

Verity Bramson – 1817365

Independent Study (Extended) – BMPF7013F

**A STUDY INTO THE USE OF SEMI-OCCLUDED VOCAL TRACT EXERCISES
FOR EFFICIENT VOCALISATION**

PART I: PORTFOLIO

Introduction and Rationale	2
Planned Programme of Study	4
Aims	4
Research Objectives	4
Timeline	4
The Literature Review Process	5
Reflection	8
Case Studies	10

PART II: THE ASSIGNMENT

Literature Review	14
Conclusion	23
Appendices	24
Bibliography	26

PART I: PORTFOLIO

Introduction and Rationale

For this Independent Study I propose to examine the use of Semi Occluded Vocal Tract Exercises (SOVTs) to aid efficient vocalisation.

I am undertaking this study in the context of my work as Head of Singing at an independent school for pupils aged 11-18. In this role, I teach one-to-one singing lessons to pupils from years 7 to 13, coach students for performances and exams, direct choirs, and manage the provision for singing teaching in the school as a whole.

I already use SOVTs regularly in my work and observe their use to varying degrees in the singing lessons of my colleagues, usually as part of a vocal 'warm-up'. I wish to examine the function of SOVTs further as I believe it important for the singing teacher to develop a functional understanding of any exercises used in order to tailor them to the student. Furthermore, my teenage students are discerning and intelligent and often wish to know why a particular exercise is being used, particularly if it involves making an unusual sound that might cause the teenage singer to feel self-consciousness. I hope that an in-depth study of the use of SOVTs will provide a rigorous scientific understanding of their impact on my students' learning and allow me to establish a strategy for their best use.

Although SOVTs were not a part of my own individual singing lessons as a teenager, my introduction to their use began through choral rehearsals where humming and lip trills were used as part of vocal 'warm-ups'. I then gained further insight into their efficacy in 2010 when SOVTs were included as part of speech therapy and singing voice rehabilitation, following surgery to remove a polyp from my vocal folds. I have observed SOVTs in other settings since, both as a complement to Ron Morris's Accent Method breathing exercises on several courses, and as part of my own singing lessons in further education with Veronica Veysey Campbell, Sophie Grimmer and Jenevora Williams respectively. In early 2020, as part of a study into the Singing Voice Rehabilitation industry, I interviewed Ingo Titze and was fascinated to hear about his pioneering research into the use of SOVTs in adult singers.

Primary research in the realms of singing teaching, voice therapy and physics reveals that SOVTs are useful for a number of reasons. One can expect to observe the following as a result of SOVTs:

1. An increase subglottic pressure (Cordeiro et al, 2012)
2. A decrease in vocal fold closed quotient and therefore in vocal load (Guzmann, Laukkanen et al, 2013; Gaskill and Erikson, 2007)

3. A narrowing of the epilarynx. The ratio between the inlet of the lower pharynx and the outlet of the epilaryngeal tube becomes larger which aids vocal 'ring' without extraneous effort. (Guzmann, Laukkanen et al, 2013; Guzman, Rubin et al 2013)
4. A stronger singers formant cluster resulting in acoustic reinforcement (Guzmann, Laukkanen et al, 2013; Guzman, Rubin et al 2013)
5. Balanced registration through encouraging vocal tract impedance which increases activity in the Thyroarytenoid (TA). (Laukkanen et al 2008).
6. A decrease in vocal fold vibration amplification thus reducing the chance of vocal injury, even at higher pitch or intensity (Titze and Laukkanen, 2002 and 2007)
7. A lowered larynx position. (Guzmann, Laukkanen et al, 2013)
8. From anecdotal experience, SOVTs encourage efficient vocalisation as a consequence without asking the student to take their attention to intrinsic vocal anatomy that they simply cannot control.

As well as asking why SOVTs are useful, I also wish to explore the best way in which to teach them, taking into account the variety of ages, stages of development and experiences of my young students, recognising that the singing teacher must always think on her feet.

I envisage that through this study, questions about SOVTs in relation to teaching teenage voices may arise. While it is not possible to examine this topic fully within the limited scope of this study, I will identify opportunities for future research.

[illegible]

Literature Review Process

Due to the timescale of this independent study, a systematic approach to conducting the literature review was required (Boell and Cecez-Kecmanovic, 2014). My literature review used mixed methods: the coding of the literature by its nature had to be quantitative, before a qualitative commentary could emerge. This allowed me to take on an 'abductive' approach to my research (Saunders et al, 2003): the original quantitative analysis of the literature was 'deductive', i.e. I had developed my own hypotheses about SOVTs before I started my reading and wanted to test these, but as a narrative emerged from my research my qualitative analysis warranted an 'inductive' approach.

At first, I worried that the literature review would not be exhaustive, but then began to see the merits in examining a range of reading materials more broadly before focusing on the valuable details of a few key texts. I found this type of 'purposive sampling' to be very liberating due to its reliance on the researcher to make her own judgements in relation to the purpose of the study (Laws et al, 2003).

Methodologically, I therefore favoured a Hermeneutic approach. This allowed me to rely on observation in order to establish a credible, rigorous and creative interpretation of the texts studied (Paterson and Higgs, 2005). The 'Hermeneutic circle' (Heidegger, 1927) whereby the researcher explores the nuances of texts before linking back to the research question, gave further credibility to my choice to use a purposive sample of texts. It felt more meaningful to examine a small number of texts in depth. I also favoured Paterson and Higgs' (2005) development of this idea into the 'Hermeneutic spiral', which assumes that each time the research question is revisited knowledge is expanded further. I felt that each time a new text was visited I was able to gain more insight into the function of SOVTs and to make assumptions about best practice in the teaching studio. Inevitably this resulted in further questions which could then be explored by further reading, and so on and so forth.

My interpretation is such that, through using the hermeneutic spiral as a methodological model, the researcher submits to the fact that there is no finite end to research. As I initially had a tendency to feel overwhelmed by the sheer volume of literature in existence, this was both humbling and comforting, allowing me to continue my research content with the acceptance of not being able to do everything.

Paradigmatically, I was drawn to a post-positive approach. It felt important to remain objective in my study of scientific texts but to view them through a critical lens when applied to the teaching studio (Trochim & Donnelly, 2007). In both my research and singing teaching I accept that findings determined through quantitative analysis are likely true, but that they may be

disproven in the future. To recognise and accept this serves to strengthen the credibility of the researcher.

I began by searching online for scientifically rigorous articles pertaining to SOVTs in professional journals, such as the *Journal of Voice* and *Journal of Singing* (NATS). Search terms relating to teaching singing to children and teenagers took me into *The Choral Journal*. It transpired that much of what was written about children and teenagers was in relation to choral rather than solo singing, and as anticipated, that very little scientific study, least of all in relation to SOVTs, had been carried out on this demographic. This was understandable due to ethical considerations. The research that had been carried out on young people most often relied on subjective observations of vocal quality following certain activities, with quantitative measurements of the vocal tract lacking.

As I explored further papers it was tempting to become engrossed into the minutiae of scientific studies examined. However, Hart's (2014) suggestion that the reviewer extract more general key ideas, theories, concepts and methodological assumptions from the literature kept me on track. I aimed to categorise the information gained early on in order to provide clarity (Denscombe, 2007), starting with a more general approach before progressing to particular ideas which emerged through the literature review process (Hart, 2014). In order to do this, I made use of a coding book (Randolph, 2009), keeping references and key themes in an excel spreadsheet that I could then easily refer to.

As my study aimed not only to research the efficacy of SOVTs in a scientific setting, but also to examine their best use in the teaching room, I saw the value in looking at the work of practitioners as well as academics. I searched books by eminent vocal pedagogues for mention of SOVTs (Ragan, 2020; Shewell 2009; Malde, 2017; Bunch Dayme, 2009; Chapman, 2012; Morris and Hutchison, 2016), and was interested in the application of SOVTs in Lessac-Madsen Resonant Voice Therapy (Verdolini-Abbot, 2008).

The need to examine practitioner-led resources led me to uncover limited grey literature. This then gave rise to a conceptual discussion on the merits of grey literature itself, and the difficulties faced when attempting to include it in a literature review.

Adams, Hillier-Brown & Moore et al (2016) explore the concepts of 'grey literature' and 'grey information' in relation to public health data. 'Grey literature', i.e., documents that are not controlled by commercial publishing organisations, includes working papers, accounts of conferences and delegations, theses, preprints, white papers, and reports that are research-based or produced by government departments, business and industry. Particularly in the social sciences, these are useful to researchers but can be difficult to find and synthesise.

'Grey information' is, according to the authors, knowledge that is even more difficult to classify, usually coming about through innovation in practice. In this study, the authors assess different search methods that could be useful to future researchers working in this area, concluding that greater incentives for accurate data recording and rigorous methodological improvements are needed in order to enhance future retrieval of grey literature and information.

Easier access to grey literature would be useful in the field of voice pedagogy research, which lives at the margin between science, social science and art. From my own observations, many findings in this field occur through practical innovation and are only then researched rigorously. Bearing in mind the time-consuming and administration-heavy process of publication, insights which were once cutting-edge might be several months or years old by the time they are peer reviewed.

Greater classification of grey literature would lead to better inclusion of pioneering ideas in academic research. In my examination of Kari Ragan's book, I noted her reference to the research of Frisancho et al (in press at the time of publication), in relation to singing through ventilation masks. In my wider reading on teaching young voices, I explored Jenevora Williams' PhD on training boy choristers, which I was made aware of purely through insider knowledge. Should search processes be more encompassing of grey literature, papers such as these could garner further readership, contributing to greater nuance in future academic studies.

In my previous research on the Voice Rehabilitation industry (Bramson, 2020), I found conference proceedings and transcriptions of talks and interviews – e.g., Oren Brown's keynote speech from the 4th International Voice Symposium in Banff (1999) and Ringel's 'History of the National Association of Teachers of Singing' (1990) – to be highly informative. These papers were discovered via citations in peer reviewed papers and books, however better classification of grey literature would alleviate the need for such chance encounters, opening up the worlds of research and practice to one another, with exciting consequences.

In the past, I have found the literature review process to be frustrating. At its genesis, it can appear an insurmountable task, seeming to primarily involve categorisation of source materials and lacking originality. Hart (2014) advocates for a reflective approach to the literature review however, aiming to explore existing theories and ideas in a creative and imaginative way. When I considered this, while modelling my methods on the Hermeneutic spiral in a post-positivist paradigm, I found that my own personal response to a range of literature types emerged, and I recognised that this in itself was innovative.

Reflection

In order to reflect on the way in which I approached the assignment, I was drawn to Kolb's (2014) four adult learning steps which describe the researcher's internal processes:

1. Concrete Experience: feeling.
2. Reflective Observation: watching.
3. Abstract Conceptualization: thinking.
4. Active Experimentation: doing.

Oelofsen (2012), states the importance of expressing the way in which each of these steps impacts the researcher's approach to work. As someone who is very emotionally led, I found myself preoccupied with the first step for a long time. My felt experience of teaching provided a lens through which to view every piece of research reviewed but also stalled me in my attempts to make real progress early on. This, coupled with a change in my circumstances from freelance singing teacher to full-time Head of Singing at a busy boarding school, had the potential to derail me.

Once I was able to take a step back and observe my own working habits (Kolb's 'Reflective Observation'), I was able to plan and categorise, distilling my previously dense reading materials, somewhat clouded by the preconceptions from my own teaching, into more manageable concepts that could then be written about in a more detached way ('Abstract Conceptualization'). While I do see the merit of examining reading materials in the context of one's own practice, I recognise that this will inevitably incite an emotional response which might not always be helpful. In order to forge ahead efficiently compartmentalisation was useful.

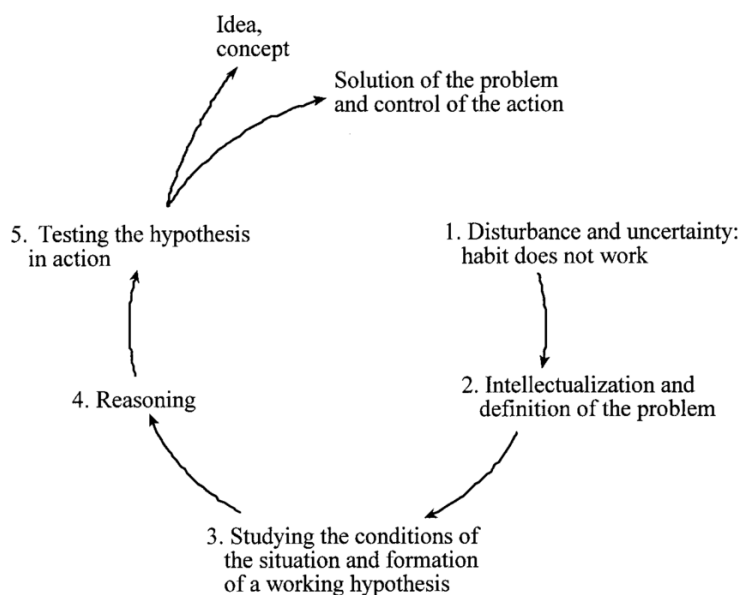
At this point, I had to make a decision about the scope of my study. Having initially hoped to look at SOVTs in the context of teenage vocal development, I realised that the task before me was too great and therefore made the decision to simplify my research question and to examine SOVTs more generally. I came to terms with the decision through the realisation that a wider understanding of the topic would in fact be more beneficial, providing an umbrella of knowledge under which I could conduct future research. With a plan to undertake research into the effects of a programme of SOVT-based exercises on my teenage students, I will be able to undertake a more specific literature review as part of this, replete with contextual understanding from this independent study.

Kolb's 'Active Experimentation' came about through the writing up of my notes and concepts. Through this summary, a conclusion began to emerge which would synthesise my felt

experience, observations and thoughts. I am particularly in favour of a conclusion that is active and experimental in the field of social sciences, as this reflects the post-positivist paradigm in which I choose to work. The researcher is therefore able to remain open to conversation or debate which, crucially, will invite important critique as scientific findings change and therefore increase the validity of research.

In conjunction with conducting and reflecting upon this literature review, I aimed to put my findings into practice in the teaching room. It was important to test what I had read because although books by singing teachers were useful, scientific papers studied tended not to give information on the practical application of SOVTs in teaching. I had already been using SOVTs in the teaching room for years however could now suggest an exercise with renewed knowledge of vocal function, using interpretation to ascertain its effectiveness for a particular student.

I decided to reflect on my teaching through three case studies describing students in whose lessons SOVTs have been particularly prevalent. Dewey's five step reflective model (1925) provided a useful framework for this:



Case Studies

Eloise, a music fan with a particular penchant for jazz and soul, began singing lessons aged 14. Until then, she had learnt to sing through listening to and mimicking the great divas of these genres.

1. Disturbance and uncertainty – identifying a problem: Due to her prowess in mimicry, Eloise's tendency was to strive towards a sound that was an assimilation of someone else (often older and with a different vocal timbre), rather than finding her own true voice.
2. Intellectualisation and definition of the problem – what I think is happening: Eloise's initial tendency was to 'push' her M1 ('chest register') beyond its natural limit. She had little experience of using M2 ('head register') and thus it was weak and breathy.
3. Studying the conditions and forming a working hypothesis – working out what can be done to solve the problem: I aimed to eliminate pressed phonation in M1 and aid vocal fold closure in M2 by encouraging Eloise to vocalise using 'puffy cheeks', sliding over a descending fifth from M2 into M1.
4. Reasoning: Laukkanen et al (2008) describe SOVTs as helping to aid balanced registration. Evidence (see assignment) suggests a link between phonation using SOVTs and decreased vocal fold closed quotient.
5. Testing the hypothesis in action: Although my observation was that after the 'puffy cheek' exercise Eloise's vocalising on a vowel was less breathy in M2, I noticed that she had a tendency to tense the root of her tongue while doing this and therefore that a more efficient form of vocalisation could be achieved. I introduced her to the 'raspberry' exercise which would aim to reduce tongue tension due to the necessity of a vibrating tongue in order to fully achieve the exercise. She was able to achieve this quickly. After a number of lessons, with the 'raspberry' a well-established part of warming up, I encouraged Eloise to attempt 'puffy cheeks' once again while maintaining a sense of 'lightness' in the tongue root. I then tested the value of this approach by inviting Eloise to alternate between 'puffy cheeks' and an /i/ vowel while maintaining the same breath pressure.

Concept/ Solution: This gradual implementation of SOVTs into singing was helpful in reducing breathiness in M2, achieved with ease rather than tension, and in achieving balanced registration, resulting in a less pressed sound in M1.

Madeleine, polite and mild mannered, and a keen choral singer, had 4 years of singing lessons behind her at age 16.

1. Disturbance and uncertainty – identifying a problem: during our first lesson I asked Madeleine what she hoped to achieve from singing lessons. She communicated the desire to improve her breath control which I understood to mean a desire to sing longer phrases with ease.
2. Intellectualisation and definition of the problem – what I think is happening: I noted a tendency towards perfectionism which meant that her vocalisation was often tentative. I deduced that the issue was not the lack of ability to sing long phrases, but a tendency to phonate without the requisite breath pressure and breath flow.
3. Studying the conditions and forming a working hypothesis – working out what can be done to solve the problem: I encouraged increased air flow through the introduction of accent method breathing exercises on voiced and unvoiced fricatives (f/ v/ s/ z/ ʃ/ ʒ/ θ/ ð). We then began to work on sustained vocalisation using SOVTs. Lip trills over a fifth, and then an octave, seemed to work particularly well and reassured me of my deduction from point 2.
4. Reasoning: Fricatives sounds are by their nature semi-occluded. SOVTs are said to encourage balanced phonation (Guzmann, Laukkanen et al, 2013; Gaskill and Erikson, 2007). In order to phonate on a lip trill for a prolonged time Madeleine would have to increase air flow while establishing the most efficient level of breath pressure to maintain the trill. Madeleine's previously tentative singing had meant she was actively decreasing air flow in order to 'control' long phrases. This was counterproductive.
5. Testing the hypothesis in action: Through working to maintain a lip trill over an octave, Madeleine became used to the sensations of efficient breath management. Without attempting to do so, she observed a more energised use of lower abdominal musculature – the abdominal wall was able to gently move in and up, and she could feel a subtle engagement of the internal obliques throughout the phrase. Ron Morris's instruction 'If in doubt, breathe out' (Morris & Hutchison, 2016) was particularly helpful here as it took away from an intrinsic focus on musculature, towards a focus on maintaining the SOVT through efficient use of air flow.

Concept/ Solution: Once Madeleine was able to repeat the exercise multiple times, I then encouraged her to sing passages of repertoire using lip trills. The challenge now is to implement the techniques gained (increased air flow, efficient breath pressure, and more efficient use of the musculature pertaining to breath management) into exercises using vowels and words.

Jim, a promising 17-year-old baritone, had studied singing from childhood and garnered a good understanding of vocal technique. However, he was chronically underconfident.

1. Disturbance and uncertainty – identifying a problem: Jim’s tendency to intellectualise the various components of singing technique had left him tied in metaphorical knots, overthinking his actions and unable to see the act of singing as the sum of its parts.
2. Intellectualisation and definition of the problem – what I think is happening: Jim’s overthinking led him to rely on aural rather than sensory feedback, resulting in tongue root tension which caused pitching issues. Constant analysis contributed to negative self-talk, meaning that Jim would start a phrase well but give up halfway through. His perception of the need to ‘do’ meant that he was over-engaging his abdominal muscles due to a misunderstanding of the concept of ‘support’.
3. Studying the conditions and forming a working hypothesis – working out what can be done to solve the problem: I needed to find exercises that would help Jim technically without causing yet more confusion. I wanted to encourage healthy breath management, tongue release, confidence and mindfulness all at once. The ‘pigeon’ SOVT, where a ‘rolled r’ is maintained inside ‘puffy cheeks’, was extremely helpful in doing so.
4. Reasoning: The need to keep the cheeks filled with air encourages efficient breath pressure and flow without the need to consciously engage the lower abdominal muscles. The ‘rolled r’ allowed tongue release to occur without a specific focus on tongue placement. This kind of a ‘mixed methods’ SOVT is particularly beneficial as cheek inflation coupled with tongue oscillation creates yet more intraoral pressure (Andrade, Wood et al, 2014). Focusing mindfully on one exercise would release Jim from the cycle of overthinking, and the knowledge that the impossible would soon become possible would, in theory, increase his confidence.
5. Testing the hypothesis in action – reworking step 3: Because the aim of this exercise is functional efficiency rather than beauty of tone Jim’s tendency to listen and critique was eliminated, giving him the confidence to sing to the end of the phrase. After attempting exercises using this SOVT, we tackled some of the more difficult repertoire passages in isolation. While Jim had given up previously, the realisation that these passages would become easier filled him with confidence and renewed energy.

Concept/ Solution: An exercise such as the ‘pigeon’ allows chronic overthinkers to phonate mindfully and without self-criticism. This is because although a strange sound is created, balanced phonation, a reduction in tongue tension, and efficient breath management can be achieved without an intrinsic focus on the vocal mechanics. Once a more positive mindset is developed, it is my hope that the efficient vocal habits garnered will translate into vowel-based exercises and repertoire.

Recognising that the reflective process is ongoing, and that the vocal development of young singers is ever-changing, it will be pertinent to repeat the five-step process later on for each student.

Through the case studies above, I not only provided a useful model with which to reflect on my teaching, but also put into practice the theories of 'Reflection in Action' and 'Reflection on Action' (Schon, 1983). The former, taking place in singing lessons, allowed me to identify knowledge gaps as and when they came up. For example, in Eloise's lessons 'puffy cheeks' were contributing to tongue tension, and by reflecting *in* action I was able to immediately acknowledge that my initial approach could be honed. On the contrary, I am now able to reflect *on* action by revisiting the written notes that I make on all my students. This gives me the space with which to reflect on what *has* happened so that I can plan effectively and find a way forward for future lessons.

Schon (1983) advocates becoming a researcher into one's own practice in order to continue the process of self-education. Bisson (2017) describes the importance of making mistakes in application, maintaining that this should not be disheartening. Both of these theories imply that the singing teacher should be able to continue her journey to effective practice while maintaining humility.

PART II: THE ASSIGNMENT

A study into the use of semi-occluded vocal tract exercises for efficient vocalisation

Vocal ‘warm-ups’ have been carried out prior to singing for many years and come in many forms. However, considering that all types of voicing involve the phonation system, one might understandably ask what constitutes a *specific* vocal exercise within a systematic approach to teaching singing (Ragan, 2020). A number of studies have assessed Phonation Threshold Pressure (PTP) before and after ‘warm-ups’ involving a series of repeated vowels (Motel, Fisher & Leydon, 2003; Elliot, Sundberg & Gramming, 1995; Milbrath & Solomon, 2003). To conclude that a ‘warm-up’ has any impact, it must be observed that the resulting PTP is lowered, however, in these studies no consistent change to PTP occurred.

The anecdotal benefits of Semi-Occluded Vocal Tract Exercises (SOVTs), either as a ‘warm-up’ or otherwise, have been widely observed. The aim of this literature review is to examine both scientific and practice-based evidence for the use of SOVTs to aid efficient vocalisation. In order to do so, I propose to summarise findings from peer reviewed research before exploring the application of SOVTs in the voice studio by comparing the writings of eminent practitioners.

A Semi-Occluded Vocal Tract Exercise occurs where the mouth is partially closed during phonation. Exercises can include but are not limited to rolled /r/ sounds, lip trills, ‘puffy cheeks’, ‘raspberries’, voiced fricatives and straw/ tube phonation in water or in air (see appendix). A sweep of the literature found a greater number of studies on the efficacy of singing into tubes and straws, though several studies have also been carried out into the benefits of lip trills and of mixed exercises.

Gaskill and Erikson (2007) undertook a study into the effect of the voiced lip trill on glottal closed quotient. Their findings revealed a reduction in closed quotient in trained and untrained singers performing a lip trill for one minute. From this, it is possible to deduce that lip trills help to reduce vocal loading or ‘pressed’ phonation. This is particularly important for trained classical singers whose aim is to maintain balanced phonation, avoiding either ‘breathy’ or ‘pressed’ phonation. In this study, the reduction in glottal closed quotient was more pronounced in untrained singers, for whom glottal closure patterns were originally more inconsistent, with closed quotient before and after the lip trill higher than for trained singers in any case. This study was particularly of interest to me because, while other methods for

artificially constricting and lengthening the vocal tract had been observed (Titze and Laukkanen, 2002 and 2007), it was the first of its kind to have been carried out.

The researchers surmised that there were two plausible reasons why glottal closed quotient could be reduced during a lip trill. Firstly, in order to achieve continuous vibration at both the lips and the glottis, it is possible that a reduction in vocal fold adduction might be necessary to achieve adequate air pressure. The authors use the following equation to illustrate this:

$$\text{Pulmonary power (P)} = \text{lung pressure (p)} \times \text{airflow (U)}$$

As pulmonary power is proportional to acoustic power, in order to maintain vibration at both the vocal folds and lips, an increase in either lung pressure (p) or airflow (U) would be required in order to deliver the necessary acoustic energy. Therefore, for this to occur we either need to increase lung pressure, or as constant lung pressure can be assumed, to decrease vocal fold adduction rate in order to increase airflow.

Secondly, there is evidence to suggest that increased air pressure in the vocal tract can have a direct effect on vocal fold vibration (Story, Laukkanen and Titze, 2000). According to Titze (1996), partial occlusion of the vocal tract during SOVTs increases supra- and intraglottal air pressure, resulting in a decrease in glottal resistance with the vocal folds positioned slightly separately from one another.

If this is the case, the changes in glottal closed quotient seen in Gaskill and Erikson's study could be unrelated to changes in adduction. Indeed, according to Titze and Story (1997), there is evidence that vocal tract inertia has some effect on vocal fold vibration.

However, as the present study lacks data on vocal fold adduction it is impossible to conclude the reason for the reduction in glottal closed quotient. It is possible that both phenomena are at play. While more research is required into this field using singers rather than artificial vocal tract models, evidence in favour of a reduction in vocal loading resulting from a sustained lip trill is undoubtedly beneficial for both the singer and singing teacher.

Cordeiro et al (2012) also studied the effects of SOVTs on glottal closed quotient through an analysis of lip trills and rolled /r/, comparative to a sustained /e/ vowel, delivered in the same pre-established frequency and strength. Using electroglottography, this study compared the mean and standard deviation of closed quotient for these sounds in 10 opera singers, all of whom were in alleged perfect health. Although the maximum and minimum intensities were compared, only the data from maximum intensities yielded statistical significance.

Vocal fold closed quotient was different for lip and tongue trills than for the sustained /e/ vowel. Lip and tongue trills achieved an oscillation in closed quotient, with 'high intensity' lip trills

contributing to a higher closed quotient altogether. This is because trills, produced when occlusion of the lip or tongue is overcome by an increase in oral pressure, are dual source and fluctuating and therefore produce variations in pressure in the oral cavity (McGowan, 1992). These variations in pressure will produce oscillations in closed quotient at vocal fold level.

Unusually, this study reveals the opposite of Gaskill and Erikson's, concluding that lip trills increase vocal fold closure rather than decrease vocal loading. Gaskill and Erikson's study revealed particularly significant results for untrained singers with a tendency towards pressed phonation (whose resting closed quotient was higher), and for whom a reduction in vocal loading was achievable through the lip trill exercise. Cordeiro et al studied trained opera singers, whose resting closed quotient could be assumed to be lower than in untrained singers. Therefore, the lip trill, relative to this, would result in an increase in glottal closed quotient. As a singing teacher, exercises must be tailored to the student. For a student with breathy phonation, it may be useful to use lip trills in order to increase air pressure and vocal fold closure, whereas for a student with pressed phonation lip trills can be used to decrease vocal loading. It is important to remember that SOVTS can be used to aid singers with both hypo- and hyperfunctional voices and that exercises must therefore be tailored accordingly.

Two studies by Titze and Laukkanen (2002 and 2007) found that straw phonation contributes to vocal economy. The first study found that phonating with a high lung pressure and high pitch during straw phonation could be completed without vocal fold trauma because the vocal fold amplitude of vibration was relatively small due to the aerodynamic changes induced by the semi-occlusion. The second found that increased intraoral pressure results in better impedance matching at the glottis, which in practice facilitates easy phonation and projection without increasing the amplitude of vocal fold vibration. Both of these studies have clear and positive implications for the practical application of straw phonation in the voice studio.

Guzmann, Laukkanen et al (2013) measured the function of the vocal tract and the vocal folds during and after vocal exercises carried out into both a resonance tube and a stirring straw. This was the first study looking at two ways of artificially lengthening the vocal tract. The one male participant alternated phonation on /a/ at speaking pitch with phonation into the tube, and then /a/ with phonation into the narrow straw. Methods for analysis included computerised topography and electroglottography, and acoustic, perceptual, and subglottic pressure measures were also obtained.

During and after phonation into the tube or straw, the authors observed the following:

1. The soft palate was able to close the nasal passage with greater efficiency.
2. The larynx position lowered.
3. The hypopharynx widened.
4. The ratio between the inlet of the lower pharynx and the outlet of the epilaryngeal tube became larger.
5. Acoustic results revealed a stronger singer's formant cluster.
6. Listening tests revealed better voice quality.
7. Vocal fold closed quotient derived from electroglottographic reading decreased during both tube and straw phonation and remained lower.
8. Subglottic pressure increased during straw phonation and remained somewhat higher.

These changes were more prominent with straw phonation than with the resonance tube. As in Titze and Laukkanen's research, the results suggested that vocal exercises resulting in increased vocal tract impedance led to increased vocal efficiency. Although the sample size was small, changes were of statistical significance and also validated through other research (for example, Guzman, Rubin et al 2013 which notes an increase in 'singer power ratio', i.e., the singers' formant cluster, after straw phonation). This study is to be commended for its clear list of the practical benefits of straw phonation.

Further studies have examined the impact of straw size. Laukkanen, Pulakka et al (2007) studied glottal area variation during phonation using straws of different lengths and diameters. The study found that increasing straw length or decreasing straw diameter created greater resistance and higher aural air pressure. Andrade, Wistbacka et al (2015) observed the relationship between back pressure and air flow through a study of eight different tubes, a resonance tube and a silicone tube in air, with the latter two experiments repeated in water. It was concluded that changes to diameter had more of an impact than changes to length. Wider tubes submerged into water produced an almost constant back pressure determined by the water depth, whereas thinner straws in air produced relatively large changes to back pressure in relation to air flow. This study, which is an extension of Sojarvi's (1966) resonance tube method, is of use when customising different exercises in order to optimise singing teaching and/ or voice therapy outcomes.

Dargin, Searl et al (2014 and 2015) carried out two studies on the same group of four singers (three tenors and one soprano), comparing changes in the larynx following three different SOVTs repeated in a random order for two minutes: straw phonation, lip trills and tongue trills. The 2014 study took measurements using transnasal stroboscopy, while the 2015 study took aerodynamic and electroglottographic measurements.

Although many studies have been carried out into the impact of SOVTs using electroglottographs (Guzman et al, 2013; Gaskil and Erikson, 2007; Cordeiro et al, 2012), fewer studies are to be found that measure the impact of SOVTs through stroboscopy or endoscopy. Guzman et al (2013) looked at singers with hyperfunctional dysphonia using this method, for good reason; many of the changes found by MRI or EGG can be found with stroboscopy, and as this is more widely in use in the voice clinic it follows that further study using this method could be fruitful. Indeed, on the basis of predictions from modelling and other studies, the authors hypothesised that differences in vocal fold closure, mucosal wave behaviour, supraglottic activity, the height of the larynx, and contraction of the pharynx could be visually measurable from stroboscopic examinations during SOVTs.

The 2014 study found that all singers 'benefitted' from at least one SOVT but not all 'benefitted' from the same one. This further supports the hypothesis that vocal exercises must be modified for each singer. Although all SOVTs result in changes to the larynx and/ or pharynx that could be considered beneficial, singing teachers must carefully assess the specific impact of using a particular exercise in teaching or voice therapy.

The 2015 study revealed that mean air flow, sound pressure level and closed quotient tended to increase, and that the magnitude, direction and consistency of change across all four SOVTs varied from subject to subject.

Although changes did result from the SOVTs, too much variation in the results led the research to be inconclusive. This was undoubtedly due to the small convenience sample size. Further research on a wider demographic of singers, with the SOVTs carried out for a prolonged duration, would no doubt yield more useful results.

That said, it remains pertinent to look at these studies within the wider context of peer reviewed research into SOVTs because the study of the impact of *different* SOVTs on one singer has largely been ignored. Further research is needed into this specific field due to its important implications for how we prescribe certain exercises in the voice studio.

Andrade, Wood et al (2014) validate this by recognising the importance of examining the often-disregarded differences among SOVTs. SOVTs may present as having a single or double vibratory source, which will impact voice production patterns. In this study, the authors examined a series of SOVTs, including straw phonation, humming, lip trills and rolled /r/, LaxVox (LaxVox, 2021), hand-over-mouth, and an exercise made up of a tongue trill combined with hand-over-mouth to demonstrate the consequence of a secondary vibratory source on the vocal tract. The authors measured vocal fold closed quotient, closed quotient range, fundamental frequency, fundamental frequency range, and the difference between the first formant frequency (f1) and fundamental frequency (f0). The lip trill, LaxVox, rolled /r/ and

combined exercise all showed a significant change in the closed quotient range, and the analysis of the difference between the first formant and fundamental frequencies showed differences for exercises with one rather than two vibratory sources. The authors summarised their research by indicating that SOVTs should be split thus:

Type	Steady	Fluctuating
Source	Single	Double
Exercise	Hand-over-mouth Humming Straw phonation	Tongue trill Lip trill LaxVox
Closed Quotient Range	Smaller	Larger
f0 – f1 difference	Smaller	Larger

The rolled /r/ combined with hand-over-mouth produced mixed effects of both groups of SOVTs thus implying that this could be the most useful and multi-purpose exercise from a therapeutic point of view, and further enhancing the need for researchers to study the effects of multiple SOVTs rather than just one in isolation.

Laukkanen et al (2008) studied the effects of SOVTs on muscular activity in the larynx. This is particularly interesting because of the implications for teaching and studying vocal registration. Modelling results had suggested that matching glottal and vocal tract impedances could improve vocal economy. As vocal economy could be calculated as maximum flow declination rate (MFDR) divided by maximum area declination rate (MADR), and changes in MADR could be associated with activity in the thyroarytenoid (TA) muscle, a link could therefore be made between the effects of impedance matching on muscular activity in the larynx and glottal resistance.

In this study, one female research subject was monitored phonating on a /pa: p a:/ before and after phonating on SOVTs (a bilabial voiced fricative and phonation into tubes of different sizes). The method of electromyography was used to monitor the activity of the TA, cricothyroid (CT) and lateral cricoarytenoid (LCA) muscles. It was observed that the subject's TA activity, in relation to CT and LCA activity, increased due to vocal tract impedance caused by SOVT phonation.

We know that the role of TA activity in voicing is to increase pitch by isometrically tensioning the vocal fold throughout what is widely considered to be speech register (Hirano et al, 1970). This study revealed an increase in TA/CT and TA/LCA ratios during SOVTs, which remained high during vowel phonation which occurred immediately afterwards. Although, due to its

single participant, strong conclusions cannot be drawn from this study, results were consistent with computer modelling and support the hypothesis that exercises which increase vocal tract impedance will comparatively raise TA muscular activity.

The singing teacher can infer from this research that phonation on SOVTs contributes to balanced registrational navigation, helping the trainee singer to establish an efficient laryngeal setting (i.e., with a low phonation threshold pressure and high vocal economy). SOVTs are therefore useful in the treatment of both hypo- and hyperfunctional voice problems, as could be seen in the seemingly contradictory results from aforementioned studies by Gaskill and Erikson (2007) and Cordeiro et al (2012).

Many eminent singing teachers and voice therapists make use of SOVTs in their practice. Dinah Harris and Dane Chalfin (2018) describe the precise management of airflow and subglottic pressure as one of the most important factors in a singer's technique, later advocating 'blowing up the lilo', 'rolled r's' and 'lip bubbles' as techniques to this end. Jenevora Williams (2010) describes 'puffy cheeks' or 'floppy trumpet' as an exercise to release laryngeal constriction. Ron Morris and Linda Hutchison (2016) use voiced fricative sounds in their Accent Method breathing exercises. Pereira et al (2017) undertook a literature review on voice therapy techniques and found that SOVTs came up more often (22.22%) than other therapeutic systems.

In my deep dive into the works of practitioners, I found Janice Chapman (2016) and Kari Ragan (2020) to have devoted most print space to the rationale for and teaching of SOVTs. While many of their views overlap, the few differences in application make for an interesting comparison.

Chapman (2016, 339) includes descriptions of the 'rolled r' and 'puffy cheeks' exercises in the appendices of her book. The former is described as assisting in the direct development of 'core skills', the oscillation of the tongue providing a secondary valve and therefore facilitating back pressure in the oral cavity which allows for easy phonation 'at the vocal fold edges'. The 'puffy cheeks' exercise is described as doubly beneficial due to the inflation of the cheeks coupled with the semi-occluded /w/ opening creating additional back pressure.

As well as including methodical exercises on straw phonation and water bubbling, Ragan (2020, 74) describes vocal fold configuration, amplification and inertance during SOVTs. There is a practical discussion on the choice of straw type for phonation, backed up by peer reviewed evidence (Story, Laukkanen and Titze, 2000; Maxfield, Titze, Hunter and Kapsner-Smith, 2014) and taking into account the anatomical differences of singers owing to gender.

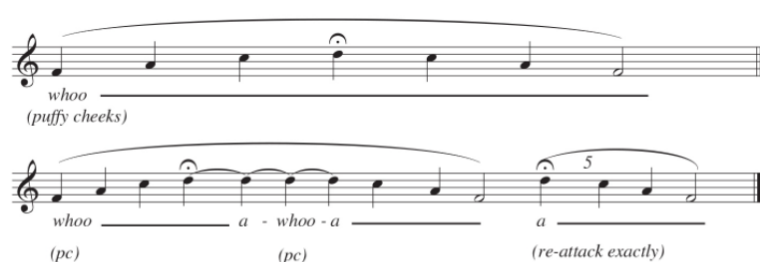
Ragan perhaps unusually describes using an anaesthesia or ventilation mask to facilitate a semi-occluded vocal tract, particularly beneficial for dysphonic singers. Citing Frisancho et al (in press at the time of publication) as evidence and describing her own anecdotal success in the teaching studio, Ragan maintains that the ventilation mask allows the singer to articulate freely while enjoying the benefits of semi-occlusion. Further research on this topic is, of course, needed.

The benefits of SOVTs are listed by both Chapman and Ragan thus:

	Chapman	Ragan
Lifted Soft Palate	x	
Stabilise larynx height – neither elevated nor depressed		x
Widened Pharynx	x	
Relaxed Facial Muscles	x	
Vocal fold efficiency	x	x
Increased Thyroid Tilt	x	
Acoustic reinforcement of the vocal tract through a narrowing of the epilarynx	x	x
Lower phonation threshold pressure		x
Improved breath management through consciousness of abdominal support	x	
Registral Problems Improved	x	x
Pressed Phonation Improved	x	x
Addresses Nasality	x	
Addressed Imbalances of Resonance	x	
Balanced onsets through gentle adduction		x
Provide a sensation of having had a laryngeal massage		x
Sensorial feedback of sympathetic vibrations of facial tissue		x

Although the majority of the benefits listed gain credibility through mirroring scientific findings (Guzmann & Laukkanen, 2013; Guzman, Rubin et al 2013; Titze & Laukkanen 2002 and 2007, and others), it is important to consider that practitioner-led literature includes opinion which might not always warrant factual backing. It is interesting, for example, to note Ragan's assertions that SOVTs provide the sensation of a laryngeal massage and sensorial feedback through the facial tissue. These must also be read with caution.

Both authors agree that vocal exercises must be developed creatively for the individual singer (Chapman, 2016, 335; Ragan, 2020, 76 & 97). In practical terms, Chapman describes the ‘raspberry puff’ SOVT as an extension of ‘puffy cheeks’ for a singer suffering from tongue root tension. Both Chapman and Ragan promote the combining of SOVTs with vowels, text and then repertoire in order to put the technical skills gained into context:



*All voices :
Use pitch range from comfortable middle voice up to above the upper passaggio.
Notice the lightening of the vocal loading at the higher pitches.*

(Chapman, 2016, 343)

Water Bubble Repertoire

Purpose 4-7

Progressing from water bubbles to repertoire is very effective at habituating efficient voice production (Figures 4-7A and 4-7B). The expectation is that there is carryover from the SOVT benefits. Practice-based evidence supports that for this author. Since SOVTs establish efficient voicing, alternating water bubbles and the text of a song ideally sets up a baseline of functional singing technique.

(Ragan, 2016, 98)

Ragan tells a ‘cautionary tale’ (2020, 97) of a singer in recovery from a vocal haemorrhage suffering further vocal fold injury from excessive intraoral pressure caused by straw phonation into water. In doing so, the importance of modifying exercises to avoid adverse effect is reinforced, along with the ethical validity of Ragan’s work.

A comparison of these two authors’ writings on SOVTs is enlightening. Janice Chapman’s long-commended work reasserts widely recognised thought, through the gaze of the author’s often unique pedagogical methods. Kari Ragan takes the now-established concept of the SOVT and gives inventive suggestions for its practical application in well-referenced, granular detail while maintaining ethical standards.

CONCLUSION

Through this literature review it is clear that an abundance of both scientific and practical evidence exists in favour of the use of semi-occluded vocal tract exercises for efficient vocalisation. Titze and Laukkanen are undoubtedly major contributors in this field, though the books of Ragan and Chapman also provide important practical information. The researcher must look to the works of practitioners and to 'grey literature', as well as to peer reviewed articles if a forensic overview of the topic is to be gained.

Phonation with a semi-occluded vocal tract can promote the following:

1. Soft palate raised.
2. Larynx stabilised.
3. Pharynx widened.
4. Epilarynx narrowed, resulting in acoustic reinforcement.
5. Phonation threshold pressure lowered.
6. Subglottic pressure increased.
7. Registers managed with ease.

That said, there is of course scope for further research into the field. Further insights are to be gained through researching 'mixed method' SOVTs (e.g., hand-over-mouth with 'rolled r'/'pigeon'), through research on human subjects rather than using tubes and models, through making use of stroboscopy, and through looking at a wider demographic of singers.

For my next project, I plan to undertake research into the effects of a programme of SOVT-based exercises on my teenage students, with data garnered from survey responses on self-perception and entries from students' practice diaries, as well as my own case studies based on Dewey's five-step reflective model. I am confident that this will provide important insight into the perceived effects of SOVTs on young voices. From a pedagogical perspective, this will allow me to plan my students' lessons more efficiently, as well as affording my students' increased self-awareness that will help them on their singing journeys.

Renewed knowledge of the multiple benefits of SOVTs has real implications for work in the voice studio. There is increasingly no place for the 'warm-up' without specific vocal function. Singing teachers have a duty to be forensic in their pursuit of the needs of their students, creatively reworking exercises to suit a variety of needs, in the knowledge that SOVTs can serve many different purposes.

APPENDIX

Semi-occluded vocal tract exercises

Lip Trills Lip Bubbles		The lips vibrate continuously together during phonation.
Rolled R		The tongue vibrates on a continuously rolling /r/ during phonation.
Puffy Cheeks Floppy Trumpet		The cheeks, and the area between the top lip and top teeth, are inflated during phonation on a loose /w/ sound.
Pigeon		A combination of the 'Rolled R' and 'Puffy Cheeks' exercises. The mouth remains partially closed with cheeks and upper lip inflated with air and phonation occurring on a rolling /r/.
Raspberry		The cheeks remain inflated as in 'Puffy Cheeks' while the tongue protrudes over the bottom lip and vibrates during phonation.
Fricative sounds		Fricative sounds create a semi-occlusion, either at the tongue or lips, and can be a useful transition into SOVTs for students who find other exercises difficult.
<i>Unvoiced</i>	<i>Voiced</i>	
/f/ <u>f</u> orte /s/ <u>s</u> emiquaver /ʃ/ <u>sh</u> ort /θ/ <u>th</u> ermometer	/v/ <u>v</u> iolin /z/ <u>z</u> ebra /ʒ/ <u>J</u> e m'appelle /ð/ <u>th</u> ese	

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