) produced by individual singers while they are directed in changes in facial expression. Within the context of singing training, it is hoped that any findings will go some way to dissuading the student from a prevailing belief in innate fixed abilities (Dweck, 2008; Welch 2001; and Whidden, 2009), and that overcoming obstacles is a normal part of learning and not a sign of chronic ineptitude (Numminen et al., 2015).

Literature Review

What is poor pitch singing and why does it happen?

Understanding why some people are challenged by poor pitch singing (colloquially referred to as 'out-of-tune' singing) is particularly complex, as the very nature of singing involves a multitude of variables that are difficult to separate or conclusively measure (Herbst, 2016; Zhang, 2016). These include neurological, psychological, physiological and artistic phenomena as well as cultural influences (Numminen, A. et al. 2015). Using a model of a Vocal Sensorimotor Loop (VSL), Berkowska and Dalla Bella (2009) have identified a range of perceptual and motor planning components that all play a vital part of the auditory-phonatory circuit. They conclude that the malfunctioning of only one part of the loop will affect the entire system, and therefore the interdependency of these components makes the identification of a single cause difficult. Essentially, successful pitch accuracy requires the coordination of complex auditory perception, motor abilities and functioning memory systems (Hutchins & Peretz, 2012; Dalla Bella, 2012; Pfordresher & Brown, 2007; Watts et al., 2003; Welch, 1983). In the professional practice poor pitch singing is more prevalent in the higher ranges, so it is interesting to note that the mechanical adjustments required for pitch elevation take longer to implement than those required for lowering the pitch (Sundberg, 1979, Titze, 1994), potentially suggesting a motor planning deficit (Dalla Bella et al., 2012). Pitch elevation requires the activation of the cricothyroideus muscle which is a muscle that can be developed with training (Sundberg, 1979, Thomson and Russo, 2007), and may be a consideration for why some singers find higher pitches more challenging in the early stages of training.

The literature is inconclusive in determining a fixed metric for measuring poor pitch singing, with research suggesting cut-off value ranges of 50 cents ($\frac{1}{4}$ tone) and up to 100 cents ($\frac{1}{2}$ tone, also called a 'semitone'), off the target note (Berkowska & Dalla Bella, 2013; Demorest & Clements, 2007; Cobes, 1972; Hutchins & Peretz, 2012; Hutchins, Roquet, & Peretz, 2012). In one listening test, trained singers were unable to discriminate pitch differences under 20-cents (Howard and Angus, 2017), however, Sundberg (1990) argues that highly skilled musicians can detect errors of 5-cents which relates to 0.3% of the frequency. Perhaps this illustrates the perceptive or, subjective, nature of auditory pitch assessment in the singing studio, supporting the use of spectrographic technology for teaching. Additionally, the dampening or boosting of particular frequencies, which contributes to timbre (Sundberg, 1990), might influence how the listener perceives the pitch. Pfordresher et.al. (2010), highlight that poor pitch singing can manifest in two ways; as a lack of accuracy or a lack of precision; 'accuracy' describes how close the sung pitch or interval is to the target note, which can be measured in cents, and 'precision' represents the consistency in the repetition of the same notes or the relative pitch (Dalla Bella, 2009). Relative pitch describes the distance between notes or how notes relate to each other in a melody (Downie, 2003). Simply put, a person who is unable to sing an isolated note with accuracy might be able to confidently sing the tune to 'happy birthday', demonstrating that their relative pitch is competent

(Berkowska & Dalla Bella, 2013, McQuade, 2016; Nichols and Pfordresher 2018). In summary, while it may be possible, through spectrographic imaging, to measure pitch accuracy, the literature suggests that determining a single cause for poor pitch singing is almost impossible due to the complex nature of the auditory phonatory circuit.

What is known about facial expression in singing and its effect on sound production?

Ascending vocal pitch range has been associated with heightened emotional arousal in performance, which may account for changes in facial expression in the higher ranges (Scherer, 2003), this extends to instrumentalists, not just to singers (Fisher et al., 2020). Facial expression may also be an unconscious emotional response to the text or music, or more deliberately, as a system of emotive communication with the audience (Pinto et al. 2014). Thompson and Russo (2007) and Titze (1994) posit that physical repositioning of the vocal apparatus may manifest outwardly as changes in facial and body posture. Certainly, pitch elevation, when examined through video endoscopic research, combined with spectrographic analysis, demonstrates the complexity of the process ie., considerable contracting of the lateral pharyngeal walls, creating a narrow tube, raising of the soft palate resulting in the velopharyngeal port narrowing particularly for higher frequencies (Janagisawa et al., 1991). The McGurk Effect (1976) is a term widely used in contemporary settings to describe the phenomenon of the merging of auditory-visual information into a unified perception of what's been heard, perhaps highlighting the importance of facial expression in the interpretation of sound. In the absence of an auditory signal, it was found that melodic information, specifically varying pitches, transmitted by singers to audiences through facial expression was effectively interpreted by the viewer/listener, illustrating the McGurk Effect (Thompson & Russo, 2007). Classical singers are widely observed to maintain flared nostrils from the on-set of a phrase, which has been revealed, through nasofiberscopy, to elevate the soft palate and widen the pharyngeal and epi-laryngeal inlets (Aura et al., 2018). This 'smelling'-related connection between the face and larynx, also supported by Miller (2006), has influenced the choice of facial postures for this study. Evidence of an intermodal association between facial expression and vocal pitch height has found that elevation of the eyebrows often correlates to pitch raising (Huron et al. 2009). However, with the increasing popularity of facial botox, as observed in the professional practice, this may become less obvious in contemporary performance, but remains a frequently observed phenomenon in accomplished singers. The zygomaticus muscles (that give the impression of lifting the cheek bones) are major muscles of facial expression and, according to McQuade (2016) and Miller (1996), can contribute to changes in the shape of the vocal tract, thereby affecting vocal timbre and amplitude. McQuade (2016) finds that lifting the zygomatic gives greater acoustic intensity (94.2%) contributing to timbre. Titze (2001) observes that singers can 'feel' symptoms of voice generation on their faces. While facial postures have been examined in many singing studies historically (Appelman, 1967; Chapman, 1981, Miller, Titze, 1981), the literature accessed for this paper, from which this research has gratefully benefitted, suggests a variety of reasons; these include, but are not limited to, an emotional response to the music or text,

a means of communication to an audience, outward manifestations of physiological changes in the vocal mechanism and a means of controlling amplitude and timbre.

Methods

Eleven participants recorded eight exercises in the same order, while using three different prescribed facial expressions, also in the same order. These recordings were run through spectrographic software and were analysed for pitch accuracy. In this study the independent variables are prescribed facial expressions, with the dependent variable being any variation in fundamental frequency occurring as a result of these changes in expression.

Participants

The purposive sample of novice adult singers ($n = 11$, 5m, 6f) with varying levels of skill, was drawn from the professional practice and are all previously known to the researcher. An email requesting participants who self-identified as beginner or novice singers was sent to 347 previous and existing students. As the research question is focussed on developing strategies for novice singers, it is that group that were selected over more accomplished singers. Furthermore, accomplished singers may have tuning strategies that extend beyond facial expression, which would be difficult to isolate (Herbst, 2016; Numminen, et al. 2015; Zhang, 2016). Some selected participants had demonstrated habitual poor pitch singing in their lessons and, as such, were of particular interest to the aims of this study.

Apparatus

Participant recordings were made using a T-bone SC-1100 condenser microphone fitted with an SZ-ISOBALL foam isolating shield. This was connected via a Scarlett 2i2 audio interface, to an Apple i-Mac M1 desktop computer running Voce-Vista software. Audio-Technica ATH-M50x studio headphones were used by the participants and the researcher during the recording. The post-experiment interviews were recorded onto an iPhone 11 smartphone and final spectrographic analysis undertaken through Praat software.

Procedure

The research was undertaken in a private studio, that also serves as the teaching studio and is an environment that is familiar to all. Each session began with a ten-minute warm-up of fricative glides, trills and short scales, an opportunity for the participant to acclimatise to the demands of the process gradually. Under the instruction of the researcher, the participant learned the two exercises to be recorded. As the accuracy of pitch matching is significantly improved by a live voice model, it was considered important that learning the exercises should be undertaken with the researcher modelling (Granot et al. 2013). The first exercise is based on the cardinal vowel sounds of [a] and [i] with the third note of each phrase being extended (figure 1). These long notes were included to

ensure that adequate audio was captured for analysis, a requirement that the participants were made aware of. In spectrographic imaging, vowels generate the maximal information about the pitch, therefore no consonants were used in the first exercise (Murayama et al. 2004). As accuracy in copying pitches decreases as the sequences get longer (Pfordresher et al., 2010), these phrases remain short and repetitive. Pitch accuracy also tends to decrease with faster tempi (Dalla Bella et al. 2006; Sundberg, 1979) therefore the speed of the exercises was kept moderately slow. Additionally, singing single pitch vowels reduces linguistic demands and memory load and has shown to be easier for novice singers to undertake (Berkowska and Dalla Bella, 2009a). The choice of notes reflects that pitch accuracy, within the professional practice, has been observed to decrease as the pitch rises, therefore the exercises increase incrementally in pitch. Lower voices sang down the octave or learned alternative pitches. It should be noted that the pitches themselves were only moderately high to reflect the general level of ability, as assessed by the researcher and, had the participants been more experienced, are likely to have been higher to account for the longer development period (Sundberg, 1979; Thomson and Russo, 2007).

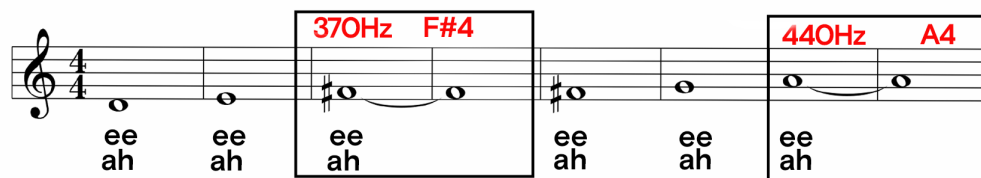


Figure 1. First vowel exercise (notes to be measured are highlighted).



Figure 2. First word exercise

The second exercise was a word-based phrase (figure 2), and, in contrast to the vowels sequence, modulates melodically both downwards and upwards in pitch. In order not to depend on pre-mapping by the Vocal Sensorimotor Loop, the melody was written for the purposes of this study and was therefore previously unknown to the participants (Brown et. al., 2004; Zarate, 2013). The notes to be examined were the second and last. Both exercises were practiced until the participant and the researcher agreed that a sufficient level of proficiency had been achieved and that the participant felt confident. Overall, the participants would generate a total of 528 fundamental frequency readings over eight pitch-varying exercises.

Facial Expressions

Further to learning the exercises, the participant received instructions on the three prescribed facial postures. These included 13-images of singers' faces (exclusively the face), verbal directions and written descriptors (figure 3). The postures included; 1. Neutral face; 2. Squinty face; 3. Sniff the Rose (abbreviated henceforth to the Rose). As current research on facial expression in singing appears mostly concerned with timbre, rather than tuning, the facial postures were selected based on evidence that supports a correlation between expression and timbre. Each posture needed to be easy for the participant to undertake and to be contrasting. The order of execution of the facial expressions was consistent across the entire experiment: Neutral, Squinty and the Rose. As Neutral presents as 'relaxed' and contextually less extreme, it was considered to be the easiest of the facial expressions and would therefore be the first to be used in each exercise. The procedure needs to consider the relative lack of experience of the participants. Changing the order between participants, although potentially interesting, may have introduced anomalies that go beyond the scope of this research.

1. Neutral face required a relaxed jaw, forehead and lips. An unenergised, dead-pan expression to be maintained irrespective of pitch. As vocal pedagogy focuses on relaxation and a lack of tension (Fisher et al, 2020), it would be interesting to discover if a completely relaxed face might impact tuning.
2. In contemporary commercial singing, the squinting face is frequently observed in live performance across all styles, notably in the higher ranges. Artists including Tom Jones, Celine Dion, Billie Eilish, Whitney Houston and many more, can be observed to squint as though being squirted in the eyes, recruiting the zygomatic musculature which gives the impression of lifting the cheekbones (McQuade, 2016). Additionally, the top lip is pulled up revealing the top teeth (Obert, 2023).
3. The Rose posture draws on the historic classical pedagogical instructions to smile, lift the eyebrows and cheekbones, flair the nostrils and show the teeth (Mancini, 1774). These facial postures are evidenced contemporaneously by world-renowned classical singers including Pavarotti, Bartoli and Fleming. Additionally, eyebrow lifting (procerus muscles) and nostril flaring (musculus nasalis) are commonly observed just before starting and during singing (Aura et. Al., 2018). Miller (2006) finds value in the historical adage to breathe in as though inhaling the fragrance of a rose, as a strategy to control resonance, inspiring the description for this facial expression.

For the recording, the individual was seated in front of a mirror adorned with the enlarged photo-images (figure 3), descriptive words and the musical notation (figures 1 and 2). The studio floor was marked with masking tape in order to ensure that the position of the chair and the microphone were consistent for every participant and that their mouths should be a similar distance from the microphone. The condenser microphone was positioned approximately 30cm from the singer's mouth (Kutsal, 2023, Titze, 1993). It was important to isolate the voice signal as much as possible for a clean voice reading (Downie, 2003; Voce Vista Guide Book, 2024). Therefore, acoustic curtains were drawn alongside the participant and pre-recordings of the piano-accompaniment for

the exercises were played through headphones. Only one ear was covered, allowing the participant to hear themselves in the ambient environment with the uncovered ear. Although there is evidence that supports occluding both ears for reducing pitch drift (Edmunds and Howard, 2023), internal frequency transmission through bone and muscle favours lower frequencies which can affect self-perception of the sound (Edmunds and Howard, 2023). Additionally, there is historical research that posits that the external sound source increases the ability to assess the accuracy of the singing, thus contributing to the one-ear only decision (Bekesy, 1948). The piano recordings included verbal instructions, starting notes and count-ins for every exercise, providing as much clarity as necessary. Similar research revealed that participants preferred the choice of the sound of the piano to other sounds (Nápoles, 2019). The total recording time for each participant was nine minutes exactly and there were to be no breaks or repeat attempts. During the recording, visual observations were made by the researcher.



Figure 3. Facial posture descriptors used by participants

Interviews

Although this research seeks a quantitative outcome to satisfy the research question, understanding the participants' responses to the demands of the experiment might reveal

unexpected observations. Therefore, short, unstructured interviews of no more than five minutes were conducted. The nature of the insider-researcher relationship is collaborative and, as such, could provide deeper insights that are not necessarily available in less-intimate research settings (Costley et al., 2010; Easterby-Smith, 2018). An initial system of deductive coding per facial expression, followed by in-vivo coding relating to participants' responses to each facial expression, may identify emerging themes.

Measuring the data

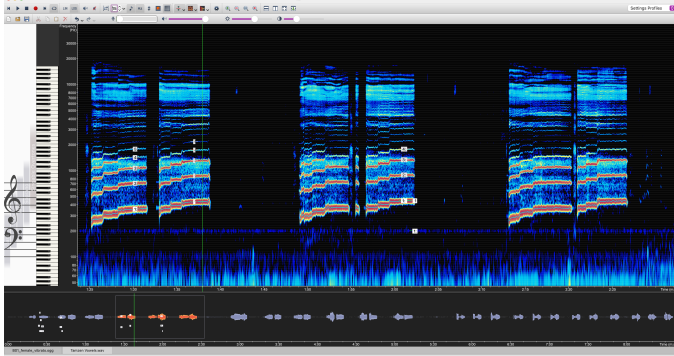
The only measurement of interest to this study is the fundamental frequency. In order to calculate the mean fundamental frequency over a period of time, the recordings were exported as WAV files from Voce Vista and imported into Praat, a computer software for speech analysis in phonetics. This software allows for the selection of a measure of time to be analysed (Boersma, 1993). In this experiment 01:00 second was selected from the middle of the note, avoiding the on-set and off-set due to the likely prevalence of instability at these points. The choice of the selection of 01:00 second of audio was dictated by the average time that participants held the target pitch. As the first note to be analysed in the second set of exercises (figure 2) was very short, the mean pitch was recorded from .50 second of audio. The data was collected both in Hertz (frequency) and in the perceptual correlate, musical pitch. In music, semitones ($1/2$ notes) hold a value of 100-cents, with whole tones being equal to 200-cents. It is the cent calculation that reveals how close the sung note is to the target pitch, for example, 440.62 Herz has a musical value of A4+3 cents (Botros, 2001). Therefore, the metric for determining pitch accuracy in this experiment is calculated in cents.

The extracted data was imported into SPSS, a statistical analysis software. The mean value of each of the facial expressions over the whole experiment was used to generate paired sample t-tests to determine any statistical significance. The primary function of the data is to determine whether changing facial expression impacts pitch accuracy, with accuracy measured as zero and all samples being over, under or exactly zero. Two-tailed hypothesis t-tests were used to calculate statistical significance, with a one-sided p-value >0.05 as the determined value of statistical significance (Birkett, 2021). Statistical significance suggests that there is a chance that the event may occur across the wider population (Field and Hole, 2003).

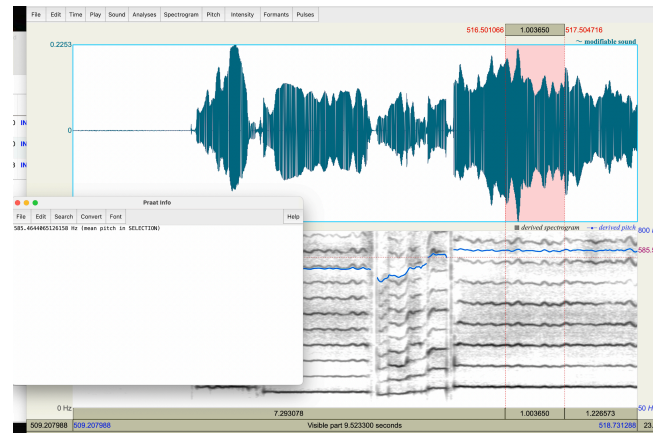
Ethical Considerations

In accordance with the University of Wales and Trinity Saint David's UWTSD ethical guidelines, the participants were fully informed about the purpose of the research, however, to avoid focus or effort in achieving tuning, the terms 'tuning' or 'pitching' were deliberately not used during the experiment. Due consideration was given to the welfare of the participants at all points of the planning; the tasks were proportionate to the level of ability and the experiment could be conducted at variable speeds. Rights to anonymity were honoured and all names were redacted and replaced

with letters. Each participant was offered a copy of their signed consent form and each will be emailed the final report, along with an expression of gratitude.



Voce Vista vowel exercise three facial expressions

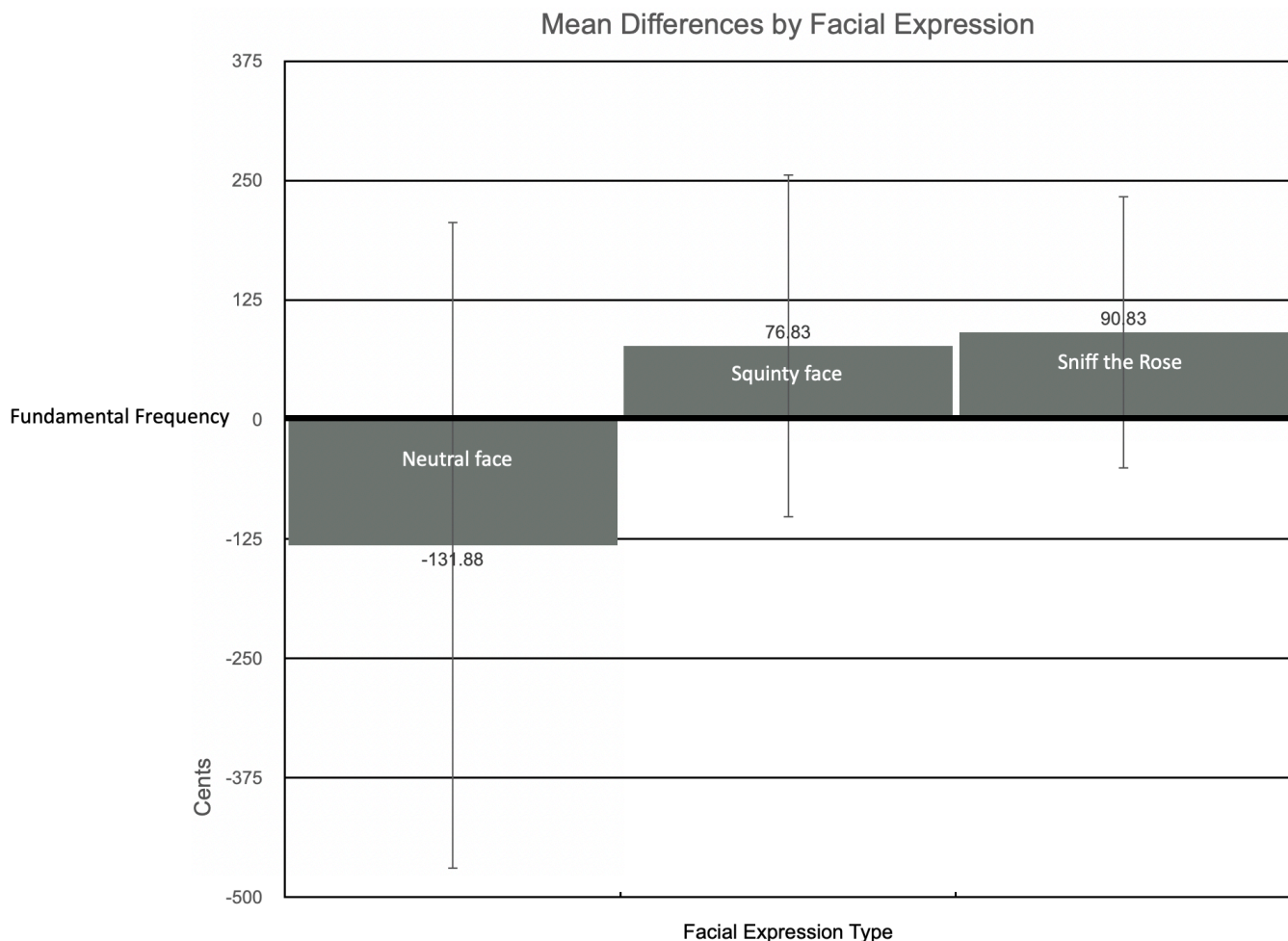


Sample collection using Praat software: palm trees exercise

Figure 4. Capturing the data

Results

The initial overview of the results, indicated the presence of two outliers, participants B and H. To reduce the effect of skewing, the data for participants B and H has been omitted from these results, allowing for 432 remaining measurements from $n = 9$ participants to be considered (Appendix G).



Note: The mean pitch ratings for specified notes in three conditions, Neutral face, Squinty face and Sniff the Rose are reported above for analysed measurements ($n = 9$). Pitch is measured in cents with zero representing the fundamental frequency. Standard error is reported in the error bars.

Figure 5. Mean differences in target pitch outcomes between three facial expressions over the whole experiment

Three paired sample t-tests were conducted in SPSS to determine the relative effect of the three different facial postures on the fundamental frequency, using the metric of cents, with zero as the metric for accuracy. The estimated effects sizes were calculated using a standard deviation (SD) and standard error of the mean (SE).

The comparison between neutral and squinty determined that when the same singers are singing the same phrases using these two facial postures, there is a statistical significance recorded in pitch outcomes in a two-sided t-test ($t = 0.041$, $p > .05$). Neutral face was compared to the Rose posture and while there is a difference in the overall mean values, the result is determined to be

statistically non-significant ($t = .078$, $p < .05$). Squinty and Rose also revealed a statistically non-significant result ($t = .855$, $p < .05$). These results indicate that there are differences in the mean values of the fundamental frequencies between certain facial expressions and that there is statistically significant data to support the hypothesis that there is a chance that facial expression can impact pitch outcomes beyond the setting of this experiment.

Findings

Overall, the resulting statistics demonstrate, in a small sample of beginner singers ($n = 9$), that changing facial expression impacted the fundamental frequency for these singers. The standard deviations (SD) suggest that some singers overshoot the margin of error to a significant degree. In-vivo observations noted that some singers exaggerated their facial postures to an 'unnatural' degree, which could account for some of the instances of over-reaching the target. As there is no metric or equipment available to the researcher to measure facial expression, this remains conjecture. The mean data suggests Squinty as being mathematically the closest to the target pitch (zero) across most of the exercises and Rose shows a consistency for above-the-target pitching within the 50-cent allowance. Participants B and H, considered outliers and therefore excluded from the data, were selected for this experiment because they had previously demonstrated serious pitching deficiencies during lessons, probably more so than any other participant. Both had displayed an inability to identify pitch direction or the required octave, meaning that their singing tended to an octave above or below the melody. When directed to use Squinty and Rose, both participants sang up the octave, suggesting perhaps, that the 'raising' quality associated with these expressions was conflated with a request to sing higher notes. This alone, may be indicative of an inability to preconceive the target pitch. Based on the behaviours exhibited by B and H, 'facial pitching' might be a more suitable strategy for those singers who are able to preconceive the note but do not yet have the developed motor skills or muscular flexibility, essential elements of the auditory-phonatory circuit (Berkowska and Dalla Bella, 2009). Sundberg (1979) and Thomson and Russo (2007), posit that these deficits, particularly if occurring in the higher ranges, can be overcome with repetition and muscle development.

Neutral face

It is striking to note the extreme pitch deficit recorded by the execution of the Neutral Face; $M = (-)131.88$ relative to the rose $M = 90.8333$ and squinty face $M = 76.83$, across the whole experiment. Statistical significance suggests that, although the sample is very small and the experiment has several limitations, the Neutral face deficit 'effect' could be representative across the wider population (Field and Hole, 2003). Based on these findings, an emerging consideration might be that a perceptual lack of facial expression, such as Neutral face, might increase the chances of pitch inaccuracy. This evolving theory may be supported by feedback from the post-exercise interviews, with some participants reporting Neutral face to be problematic in achieving high notes; G, a professional orchestra musician, stated that as an instrumentalist, they internalised the pitch before playing it (Fisher et al, 2020) and that high notes "feel" higher in the

head, therefore, attempting to maintain a neutral facial posture on ascending pitches proved challenging. G's statistics reveal that they were generally below the target pitch on Neutral but never over the threshold of 50-cents, however, they conceded that they had probably instinctively elevated their facial features. Participant A, posited that "Neutral face highlights how singing is easier if you use your face". Participants I and J also reported that it was difficult to maintain Neutral on ascending intervals as their natural instinct is to raise their faces along with an internalised sensation of elevation. Participant I observed that the descriptor 'Neutral' was misleading, suggesting it was in itself an extreme facial expression akin to a theatrical 'dead-pan' expression. In contrast, (C and D) expressed Neutral to be the easiest and the most comfortable posture and both associated it with being relaxed. However, D was variously very close to the acceptable negative allowance and as the pitch ascended, went beyond that threshold (up to -110 cents). C was well within the acceptable range for all the postures over the exercises. F, whose voice type is bass-baritone, described Neutral as feeling "lower in the body" and representing their singing norm, strongly identifying with the image of the basset hound as representative of this posture. Other than C, D and F, the consensus, variously, is that Neutral felt under-powered, was a hinderance in high note singing and that the overall sound was dull.

As this research is ultimately concerned with helping singers to improve pitching accuracy, it is worth considering the implications of the results of using the Neutral posture in a pedagogical setting; one of the primary focuses in singing pedagogy is for the singer to learn to avoid excessive tension in the vocal system (Fisher et al., 2020; Larrouy-Maestri and Morsomme, 2014), and many pedagogical texts include the necessity for avoiding stress in the facial musculature (Bunch-Dayme 2006, Kitch et al., 1994, Linklater, 1976, 2006). Perhaps then, consideration should be given to the interpretation of 'relaxation'. 'Relaxation' was a key word used in the description of Neutral for this experiment, and yet the posture was found to be inhibiting. This may suggest that a student instructed to relax their face may variously resort to a static or "dead-pan" posture (participant I) and perhaps the effort to relax in itself, might create tension in the vocal system, when misconstrued. Fisher et al., (2020) highlight the necessity for pedagogues to include training in appropriate facial muscle activation for vocalists and musicians for health and technique. Perhaps another consideration arising in response to the data, is the importance of facial animation in early years teaching to avoid children learning to sing with neutral expressions, which could lead to potential tuning deficiencies in adulthood. The valuable research undertaken by Dr Ed Tronick (1975), known as the 'Still Face Experiment' illustrates the power of emotion coaching in early years and, as such, a lack of emotional engagement through facial posture may result in not equating singing with emotional expression, but rather a more abstract or intellectual exercise. Within the context of the research question, the statistically significant outcomes on the Neutral posture, particularly on ascending pitches, might suggest a review of the semantics surrounding the notion of relaxation in singing training for all years.

Sniff the Rose

Squinty and Rose, when compared, showed little statistical difference in the results. However, in terms of developing teaching tools, the participant feedback has yielded some valuable insight. The Rose was the most overtly popular, with a sensation of “fluidity” in the breathing, “it made me want to sing out and perform” (C), “it felt like Rogers and Hammerstein, a performance element” (E), “It felt more dynamic. It felt like more power coming through. Opening everything up, opened me up” (F). “the sound is nicer on Sniff the rose. The sound is rounder” (G), adding that “seeing Pavarotti was useful”. Additionally, J adds “breathing-wise, sniff the rose gave me the most energy for the breath. Everything felt more open and that felt good”. One participant was observed to instinctively hold an imaginary rose under their nose, as per the images. The word ‘surprised’ was included in the descriptors and several participants agreed that this was the keyword for enabling the posture with ease, having found that it was hard to maintain the sniffing element through the phrase. The researcher observed, with the exception of G, the participants made adjustments to their shoulder posture while ‘sniffing’, pulling them back to different degrees, consequently changing the head-neck alignment (Miller, 1996). On exercise two (figure 2), the first note analysed had a downward pitch modulation, and the measurements in fundamental frequency reveal negative frequencies as a norm for this note on the Rose. However, the second note analysed modulated upwards and was consistently above and generally very close to the target pitch. Both notes possessed the same vowel [I]. As similar patterns occur with pitch direction using squinty face, this might suggest that the Rose and Squinty postures are particularly efficient on ascending intervals.

Squinty face

In terms of participant feedback on Squinty, several suggested that the posture helped with accessing the higher notes, particularly on [I]. The observations and feedback reported that Squinty was hard to achieve, with some singers appearing to make strenuous effort. Participant F, although finding it difficult to adopt, felt that it was “potentially easier to reach high notes than sniffing” adding that seeing an image of the singer Tom Jones, was helpful in understanding the requirements. It should be noted that F was found to be considerably over the target pitch on the higher notes, despite reporting a sense of ease. J expressed squinty face as the easiest for accessing high notes “especially showing the teeth and lifting the cheekbones.” G agreed that it was easier to produce higher notes, but felt that “Squinty has a more piercing quality to the sound” and preferred the rounder sound produced by the Rose. It was observed that hand gestures were often used to describe the sensations relating to the postures; generally Squinty produced gestures representing ‘small’ spaces’ and in one case, using the hand to form a forward arrow in front of the face. The Rose generally elicited hand gestures representative of roundness.

The experiment itself was praised by the participants for its clarity. Without exception, the participants appeared to enjoy and engaged with the process, with none showing embarrassment at being asked to pull extreme facial expressions and all showing interest in the results.

Limitations

It is not possible to identify a single cause for poor pitch singing (Dalla Bella, 2012; Hutchins & Peretz, 2012; Pfordresher & Brown, 2007; Watts et al., 2003; Welch, 1983), and by the very complex nature of singing (Herbst, 2016; Zhang, 2016) neither is it possible to know, in this experiment, whether it is facial expression alone, that has caused the acoustic changes in the output. For example, the act of sniffing engages the muscles of the nostrils and elevates the soft palate, which changes the shape of the vocal tract, thus impacting the vocal spectra (Aura et al, 2019; Miller, 2006). The observation that participants pulled their shoulders back on the Rose posture, might have had a bearing on the acoustic output. One might argue that it is these manoeuvres, rather than facial expression in itself that elicits changes in the fundamental frequency. It is also difficult to measure facial expression as the perception and execution is likely to be different from person to person, as highlighted by participant D who found it “difficult to distinguish differences between squinty face and the rose”. Additionally, the participants tended to use exaggerated facial postures to a degree that may have affected the pitch outcomes. However, without the benefit of high definition and motion capture video, neither of which was available to the researcher, it remains impossible to get an exact metric (McQuade, 2016). A further limitation to the study is that the sample size is very small to be truly representative of the population and it is limited to amateur singers. If the study were to be repeated, an examination of more advanced singers using more naturalistic interpretations of the postures and who are working across different genres, might be of value.

Conclusions

Singing in tune is considered a foundational skill (Bunch-Dame, 2006, Dalla Bella, 2009; Edmonds et.al, 2023; Pfordresher and Brown, 2007), however, it can present as a major challenge to some people. Finding remedial strategies for improving pitch accuracy is complicated, involving a complex array of phenomena, thereby making the identification of a single cause, difficult (Berkowska and Dalla Bella, 2009; Herbst, 2016; Numminen, A. et al. 2015; Zhang, 2016). Building on historical and contemporary vocal pedagogical texts (Bozeman, 2019; Miller, 1996, 2004; Obert, 2023; Lamperti, 1877; Tosi, 1723) the research sought to explore a correlation between facial expression and pitch accuracy using spectrographic imaging. The statistical results demonstrated that Neutral face consistently recorded negative target pitching and the qualitative element of the study aligned with these findings, with participants positing that Neutral can feel inhibiting, particularly in higher singing. In contrast, the postures that elevated the facial features, Squinty and the Rose, delivered either above or very close to the target pitch, most notably on ascending intervals and presented as helpful in high singing. These results, along with participant feedback, suggest that using the face as a remedial tool for poor-pitching in singing training could have benefits. However, two outliers who were found to be unable to judge pitch direction or octave, may indicate that the use of facial expression in this context might not be effective for all singers. In conclusion, despite the limitations of the study, a statistically significant result was found

between Neutral and the other two postures suggesting that a larger sample group, with a pre-tested minimum pitching proficiency might add depth to the findings.