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‘Support?’

An investigation into the ambiguity of this term within vocal pedagogy, and the implications for the singing student.

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Glossary

Abbreviation	Definition
TR	Trapezius, a large superficial back muscle attached at the top of occiput that runs down the back on the neck, into the shoulder and between the shoulder blades.
CWK	Chest wall kinematics, movements of the chest wall. The chest wall is the bone-and-tissue framework that creates a cage around the vital organs such as heart and lungs.
AB	Abdominals, a set of strong bands of muscles which line the abdomen, the trunk of the body.
ABW	Abdominal wall, formed of skin, fascia and muscle encases the abdominal cavity and viscera.
INT	Intercostals, muscles situated between the ribs.
RC	Rectus abdominus, abdominal muscles front and centre of the trunk. Can be seen as the 'six pack', moving the body between the ribcage and pelvis.
OBL	Oblique abdominal muscles, of which there are two types, internal and external. They are situated on the sides and the front of the trunk.
IOM	Internal oblique muscles, covers the transvers abdominis and forms the middle layer of the lateral abdominal muscles.
EBVP	Evidence based vocal pedagogy (Ragan, 2018), a model for vocal pedagogy based upon evidence-based medicine.
ILV	Initiating lung volume, measurement of lung capacity to initiate phonation.
TLV	Terminating lung volume, measurement of lung capacity at end of a breath for phonation.
STM	Sternocleidomastoid, a large superficial neck muscle that runs from the sternum to the sides of the head in a V shape.
SC	Scalene, three muscles located just behind STM. They form part of the posterior triangle of the neck, acting as accessory muscles of respiration and enabling flexion of the neck.

EMG	Electromyographic equipment measures the electrical activity of muscles.
EGG	Electroglottography equipment measures the changes of relative vocal fold contact during laryngeal voice production.
UTX	Upper thorax, the upper area of the trunk between the base of the neck and the diaphragm.
PN	Posterior neck region, the back of the neck.
BF	Biofeedback, a mind-body technique that enables you to control some of your body's functions such as muscle responses.
PC	Pectoralis major muscle, the large superficial muscle that spans the front of the rib cage, originating from the sternum and outer clavicle connected to the humerus.
F	Female.
M	Male.
N	Number.
CCM	Contemporary commercial music.
SPLAT	Singers, please loosen abdominal tension (Chapman and Morris, 2023).
MT	Music Theatre.

Gaant chart of proposed work plan

			19/06/2023	26/06/2023	03/07/2023	10/07/2023	17/07/2023	24/07/2023	31/07/2023	07/08/2023	14/08/2023	21/08/2023
			Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Task	Start	Finish										
PHASE1 PREPARATION												
Decide on topic	19-Jun	10-Jul										
Order books	19-Jun	03-Jul										
Reading on utilising grey literature	26-Jun	03-Jul										
Reading exemplars	26-Jun	10-Jul										
Reading & beginning overview review	17-Jul	31-Jul										
Send in title	03-Jul	03-Jul										
PHASE2 READING & WRITING												
Begin reading articles & ANTIC	03-Jul	09-Oct										
Begin writing Portfolio (rationale)	03-Jul	09-Oct										
Send beginning of portfolio to tutor	24-Jul	24-Jul										
PHASE3 ASSIMILATING & ANALYSING												
Create a synthesis matrix	14-Aug	02-Oct										
Create a summary table	11-Sep	02-Oct										
Map the literature	18-Sep	02-Oct										
PHASE4 WRITING UP												
Write reflective diary	19-Jun	18-Sep										
Write literature review	04-Aug	09-Oct										
Write reflective review	18-Sep	09-Oct										
Draft deadline in	16-Oct	09-Oct										
Revise project post feedback	16-Oct	30-Oct										
Submit work	30-Oct	30-Oct										

			28/08/2023	04/09/2023	11/09/2023	18/09/2023	25/09/2023	02/10/2023	09/10/2023	16/10/2023	23/10/2023	30/10/2023
			Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20
Task	Start	Finish										
PHASE1 PREPARATION												
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‘Support?’

An investigation into the ambiguity of the term ‘support’ within vocal pedagogy, and the implications for the singing student.

1. Portfolio

Introduction and Rationale

I have both heard and used the instruction to ‘support the voice’ many times in my career as a singer and freelance singing teacher, yet Dewey (1910, p.177) challenges the use of “catchphrases, cant terms, familiar propositions” in teaching. Emerich-Gordon and Reed, (2018), describe ‘support’ as nonspecific, Sonninen et al. (1993, p.258) states it as “a vague concept” and Pettersen (2005, p.256) contends there is “no consensus about the meaning of the term”. Macdonald et al., (2012) Sonninen et al. (1993), and Sand and Sundberg (2005) also argue that ‘support’ is vital, difficult to learn and teach, and used in judgement of singers who are not using enough of it. Two recent scenarios from my practice demonstrate this; A 9-year-old student was repeatedly critiqued in her grade 3 singing exam for needing ‘more support’, and a postgraduate advanced singer and potential student was critiqued by colleagues for lacking support. How helpful is a term without “exact physical correlates (that) have not yet been accurately identified” (Sand and Sundberg 2005, p.51) to these students? The purpose of this assignment is to investigate whether the term ‘support’ is ambiguous and therefore potentially unhelpful within vocal pedagogy, whether it can be more clearly defined and what impact the common usage of an ambiguous word has upon students.

Aims

- Critically explore what is meant by vocal 'support' primarily within Western classical vocal pedagogy.
- Compare what is meant by vocal 'support' for non-classical styles (contemporary commercial music CCM).
- Explore how esteemed vocal pedagogues teach and define 'support'.
- Explore any ambiguity associated with the term 'support' and what effect ambiguity of terms may have upon teaching and learning.

Objectives

- Explore science-based literature to critically examine what is meant by the term 'support' to see if any ambiguity can be clarified.
- Identify and analyse the approaches taken by esteemed pedagogues to teach 'support'.
- Explore the literature to explore the ramifications on teaching and learning when terms are ambiguous.

Learning Outcomes

- Be better equipped and more confident to define 'support' using appropriate and specific terms.
- Be better equipped to teach 'support' appropriately to every level of singing student.

Research Questions

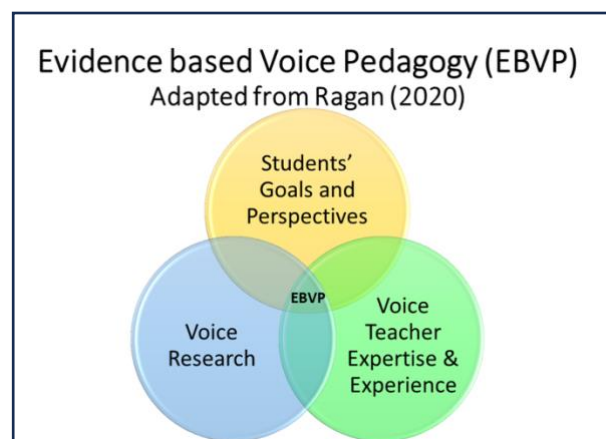
- What is physiologically happening when a singer uses 'support'? What muscles are engaged in the body?
- Which pedagogues are highly respected in vocal pedagogy and how do they teach 'support'?
- Does their methodology correspond to current research?
- Do other styles of singing require the same usage and level of 'support'?
- Can I create an artefact that physically facilitates 'support' for students obviating the need to use the term?

Ethical Considerations

“Informal conversations” (Swain and King, 2022, p.2) were undertaken early on with colleagues and this presented an ethical dilemma because I had no ethical approval to interview them. Thankfully this dilemma diminished as my research progressed, as the influence of these conversations dwindled into “background information” (Swain and King, 2022, p.3). Similarly, in keeping a reflective diary of student’s lessons, confidentiality was protected by using pseudonyms and avoiding any identifying information (Allmark et al. 2009). Additionally, the reflective model was utilized to analyse the content of the diary for salient information rather than including the diary, which further protected anonymity. Another temptation was to treat singing students as guinea pigs (Rao and Lanjewar, 2022) trying out new ideas on them. To combat this, a student-led approach was prioritised choosing the most appropriate strategy (appendix 6) for best results on an individualized basis (Bozeman and Ragan, 2022; Holding and Ragan, 2022).

The Literature Review Process

Ragan’s (2018) evidence-based voice pedagogy (EBVP) model was chosen to organise this assignment as it acknowledges voice research and voice teacher expertise equally whilst prioritising the student.



EBVP is based on evidence-based medicine (EBM) where patient care decisions are built on high-quality clinical trials. EBM is critiqued for a generalist approach which fails to consider patient individuality, for a lack of acknowledgement of bias driven by economics, and a narrow definition of evidence (Cohen and Hersh, 2004; Ratnani *et al.*, 2023). Ragan’s EBVP framework (Ragan, 2018, 2020; Maxfield and Ragan, 2021; Bozeman and Ragan, 2022; Holding and Ragan, 2022) recognises these limitations and seeks to address them by; valuing the importance of scientific research whilst acknowledging it’s limitations, incorporating expertise in vocal pedagogy that is proven in practice but lacking scientific data (Watson and Hixon 1987, Maxfield and Ragan 2021, and Glasner 2023), and finally acknowledging the individual goals of the student (Maxfield and Ragan, 2021).

Voice Research

The process of researching the voice literature followed Hart's (2001) touring and camping model, developed by Gray (2009). A broad-based search was conducted of peer-reviewed literature on 'support' using key words (Cooper, 1988) to search various databases, Google Scholar, PubMed and Scopus from 1980 to 2023 (Gordon and Reed, 2018). 'Support' and 'singing' yielded seven explicit articles (appendix 2) and bibliographies of these articles highlighted other articles which were systematically logged and prioritized according to relevance. Other key search terms such as 'abdominals' and 'breathing' emerged. Recent articles were found to review and summarize seminal work, authors, and theories and in listing over one hundred articles, authors began reappearing, also identifying key work. Articles were prioritized for relevance in recognition that the search could not be exhaustive given time constraints as an individual working alone (Boote and Beile, 2005, Flett et al., 2016a). Just over thirty articles were "camped" (Gray 2009, p.101), identified as most relevant and worthy of analysing in greater depth.

The quality of best available studies (Ragan, 2018) was variable and considerable limitations must be acknowledged (Morrison and Van Der Werf, 2018). Most are science-based and quantitative, (Hewitt and Keen 2009), with a lack of qualitative studies. The internal validity of these studies must be questioned (Iannidis, 2005) for the following reasons (Kang, Scholp and Jiang, 2017): These studies often do not state clear hypotheses, funding sources, or much self-awareness of bias. The sample sizes are small, sometimes as few as two subjects (appendices 2 and 3). Only four studies included a larger sample size of twenty to fifty, still small samples, and few studies used a control group. Most studies were conducted with professional classical singers. Whilst this is my bias, these studies raise the question of external validity; how relevant these methods of support are for singers who are neither professional nor classical. Such quantitative studies with a specialist population may not be generalized (Molnar, 2023). Only one study was both quantitative and qualitative (Griffin *et al.*, 1995) revealing a chasm between what a singer does and what they understand themselves to be doing highlighting a need for further research. Key articles were listed in date order and then collated and synthesized into summative charts (appendix 2 and 3) (Green, Johnson, and Adams 2006). It was also difficult to compare studies when researchers used different or generalised physiological terms such as lateral abdominal muscles (P. J, Watson *et al.*, 1989). Having analysed the literature certain key themes emerged: support, breathing, use of abdominals, posture, other muscles, and subglottic pressure. The chosen pedagogues were then critically examined for their opinions on these topics. Although the focus of this review was classical singing technique, the literature was examined briefly to investigate what 'support' means for non-classical (CCM) styles. No explicit

'support' literature was found for CCM styles, but two studies made comparisons between styles (Macdonald *et al.*, 2012; Sundberg and Thalen, 2015), so their bibliographies were scrutinised for further articles. 'Ambiguity in education/classroom' was chosen as the key search term (Cooper, 1988) to explore ambiguity, combined with a berry-picking approach (Bates, 1989) exploring this issue from a variety of sources within education and psychology.

Voice teacher expertise and experience

World renowned vocal pedagogues were identified to investigate their perspectives on 'support' (Bozeman and Ragan, 2022). Richard Miller (1997) investigated different national schools of singing giving a historical and cross-cultural perspective to Western classical singing. Janice Chapman and Ron Morris (2023) were identified as current world-renowned specialist classical pedagogues who have also published peer reviewed articles. Sadolin, (2012) was chosen for having developed a comprehensive system for teaching CCM. Ragan (2020) was chosen for her work as an academic and practitioner, but also for her ability to cross-over between classical and CCM styles as was Obert (2023), who in addition is a speech and language pathologist and recent influence on my teaching practice. Effort was made to procure the latest edition of published resources. These sources were analysed and synthesized to identify what each teacher understands by 'support'. As the research process moved to "specifying and integrating" (Gray 2009, p.101), certain themes began to appear, and literature was coded and synthesized (Efron and Ravid, 2019) (appendix 3). A general narrative literature review was chosen aiming to create a narrative synthesis by analysing theories and practices of 'support' (Juntunen and Lehenkari, 2019), give some historical context (Onwuegbuzie and Frels, 2016), all investigated through the lens of ambiguity. Material central to the subject was focused on (Cooper, 1988) but this subject is interrelated (Huesler and Rodd-Marling, 1976) to the whole singing mechanism (Herbst, 2016) and it is impossible to be entirely comprehensive within the scope of this submission.

Critical Reflection

The topic of 'support' was always going to prove to be a challenge for a non-scientist with an aversion to quantitative research. The subject proved to be extensive and at times overwhelming with increasing topics presenting themselves (Herbst, 2016) as potential rabbit holes (Donahue *et al.*, 2011). I recognised my bias for breath control early on and chose two additional foci to combat overwhelm: muscular engagement and the relationship of the breath with subglottic pressure. Writing on these complex issues for readers who are both experts (Hart 2001), and who will also have their own bias (Collyer, Kenny and Archer, 2011) was unnerving. Freshwater, Rolfe, and Jasper's (2001) model of reflection was chosen for its simplicity; to facilitate clarity where the subject is complex and ambiguous, and because it coheres with the goal of seeking students' improvement. Consequently, I shall write under their structures, what, so what and now what?

What?

Green, Johnson, and Adams (2006) identify that narrative literature reviews are often fraught with bias, and I acknowledge several. Firstly, the bias that 'support' means breath support revealed by Glasner's, (2023) pedagogical flowchart (appendix 4) which also challenged my presupposition that breath support comes first and foremost. Obert's (2023) course 'vocal pedagogy in the era of the modern voice studio' taken in July also highlighted that 'support' can be what is happening at the vocal fold level in controlling subglottic pressure, challenging me to consider issues of phonation or resonance more readily. Certain notions of what is correct have been confronted. Glottal onsets previously regarded as wrong and dangerous have been examined as reflecting my classical singing technique. Teaching a glottal onset as a means of encouraging better vocal fold closure particularly for those with a breathy phonation or those running out of breath has been revelatory (Herbst, 2016; Obert, 2023).

The choice of the word 'ambiguity' also reveals a bias, and it was also revelatory to discover that intolerance for ambiguity is well recognized in psychology (de Vries, 2021) and is a personality trait that can lead to stress and anxiety (Moffett et al. 2021, Derakhshan et al. 2022). Learning that accommodating ambiguity is a psychological strength (Hancock and Mattick, 2020) has been challenging, but also helped underline that complexities and ambiguities are there for all (Herbst, 2016). Exploring the use of an ambiguous term such as 'support' has also led to a reflection on all language used in the teaching studio. Watson and Hixon (1987), and Griffin's et al. (1995) studies highlight that there is a distinction between the body somatically

learning and understanding what to do and cognitively understanding what the body is doing. It is debatable whether it is better or more helpful to use “biomechanical descriptions” (Emerich-Gordon and Reed 2018, p.243) at all in the studio and while knowledge has grown, wisdom and restraint are needed to curtail the temptation to share new terminology with students. Finding practical ways for students to experience their learning somatically rather than intellectually (Treinkman 2022) is the priority considering different learning styles (Obert, 2023). The development of the artefact is an attempt to embed findings from the research into a practical tool that students can use to facilitate ‘support’ using less words alongside hand symbols, other equipment, and analogy (Ragan, 2020; Chapman and Morris, 2023; Obert, 2023). This only skims the surface of this subject, and this area requires further study (Jäncke 2012, Hoch and Sandage 2017, Sardana and Rathore 2022).

So what?

Replacing certainty with uncertainty is uncomfortable and unsettling as the reality that there are many breath techniques for singing has been faced. Before this research I was possibly guilty of the Dunning-Kruger effect and ignorant of my own ignorance (Dunning, 2011). Realising how little I know and how much there is still to learn has caused me to question the quality of my own teaching, knocking my confidence as I have hesitatingly investigated new ways of teaching ‘support’. Learning has never felt so uncomfortable, and it has felt a fragile hope that I am growing in excellence (Kumagai, 2022). However, when I felt most uncomfortable, Bozeman and Ragan (2022) reminded me that I have thirty years of experience and success with many students which must triangulate with new learning rather than being discredited or devalued.

Now what?

One key issue revealed and confirmed through the research is the importance and vitality of the abdominal muscles when breathing (Watson and Hixon, 1987; P. J, Watson *et al.*, 1989; Thomasson and Sundberg, 2001; Salomoni, van den Hoorn and Hodges, 2016; Cunsolo *et al.*, 2022). Breathing patterns may differ, and the abdominals may be used in varying amounts according to style, but they are strategic for controlling subglottic pressure, and Ragan’s analogy that they are the singers’ “gas pedal” (Ragan 2020, p.36) is instructive. Consequently, whilst the term ‘support’ may lack specificity, it may still be a helpful word for describing the work the torso does to facilitate phonation. Chapman and Morris’s (2023) model featuring the diamond of support, primal sound, and the SPLAT (singers please loosen abdominal tension) breath are extremely helpful as they facilitate accessing the muscles without unnecessary

explanation, and a teaching artefact based on this has been developed. A more accurate shape is a kite which is also an imaginative and fun shape to use with children but also instructive in identifying the parts of the body required without using physiological names which Treinkman (2022) identifies as preferable. The kite is placed in position and the student encouraged to SPLAT through the centre of the kite with the in-breath (appendix 1). A warmup song has also been created to 'Let's go fly a kite' (appendix 8). In using a fun, uplifting song as a warmup exercise with the kite, the emotions of joy and freedom the song engenders can be encouraged which may also lead to better physical engagement of the muscles (Foulds-Elliott *et al.*, 2000). This artefact is suggested for a classical approach recognising that other approaches may be needed for CCM (Ragan, 2020; Obert, 2023).

It is difficult to extrapolate from academic research exactly what the correct amounts of 'support' are in the sound from a nine-year-old to a classical singing graduate and I will continue reflecting on this beyond this assignment, but the above artefact may help all levels in a fun and imaginative way with minimal verbal cueing. I have identified that I would like to shadow other teachers who teach at post graduate level to better equip my own ears. However, I have been challenged that this issue may continue to be somewhat ambiguous and affected by the bias of the person watching who may expect to see certain parts of the torso moving in a particular way depending on the technique they have been schooled in (Miller, 1997; Sonninen *et al.*, 2005; Collyer, Kenny and Archer, 2011). In discerning this I have been challenged to listen more than to watch and to close my eyes to isolate the auditory, and to be more confident in my own ability to hear the presence of 'support' in the sound (Sand and Sundberg, 2005; Sonninen *et al.*, 2005). In addition to this, I seek to be more careful and specific in offering feedback so that I am not guilty of offering a truism, 'more support needed' as feedback to a student.

2. The Assignment.

Best available research.

What is 'support' and why is it important?

There is evidence within the best available research of a clear distinction between 'supported' and 'unsupported' singing. Two studies specifically explored the issue seeking to observe the physiological differences, and to develop a definition. In the first, Sonninen et al. (1993) tasked his sample of professional singers to sing with and without support, and he found three characteristics for supported singing: longer phonation time, a lower larynx, and higher subglottic pressure. In the second, Griffin et al. (1995, p.54) found similar quantitative results when comparing trained with untrained singers describing the "supported singing voice" as

"distinguished by its spectral characteristics and high sound pressure level and singers produce it by increasing peak airflow and subglottal pressure and making changes in glottal and/or laryngeal configuration."

These studies highlight that 'support' is something that professional singers can choose to use and distinguishes that those who have been trained tend to sing with 'support' and untrained singers do not. Furthermore, 'support' is distinguished by the position of the larynx and higher subglottal pressure which is accessed through breath control.

Further studies show evidence that 'supported' and 'unsupported' singing can be distinguished audibly. Sand and Sundberg (2005) found that expert listeners could hear differing levels of support in the voice, and that 'supported' sound does have certain acoustic characteristics that can be identified concurring with Sonninen et al. (1993) and Griffin et al. (1995). Sand and Sundberg's, (2005) study had certain weaknesses with concerns that results were exaggerated, Cronbach alpha of 0.91 being questionable (Tavakol and Dennick, 2011). However, Sonninen et al. (2005) carried out a similar investigation and showed that 'support' could not only be detected in the samples by experts, but it was associated with what the listeners thought of as "good voice" (Sonninen et al. 2005, p.227) and furthermore it could also be detected by non-singers, potentially challenging the idea that only experts can detect 'support' in a voice. However, they cautioned that this was "not categorical" (Sonninen et al. 2005, p.227) citing clear disagreement over certain samples.

If 'supported' singing is identified as "good" singing (Sonninen et al., 2005, p.227) and is the means of making a higher sound pressure level (Griffin et al., 1995), then this identifies 'supported' singing as important for students seeking to improve. This research would seem to suggest that 'support' is a straightforward issue. It can be distinguished in the voice (Sand and Sundberg, 2005) even by non-singers (Sonninen et al., 2005), and the physical correlates of a supported sound can be identified (Sonninen et al., 1993; Griffin et al., 1995). However, this issue is far from straightforward which is indicated in Sonninen et al's., (2005) study when they cite disagreement over degrees of 'support' heard in some of the samples in their study.

Breath control and the interaction of rib cage and abdominals.

Griffin et al., (1995) found that the professional singers in his study described 'support' in terms of what they were doing to control the breath. The differences in breath control between those who have received training and those who have not shall now be examined. Kang, Scholp, and Jian (2017) outlined that respiratory differences are evident when comparing singers with non-singers. Whilst there is no difference in total lung capacity between singers and non-singers, trained professional singers have a better breathing reserve and ability to utilize their breath efficiently to produce sound more effectively. Salomoni, van den Hoorn, and Hodges (2016) explored whether and how trained singers breathed differently to untrained singers. They found that both trained and untrained participants breathed identically when not singing, and there was astonishing uniformity between breathing patterns shared by the non-singers when breathing for singing. Overall professionals used their abdominals 2.5 times more when singing than non-singers. However, the professional singers all breathed differently from each other when singing with a spectrum of variations of rib cage (RC) and abdominal (AB) usage. This finding of huge variation in breathing techniques amongst professionals begins to reveal an ambiguity when trying to discern whether there is a correct way of breathing to 'support' the sound.

Other studies which show a huge array of breathing patterns between professional singers are: Watson and Hixon, (1987) who showed that there was a wide variation of RC and AB usage even within their small single sex sample of professional singers. Thomasson and Sundberg (1997) who found the breathing system to be central in enabling the singer to control subglottic pressure to vary pitch and loudness, also finding variations of strategy between singers. Although Thomasson and Sundberg (2001) found rib cage and lung volume to be consistent between singers they found that the use of the abdominals was highly variable. Peultier-Celli et al. (2022) also found wide variations of breathing patterns which overall fell into three categories; 70.6% of their subjects used abdominal breathing, 23.5% thoracic and 5.9% used

clavicular breathing. Cunsolo et al. (2022) tested a device to noninvasively gauge ribcage and abdominal movements as well as vocal fold activity comparing professional singers with a control group. Results showed that whilst both groups used the same volumes of air, non-singers utilized much more of the rib cage indicating thoracic breathing, while the professional singers engaged their abdominal muscles far more, five times as much than the control group. They conclude that the professional singers by utilizing their abdominal muscles were able to minimise the effort required at the vocal fold level, thereby far more efficiently and safely phonating.

Thorpe et al. (2001) also found that breath management was key for 'supported' singing, showing that the professional singers in their study increased their use of RC and AB, decreasing mean expiratory flow, controlling subglottal pressure at the vocal folds leading to an increase in acoustic power. In contrast to Watson and Hixon, (1987); Thomasson and Sundberg, (1997); Cunsolo et al., (2022); and Peultier-Celli et al., (2022) this study appears to show a far greater uniformity of breathing patterns between the professional participants. However, this is likely to be due to all the subjects being taught breathing technique by pedagogue, Janice Chapman, who was also a participant. Foulds-Elliott et al. (2000) found that professional singers breathed and sang completely differently depending upon whether they sang technically or with emotion. Emotional connection led to higher initiating lung volume and lower terminating lung volume, an increased use of the abdominals, particularly the laterals, and singers used more air and a greater percentage of their vital capacity. They argue that connecting with emotions can facilitate a better and more coordinated engagement with the body.

Collyer, Kenny, and Archer (2011) researched whether expert pedagogues could hear different breathing techniques in samples where the singers breathed in 3 different ways: habitually with no instruction, abdomen in and abdomen out. They hypothesized that the experts would immediately distinguish habitual breathing, and that they would identify the abdomen out singing strategy as better. Whilst they did favour the singer's habitual pattern, they found little evidence to support the notion that pedagogues can hear different breath strategies in the tone, however they did find evidence of pedagogues being highly critical of breathing strategies in general.

To summarise, breath control is strategic for activating 'support' (Griffin et al., 1995; Thomasson and Sundberg, 2001; Thorpe et al., 2001; Peultier-Celli et al., 2022). Non-singers breathe in a uniform way, differently to professional singers (Salomoni, van den Hoorn and Hodges, 2016; Kang, Scholp and Jiang, 2017). Professional singers use abdominals to a far greater extent than non-singers, one study showing two and a half times more (Kang, Scholp and Jiang, 2017)

and another study showing five times more (Cunsolo *et al.*, 2022), and professionals sing with more 'support' when they sing with emotion (Foulds-Elliott *et al.*, 2000). Despite this commonality, professional singers exhibit a wide variety of ways to breathe for singing (Watson and Hixon, 1987; Thomasson and Sundberg, 1997; Cunsolo *et al.*, 2022; Peultier-Celli *et al.*, 2022). It seems that this may be due to singing teachers teaching breath technique in various ways as observed in the uniformity of breathing patterns in one study where participants were all trained in one technique (Thorpe *et al.*, 2001). In addition, singing pedagogues may be biased about which breathing technique they prefer, a judgment based not on the sound produced but other parameters (Collyer, Kenny and Archer, 2011). This indicates that variations of breathing techniques between professionals may be largely due to different teaching methodologies, highlighting a key ambiguity in breathing technique requiring further research.

Use of abdominals.

Studies repeatedly show variations of breathing patterns to be related to the proportions of rib cage (RC) and abdominals (AB) utilised. Sundberg *et al.* (1991) found that the abdominals were vitally important and significantly interacted with the rib cage and diaphragm to control subglottic pressure, however Thomasson and Sundberg, (2001) found that variations between singers' techniques were due to AB usage rather than RC or lung volume. This may partly be explained by the complexity of the abdominals and the fact that they are comprised of four sets of muscles (Seeras *et al.*, 2023), so specificity of AB muscle usage shall now be explored. Two studies highlight the increased use of the lateral abdominal muscles; Foulds-Elliott *et al.*, (2000) found the lateral abdominals engaged more convincingly when professionals sang with emotion and Watson *et al.* (1989) found that the lateral abdominal muscles were strategically used by singers with many variations between the use of the upper and lower lateral muscles. Watson *et al.*, (1989) do not specify exactly which set of lateral abdominal muscles; whether they mean the transverse abdominis for lower lateral muscles and the rectus abdominis for what they call the "middle region" (Watson *et al.*, 1989, p.31) which they state as inactive. The inactivity of the rectus abdominis is controversial as textbooks such as Calais-Germain and Germain (2016) cite the use of the rectus abdominis for singing. Despite Watson *et al.*'s (1989) lack of specificity, these findings however do appear to cohere with Blake's (2009) later clinical observations. Blake (2009) as a specialist singing physiotherapist working in a clinical setting with singers encountering vocal health problems, brings a useful perspective to the discussion on breath 'support' using ultrasound to observe what is happening to the abdominal wall (AW). In his clinical observations he notes how vital the transverse abdominal muscle is for controlling subglottic pressure, and how the overuse of the oblique muscles or the rectus abdominis can be

problematic. Macdonald *et al.*, (2012) also used ultrasound to measure the use of two sets of abdominal muscles; the transversus abdominis muscles (TAM) and internal oblique muscles (IOM) when singing. They found that both sets of muscles were recruited for singing, however the TAM muscles were recruited preferentially and to a greater percentage than IOM. They concluded that “the peri abdominal muscles do play a role in ‘supporting’” the voice (Macdonald *et al.*, 2012, p.815, e9). Whilst these muscles can be strengthened in various ways singers benefit more when they are trained in the context of singing (Ray, Trudeau and McCoy, 2018).

In summary, studies show that there are wide variations in the amount of abdominals used by professionally trained singers (Thomasson and Sundberg, 2001). It is the transverse abdominis, the deep lateral abdominals that play the most important role in ‘supporting’ the voice (Watson and Hixon, 1987; Blake, 2009; Macdonald *et al.*, 2012), however the internal oblique muscles are also utilised (Macdonald *et al.*, 2012). Overuse of the IOM and the rectus abdominis may be contraindicated (Blake, 2009). Whilst this research is useful in specifying which abdominal muscles are preferably recruited, without specialist equipment it is difficult to know exactly which abdominal muscles are being recruited, to what degree, and what classifies as overuse. It is also challenging for students to be aware of which muscles they are recruiting as studies have shown that even professional singers do not correctly understand what is happening in their bodies when they sing (Watson *et al.*, 1989). This adds to the ambiguity of teaching ‘support’.

The larynx.

Sonninen *et al.*, (1993) and Griffin *et al.*, (1995) state that a low larynx is a characteristic of ‘supported’ singing, however this may reflect the fact that these studies were conducted with classical singers for whom a low larynx is preferable (LeFevre, 2015). Whether this is due to the way the breath is controlled by trained singers shall now be examined briefly.

Thomasson and Sundberg (2001) hypothesised that breath control is strategic for controlling the larynx but were unable to prove or disprove this hypothesis. Iwarsson (2001) similarly hypothesized that abdominal inhalatory patterns would create a downward laryngeal pull, however the opposite was found. She had previously found that a high lung volume was associated with a lower larynx position and that breathing behaviour influenced the way the vocal folds vibrated (Iwarsson and Sundberg 1998, Iwarsson, Thomasson, and Sundberg 1998). It would seem from these studies that a high lung volume had a greater impact on the larynx than the movement of the abdominal wall during breathing, that is, high lung volume could account for a laryngeal pull downwards. These findings imply that using the abdominals does

not have an untoward impact on the laryngeal position for different styles where a higher larynx is desirable. Ternstrom and Selamtzis (2020) also studied the effects of lung volume on the electroglottographic (EGG) waveform hypothesising that tracheal pull would be evidenced with changes in lung volume. The results were inconclusive although they argue for some evidence of tracheal pull downwards at lower sound pressure levels. They observe that more research is required into effects of lung volume on the larynx.

To summarise, Sonninen *et al.*, (1993) and Griffin *et al.*, (1995) both associate a 'supported' sound with a lower laryngeal position. Iwarsson, (2001) and Thomasson and Sundberg, (2001) hypothesised that a lower larynx was due to the distinct abdominal breathing patterns associated with professionally trained singers, however they failed to prove this. It would therefore seem premature to state that the abdominal breathing patterns of 'supported' singing cause a low laryngeal position or that a 'supported' sound must always have a low larynx.

Other 'support' muscles.

Pettersen (2005) is a researching pedagogue who explored the use of other 'support' muscles used by classical singers. He conducted seven experiments using electromyographic equipment (EMG) which Imran Ramli *et al.* (2019) verify as effective at monitoring vocal loudness. He also experimented with EMG biofeedback (EMG BF) which enables precise feedback to muscles to facilitate lowering the loading levels of chosen muscles. Pettersen and Westgaard, (2002), were able to show that BF was effective in lowering the activity of the trapezius (TR), and sternocleidomastoid (STM) muscles and they concluded that the singers overused TR and STM. They found that professional opera singers engaged TR muscles more than student singers, which surprised them. They hypothesized that this was due to more extreme singing and therefore greater need for higher subglottic pressure utilized by these singers. However, one singer in this group managed to sing with very little input from her TR muscles despite comparable loudness and extreme tones. In addition, with BF, Pettersen was able to diminish the amount the TR was activated by the other singers, without any untoward effect on tone, and as this happened the upper thorax (TX) circumference expanded which Pettersen notes as beneficial. Pettersen and Westgaard (2005), analysed EMG activity in the posterior neck (PN) and scalene muscles (SC) in addition to TR, STM. EMG BF lowered activity levels of TR and STM, and SC and the PN muscles. Pettersen (2005a, 2005b) compared singers with classical pianists in the use of TR and STM. Despite the singers not needing to use their arms and these being relaxed by their sides, he was surprised to find that the loading levels of these muscles were roughly equivalent for both groups when the music was challenging and loud. Finally,

Pettersen et al. (2005) explored his hypothesis that the STM and SC muscles activate to create a counterforce that resists the compression of the upper TX (UTX) at extreme pitch, which he demonstrated as these muscles were utilized far more when singers sang higher pitches during glissandos compared to non-taxing tasks such as singing in the lower part of the voice or speaking. He concluded that these muscles, the STM and SC are both important muscles for breathing and singing.

Pettersen (2006) then examined the use of the pectoralis major muscle (PC) comparing professionals with student singers. EMG measured the PC muscle during inhalation and phonation, and the interaction between PC muscle, STM and UTX. Pettersen found four different ways that the singers used their PC muscle when inhaling and singing, again indicating the variety of muscle pattern usage. The PC muscle is a muscle of support that can be recruited to help lift the UTX during inhalation and singing, but Pettersen argues that more research is needed. Pettersen and Eggebo (2010) researched the diaphragm (DPH), the major inspiratory muscle from two perspectives, anterior and dorsal, testing the use of ultrasound imaging (USI) to see if this was an effective means of observing the muscle which they found it to be. With a small sample Pettersen emphasizes that no conclusions can be drawn from this, however he hypothesised that different singing techniques and body types utilise the rib cage and abdominals to varying degrees most probably accounting for the ways these subjects moved their DPH. This requires further research.

Watson, Williams, and James (2012) investigated the use of latissimus dorsi (LD) and sternocleidomastoid (SCM) muscles finding that all their singers utilized LD when they 'supported' their singing which helped keep their thorax lifted. SCM were also utilized during deep inhalation. SCM have historically been associated with thoracic breathing, but they conclude that this is not the case. They also found that singers were able to disengage their support without LD but when they did so this led to less sound being produced. Gordon and Reed (2018) produced a thorough multidisciplinary literature review on the role of the pelvic floor in respiration and singing examining 85 articles from 1985-2017. They demonstrated that although there is a proven medical link between the pelvic floor and respiration, there was little research or acknowledgment of the use of the pelvic floor muscles in the voice literature, despite this being a key support muscle which voice pedagogues refer to (Ragan, 2020; Chapman and Morris, 2023).

To summarize, Pettersen and Westgaard (2005) found STM and SC muscles to be important 'support' muscles, and TR may be used as a muscle of 'support' by professional singers for demanding singing. However, TR muscle can also be isolated to decrease its load with BF

without apparent detrimental effect to the sound (Pettersen and Westgaard 2002), unlike LD muscle which was found to be vital to supported and projected singing in one study (Watson, Williams, and James 2012). An expanded thorax was also found to be a characteristic of supported singing (Pettersen 2006, Watson, Williams, and James 2012). The movement of the DPH seems to reinforce evidence for individualised usage of RC and AB according to technique and body shape (Pettersen and Eggebo, 2010). Other muscles than those listed above are likely to be utilised for 'support' but research does not yet exist for these (Gordon and Reed, 2018).

'Support' and other vocal styles

Every study so far examined has utilised classical singers and often compared these to non-singers rather than singers of other styles and Bartlett, (2014) highlights this lack of research. Sundberg and Thalen, (2015, p.418) compared what they called "neutral" singing with belt, a music theatre (MT) technique which uses a higher laryngeal position and chest voice higher up the range with professional MT singers as their participants. Just like the studies for classical singers, Sundberg and Thalen, (2015) found that every singer used a completely individualised breathing strategy but also that their strategy was the same for belt and other singing. They suggest that diverse strategies may be due to body size and postural variations. *Macdonald et al.* (2012) compared singing student's use of the transversus abdominis muscle (TAM) and the internal oblique muscle (IOM) comparing different styles: operatic, belt and normal. They showed that the TAM muscles were activated for all types of singing. However, this study does not reveal what styles the singers were primarily training in so the use of these muscles may reflect a baseline of classical singing technique even when singing other styles. Bassig, (2020, p. 37) describes the difference in breathing technique for a classical singer to belt as "the abdominal muscles will feel slightly more engaged when belting which will result in not as much movement in the abdomen during respiration". This indicates that the abdominals are still utilised for this style of singing. There is also evidence of a firmer contraction of the vocalis muscle when belting (Bjorkner, 2008), greater glottal adduction (Sundberg, Gramming and Lovetri, 1993; Stone *et al.*, 2003; Sundberg and Thalen, 2015) which may form a different type of 'support' for these styles of singing. This coheres with Griffin *et al.*'s, (1995), definition which highlights changes in the glottis and larynx, however it is beyond the scope of this assignment to consider these in depth.

To summarize, CCM often requires greater subglottal pressure and vocal fold adduction. CCM does require training (LoVetri, 2013) and the use of the abdominals would seem to be key to

providing 'support' to singers singing in these styles (Macdonald *et al.* 2012, Roll 2014, Sundberg and Thalen 2015, Salomoni, van den Hoorn, and Hodges 2016, Bassig 2020, Cunsolo *et al.* 2022).

Summary

Griffin *et al.*'s., (1995) definition is helpful in highlighting the characteristics of 'supported' singing. Having analysed and synthesised the voice science literature on 'support', there is evidence for use of breath and abdominals controlling "peak airflow" and "subglottal pressure" as well as facilitating changes in "glottal and/or laryngeal configuration" (Griffin *et al.*, 1995, p.54). However, there are a wide variety of breathing patterns and co-ordinated muscular patterns amongst professional classical singers (Watson and Hixon 1987, Thomasson and Sundberg 2001, Pettersen 2006, Pettersen and Eggebo 2010, Salomoni, van den Hoorn, and Hodges 2016, Ternstrom and Selamtzis 2020, Cunsolo *et al.* 2022, Peultier-Celli *et al.* 2022). There is even variety of usage within singers according to technical and emotional singing (Foulds-Elliott *et al.* 2000). This may be accounted for not just by variations in technique but also differences in body shape and size (Pettersen and Eggebo 2010; Sundberg and Thalen 2015), and gender (Thomasson and Sundberg, 1997; Pettersen and Eggebo, 2010). Perhaps it is because of this wide variety of breath techniques and proportions of RC and AB engagement that breath technique is controversial and therefore ambiguous. Despite teachers being unable to aurally identify different types of breath control they may be especially critical of techniques they observe to be different to their own, revealing a personal bias (Pettersen, 2005a). Professional classical singers have been found to be ignorant of what they are doing whilst singing (Watson and Hixon 1987, Griffin *et al.* 1995) which adds another layer of ambiguity. Whilst most research has been conducted with classical professional singers, best available research suggests that other styles benefit from greater use of abdominals than non-singers would use (LoVetri 2013, Macdonald *et al.* 2012, Roll 2014, Sundberg and Thalen 2015, Bassig 2020). Other muscles that contribute to 'support' are: LD which are crucial (Watson, Williams and James, 2012), STM, SC (Pettersen and Westgaard, 2005), PC which helps lift UTX (Pettersen, 2006; Watson, Williams and James, 2012) and TR which may be overused as a muscle of support (Pettersen and Westgaard, 2005). It is difficult for students and teachers to know when any muscle is being overused and this also contributes further to the ambiguity of the subject. It is important to state that some of these findings only have one study to support them so findings must be treated cautiously. Having considered best available research, these findings shall now be compared to the practice of a selection of world-renowned vocal pedagogues.

Renowned vocal pedagogues' experience and expertise on 'support'

Herbst (2016) is a voice scientist and pedagogue who demonstrates that historically renowned vocal pedagogues have held varying perspectives on what 'support' is as shown in the table below, adapted from Herbst, (2016):

Table identifying different positions on 'support' by Herbst (2016), summarised and adapted by Shea.

A) <u>Lamperti</u>	Support = Muscles of breathing
B) <u>Luchsinger</u> and <u>Arnold</u> citing <u>Winckel</u>	Support = Control of subglottic pressure
C) <u>Doscher</u>	Support = Breathing system and larynx
D) <u>Enciclopedia</u> <u>Garzanti della</u> <u>Musica</u>	Support = Breathing system and vocal tract
E) Herbst (2016)	Support = Interaction of all three subsystems: The power source (breathing system), sound source (larynx and vocal folds) and sound modifiers (pharynx, nasal and oral cavities plus the velum) are all connected in a non-linear way.

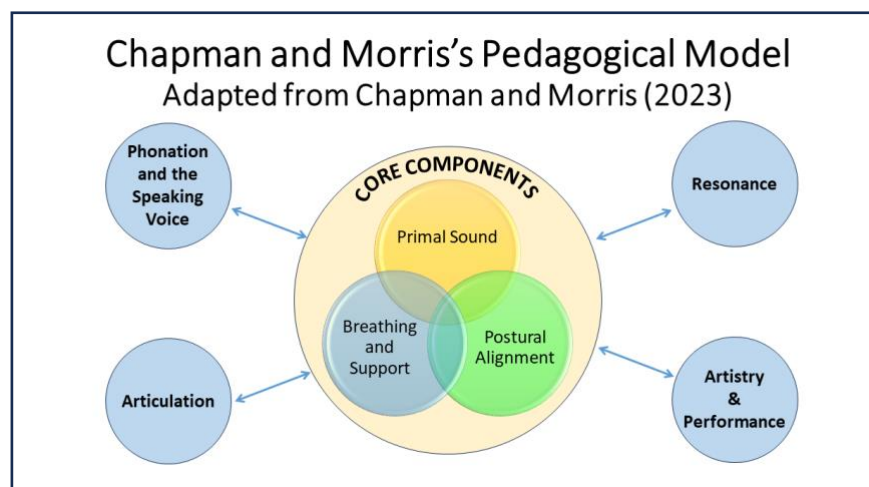
Herbst, (2016, p.249, e13) shows that there are “discrepancies” and even contradictions between the four positions shown above. However, he argues that no definition is incorrect, but only a partial explanation, and he reconciles all four historical positions with his own theory; that 'support' is holistic and an interaction of all three subsystems. Firstly, any adjustment in the vocal tract affects the sound source (vocal folds and larynx), secondly, vocal fold adduction affects the flow of air and subglottal pressure, and finally, the use of the respiratory system can cause a tracheal pull (Iwarsson and Sundberg, 1998) which in turns affects the vertical larynx position. His work on glottal resistance highlights how mean airflow rate is controlled by both the breathing mechanism and glottal adduction which he offers as evidence of the interconnectedness of each subsystem. The varying positions he describes demonstrate the ambiguities of 'support' and his theory reveals the complexities of 'support' as it cannot be accounted for by any one subsystem such as breath control, larynx, or pharynx, as each subsystem is synergistic.

Five expert pedagogues are now examined considering Herbst's, (2016) categorizations. Without exact definitions of 'support' from each pedagogue their positions are inferred. Whilst each pedagogue takes a different approach, they all recognise the interplay of the three subsystems (Herbst, 2016). Whilst this highlights some ambiguity it also indicates a unity in contrast to Herbst's (2016) selected pedagogues which perhaps reflects the influence of recent vocal research on practice. Their positions are summarised in appendix 7.

Miller (1997) found great variations between national approaches to breath management and 'support' in classical singing: The French emphasised natural breathing and posture, the English emphasised the use of the upper back whilst fixing the ribs, and the German school emphasised outward pressure on the abdominal walls. He sides with the Italian, 'appoggio' school of singing, which means to lean or 'support'. Miller, (1997) uses the term 'support' characterized by a high sternum, relaxed but poised posture, use of the abdominal muscles, supportive use of the pectorals and neck muscles which are expanded but not tense. He does not refer to subglottal pressure, but he does highlight the "total system" as well as "resonance" (Miller, 1997, p.41). Miller's (1997) description of the Italian school does cohere with the characteristics of optimal breathing techniques used by professional classical singers (Watson and Hixon, 1987; P. J, Watson *et al.*, 1989; Sundberg *et al.*, 1991; Pettersen, 2005a; Macdonald *et al.*, 2012; Salomoni, van den Hoorn and Hodges, 2016; Ternstrom and Selamtzis, 2020; Cunsolo *et al.*, 2022). Variations of technique between national schools may partially explain why variations of breath control are exhibited by professional singers.

Chapman and Morris (2023) ascribe to a science informed holistic singing technique that clearly links breath use to 'support'. This detailed pedagogical model uses the term 'support' in connection with breath and has three core components: breathing and support, primal sound, and postural alignment.

This three-fold nucleus is surrounded by four satellites that all continually feed between each other: phonation/speaking voice, resonance, artistry/performance, and articulation.



Like Herbst (2016) they emphasize how holistic the model is, but they also ascribe a hierarchy to the core skills, in particular emphasizing primal sound as key for breath 'support'. They argue that this invokes a coordination of the whole body through the emotional motor system. They cite Brown (1996) and Jones (2016) and Chapman's own experience to support this. Chapman distinguishes between her use of the SPLAT breath (singers please loosen abdominal tension) and Miller's lower abdominal expansion during inspiration which seem very similar, yet she argues is contrary to primal sound causing unnecessary tension. She describes a diamond of 'support' to engage the sound to control subglottic pressure which incorporates the xiphoid at the top of the abdominal wall, the sides of the waistband (internal/external and deep transversus abdominis muscle) and the lower abdominal pubic symphysis citing Gordon and Reed (2018). She describes a last element of 'support' as a collar connection with a natural expansion at the bottom of the singer's throat coordinated with phonation once a singer has mastered the diamond of support. This she claims is evidence of good control of the subglottic pressure allowing the strap muscles to exert a depressing effect on the larynx optimal for classical singing. Chapman and Morris's (2023) model consequently underlines the importance of posture (Sundberg *et al.*, 1991), primal sound Foulds-Elliott *et al.* (2000), working with breath management to provide a gateway to access the important support muscles which include the abdominals (Peter, J Watson *et al.*, 1989; Blake, 2009; Collyer, Kenny and Archer, 2011; Macdonald *et al.*, 2012), latissimus dorsi (Watson, Williams and James, 2012), and pelvic floor (Gordon and Reed, 2018). She also warns against the overuse of the STM, PC and TR muscles (Pettersen and Westgaard, 2002; Pettersen *et al.*, 2005). This model is accessible and supported by science-based literature as well as the pedagogues' years of experience, however it is focused entirely on the classical singer.

Sadolin, (2012) presents a detailed pedagogical approach for CCM singing and argues that 'support' is vital. She is explicit in her description of 'support'.

"Support means working against the natural urge of the diaphragm to release the air. This is achieved through an interaction of three muscle groups: the abdomen, the loin, and the back." (Sadolin, 2012, p. 20)

This definition clearly links breath control with the use of the abdominals, pelvic floor and back muscles which coheres with voice research (Watson *et al.*, 1989; Macdonald *et al.*, 2012; Emerich-Gordon and Reed, 2018). However, her use of the abdominals subtly contrasts with Chapman and Morris, (2023) as she focuses on abdominal usage around the diaphragm warning against expanding the abdominals whilst singing. She distinguishes between degrees

of 'support' required for challenging singing, encouraging an economical use of the muscles of 'support'.

Ragan, (2020) and Obert's, (2023) approaches share the following commonalities: They are explicitly research based, they do not advocate or use the term 'support' but only expand upon it in the context of others, not promoting one system of breath control, and they align with Herbst, (2016) in acknowledging the interrelatedness of the whole system. Ragan (2020, p.19) describes breath mechanics and good technique as "coordination of the muscles to regulate subglottal air pressure and airflow" comparing the abdominals to the "gas pedal" (Ragan 2020, p.36). She encourages gaining control of the RC separately from the abdominal wall (ABW) to enable different breath management systems for different styles, with belting requiring less ABW because of greater glottal closure. She cites Sundberg and Thalen (2015) as evidence for this however this seems to be an overstatement of their study. She gives various exercises often using equipment such as medicine balls to engage the abdominals but avoids using the term 'support'. She only refers to 'support' in reference to the abdominal belt developed by Juilliard Faull. Likewise, Obert (2023) states that 'support' is associated with both breath control as well as muscular engagement. She encourages different breathing techniques for different styles, controversially stating that clavicular breathing which is disregarded by classical pedagogues such as Miller and Chapman (2023) may be useful if the style requires a higher larynx position and a brighter sound. As such 'support' can mean different things according to the style being sung. She utilises Estill's, (1988) word anchoring to describe the muscular effort required by the large muscles of the body to support the smaller, describing it as breath flow, subglottic pressure, and torso engagement/ anchoring.

Summary

Herbst (2016) highlights the confusion and ambiguity over what 'support' is illustrating that there are four different ways that vocal pedagogues have understood 'support' historically. These are somewhat reflected in the five pedagogical approaches examined here. Some clearly emphasise 'support' and link it to breath technique such as Chapman and Morris, (2023) and Sadolin, (2012), whilst others downplay it and encourage an energization of the sound by incorporating equipment such as medicine balls such as Ragan, (2020) and Obert, (2023). 'Support' has also been taught in Western classical music in a variety of ways as reflected in different national schools with their various strategies (Miller, 1997). Despite there being differing approaches, it is helpful to observe one commonality. Engaging the abdominals is vitally important and the use of these muscles is emphasized by every pedagogue. It is the

recruitment of these muscles when breathing which distinguishes those who have been taught from those who have not (Salomoni, van den Hoorn, and Hodges 2016, Cunsolo *et al.* 2022). There is perhaps also a clue here to differing requirements of abdominals for different styles, with classical singing requiring a different type of abdominal recruitment than music theatre (Bassig, 2020). However, it is difficult to be specific about amounts, only Sadolin, (2012) attempting this, and perhaps this is where the singing pedagogue must rely more on audible cues for 'support' than visual (Sand and Sundberg 2005, Sonninen *et al.* 2005, Collyer, Kenny, and Archer 2011).

Student goals and perspectives.

If Herbst (2016) is correct in his theory that 'support' is the interplay of the entire vocal mechanism, then 'support' in vocal pedagogy is an extremely complex and consequently ambiguous phenomenon which lacks a common terminology (Heinrich *et al.*, 2008). This renders the term potentially very confusing for a student. Hausknecht *et al.* (2021) found evidence of confusing and ambiguous language used by specialist singing education institutions. They found that 292 terms were used to describe voice quality, and with lexical grouping they could reduce these terms to five groups: tone (92%), breathing (78%), musicality (70%), technique (70%) and posture (23%). The term 'support' may straddle three groups in this study: breathing, technique, and posture. This study highlights the need for further research to reach a consensus of singing terms within vocal pedagogy to achieve clarity. If there is lack of consensus and ambiguity at higher levels of specialist singing education, then ambiguous terms such as 'support' will be used in lower graded music exams causing confusion for students.

As ambiguity of terminology has been evidenced, it is important to recognise that toleration for anxiety is a recognised personality trait (de Vries, 2021; Derakhshan *et al.*, 2022) with low levels of tolerance for ambiguity known to cause stress (de Vries, 2021). It would therefore be worthwhile for the singing teacher to reflect on their own tolerance for ambiguity as well as their student's tolerance levels as this will affect the atmosphere of learning in the singing studio. Obert (2023) distinguishes between literal learners and symbolic learners (Greschner, 2014), so the teacher is aware of the learning style of each student and can seek to use language that is student specific. Sonninen *et al.*, (2005, p. 231) highlights this too stating, "for some singers 'support' is an important tool for producing a good voice quality, whereas for others, 'support' evokes images that might have a harmful effect on effortless phonation". With the development of EBVP highlighting science-based research, teachers are increasingly aware of precise muscles being used and have begun to utilize this language where needed with literal learners.

However, this issue is complex, as Collyer, Kenny, and Archer (2011, p.e17) point out “the perceptible effects of such instructions are unknown” and where there is unclarity over exact muscles because of the complexities of the system, literal learners may be at a disadvantage in needing exact, literal concepts. In addition, recent motor learning research also indicates that reference to specific body parts is often unhelpful for the singing student, and instead of utilizing internal cues, singing teachers would have greater success using external cues (Treinkman 2022). Treinkman’s (2022) survey with 278 singers found that they were instructed with external cues more frequently (50.8% of the time) than with internal cues (39.42%). She argues for external cues for teaching breathing and ‘support’ and cites examples of analogies to be more effective than directives to the ribcage and abdominals. She also cites the use of such props as ‘support’ belts, chairs and medicine balls which can activate ‘support’ without needing to use confusing language which Ragan (2020) has taken in her teaching methodology. This is fascinating given that historically singing teachers have relied more heavily on imagery and analogy rather than on instructing with reference to exact body parts and it is also evident that singers have become professionals without accurate physiological understandings of what they are doing (Griffin *et al.* 1995). What is clear is that the use of language in the vocal studio is a complex issue requiring further research.

Conclusion.

In line with the objectives of this assignment, peer reviewed literature was critically examined to explore the topic of vocal ‘support’, and five esteemed vocal pedagogues were identified to explore their understanding and teaching of ‘support’. It was found that ‘support’ makes an audible difference to the sound (Salomoni, van den Hoorn and Hodges, 2016; Cunsolo *et al.*, 2022), however there are a wide variety of professional opinions and theories on how ‘support’ is taught. Breathing technique is associated with ‘support’, yet breathing techniques vary greatly between trained singers reflected in different schools (Miller, 1997) compared to untrained singers who breath in a uniform way (Salomoni, van den Hoorn and Hodges, 2016). Within vocal pedagogy, the term ‘support’ is therefore ambiguous, and it is impossible to exactly define, especially when understood to be holistic (Herbst, 2016).

Whilst Herbst’s theory may be helpful for the pedagogue, this is not necessarily helpful for the singing student who may struggle with anxiety due to ambiguity (de Vries, 2021; Derakhshan *et al.*, 2022). It is therefore imperative to aim for some clarity. The following is therefore suggested for clarity: all pedagogues studied here acknowledge the importance of activating the abdominal muscles. For the student, this may be explained simply as the use of the larger muscles of the

torso or core to facilitate easier phonation or energize the sound (Ragan, 2020; Obert, 2023). Chapman's 'diamond of support' and SPLAT breath are useful tools to encourage use of these muscles and the artefacts may further develop these ideas. Firstly, a kite (appendix 1) a physical version of the 'diamond of support' to encourage 'support' (Treinkman, 2022), and secondly a warm-up song to be used in conjunction with the kite in recognition that greater bodily activation is activated through emotional engagement with a song rather than just technical exercises (Foulds-Elliott *et al.*, 2000). Whilst most studies have been conducted with classical singers, the evidence points to these muscles being crucial for all styles of singing (Weekly and LoVetri, 2009; Macdonald *et al.*, 2012; Roll, 2014; Sundberg and Thalen, 2015), and it is the use of these muscles that distinguish between those who have had singing training and those who have not (Salomoni, van den Hoorn, and Hodges 2016, Cunsolo *et al.* 2022). It would seem that classical singing styles and training of advanced classical students would necessitate the most usage of these muscles (Salomoni, van den Hoorn and Hodges, 2016; Cunsolo *et al.*, 2022). The singing teacher may find that listening in preference to watching may circumvent judgments based on their own biases for breathing techniques (Collyer, Kenny and Archer, 2011) as a 'supported' sound can be distinguished auditorily by both musicians and non-musicians alike (Sand and Sundberg, 2005; Sonninen *et al.*, 2005). There are expert singing pedagogues who avoid using the term 'support' (Ragan, 2020; Obert, 2023). This assignment has demonstrated that it would seem judicious to use the term 'support' with care, seeking to teach it in practical ways, explaining it in ways that are appropriate for each individual student taking into consideration their learning style, age, goals, and toleration for ambiguity.

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Appendix 1

How to use the “Kite of Support”?

- ❖ Hold the Kite at Points A&C with thumbs on outer waist
- ❖ Ensure points B&D create the shape of a Kite
- ❖ With breath in concentrate on tummy “SPLATTING” through the centre of the kite (SPLAT = Singers Please loosen abdominal tension – Chapman and Morris (2023))
- ❖ The Muscles at points A,B,C and D will activate if the SPLAT takes place
- ❖ Keep focussing on SPLATTING with each “in breath”



How to make the “Kite of Support”?

You will need two thick (160g plus) A4 pieces of card and 4 brass split pins

- ❖ Measure 4 cm up from bottom A4 card and rule a dotted straight line then measure up another 4cm and rule a solid line
- ❖ (Repeat times 2 up the page) – see Diagram 1
- ❖ Cut along the solid straight lines yielding an 8cm x 21cm strip and then fold along dotted line to produce a double thickness (repeat)
- ❖ You should then have 2 times 4cmx21cm pieces of card, carefully use scissors and a split pin and join the two pieces together at point B
- ❖ Take a second piece of card and this time measure 4cm across the full height of an A4 page (see Diagram 2), draw a dotted and then a solid line as before (for a child measure in 4.7cm from the RHS)
- ❖ Make up two 4cmx29.7cm strips of card (or 25cm for a child) attach with 3 split pins at points A, D and C to form the support kite shown above.

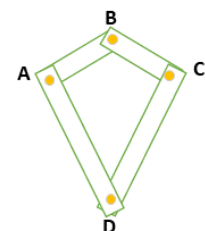


Diagram 1



16cm CUT
12cm
8cm CUT
4cm

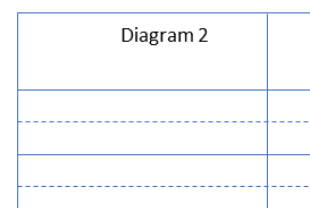


Diagram 2

16cm CUT
12cm
8cm CUT
4cm

4cm smaller (child)

Appendix 2

Summative chart of Literature specifically addressing supported singing SS= supported singing

Name	Pro's	Numbers	Quant	Qual	Findings
(Sonninen <i>et al.</i>, 1993)	Y	9 (4m,5f)	Y	N	SS = longer phonation time, lower larynx, high subglottal pressure
(Griffin <i>et al.</i>, 1995)	Y	8 (4m, 4f)	Y	Y	SS = spectral characteristics, high sound pressure level, increased airflow, increased subglottal pressure, laryngeal/glottis changes. Physiological differences unrelated to breathing yet singers understand support as breath control
(Thorpe <i>et al.</i>, 2001)	Y	5 (3m,2f)	Y	N	SS = Increase in sound pressure level. Decrease in airflow. Increase RC & AB activity via breath control
(Sand and Sundberg, 2005)	N	5 students (1m,4f) 9 experts	Y	N	Experts identified SS in 42 samples, although some disagreement
(Sonninen <i>et al.</i>, 2005)	Y	7 (3m,4f) 63 mixed ability listeners	Y	N	SS can be identified by non-experts. SS = changing from being exclusively about breathing
(Blake, 2009)	Y				Transverse abdominis muscles control subglottic pressure. Cautions use of oblique and rectus abdominis muscles
(Herbst, 2016)					Presents a holistic theory of SS: Interactions of 3 subsystems, power source, sound source & modifiers

Appendix 3

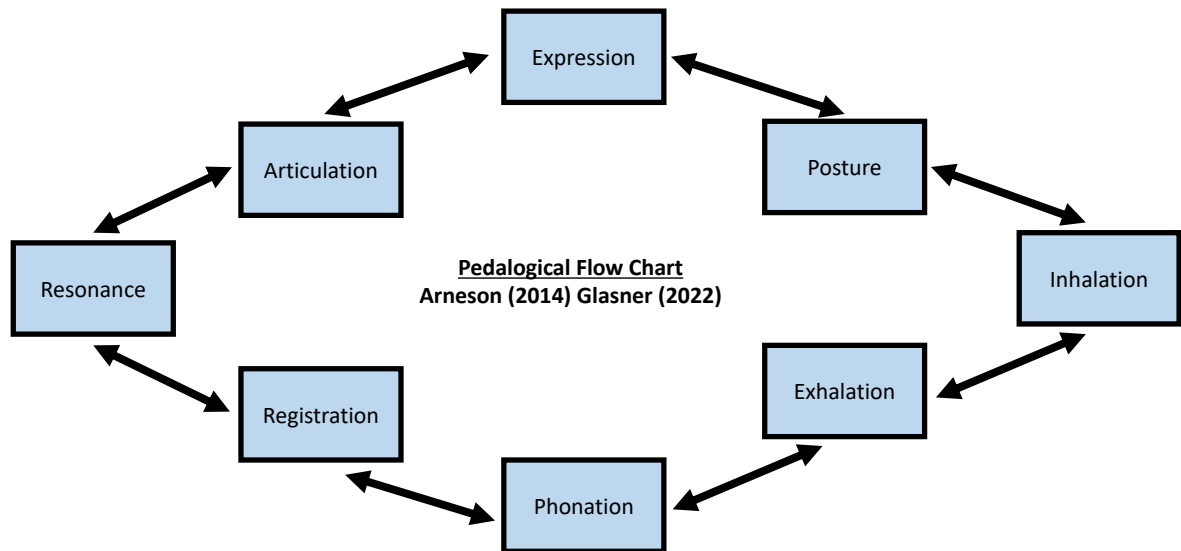
Summative chart of remaining literature

Name	Pro's	Numbers	Quant	Qual	Findings
(Watson and Hixon, 1987)	Y	6 (6m)	Y	Y	Vast variety of breathing patterns. Singers understanding did not match their somatic usage
(P. J, Watson et al., 1989)	Y	4 (m)	Y	N	Use of upper and lower lateral abdominal muscles used for singing but with many different ratios between singers
(Sundberg et al., 1991)	Y	2 (m)	Y	N	Varied posture. Abdominals vitally important interacting with RC and diaphragm. Body adept at compensating.
(Thomasson and Sundberg, 1997)	Y	7 (4m,3f)	Y	N	Singers used 70% higher ILV compared to nonsingers. Negotiate muscular, recoil and gravity forces. Breath= key to controlling subglottal pressure
(Thomasson and Sundberg, 2001)	Y	5 (3m,2f)	Y	N	Hypothesis that breath controls the voice source, unproven but not rejected. R.C & lung vol=consistent. A.W extremely variable between singers. No 'uniform strategy' p.383
(Foulds-Elliott et al., 2000)	Y	5 (3m, 2f)	Y	N	Emotional connection leads to higher ILV. Increased used of

					abdominals, especially laterals and more air.
(Pettersen and Westgaard, 2002, 2005)	Y	16 (4m, 12f) 8 (2m, 6f) 8 (2m, 6f)	Y	N	BF lowered use of TR & STM BF effectively lowered TR TR, TX & obliques researched Pro's engaged TR more, but BF could lessen this leading to elevated TX
(Pettersen and Westgaard, 2005)	Y	5 (2m, 3f)	Y	N	EMG activity in TR, STM SC & PN Less TR & SCM led to less SC & PN
(Pettersen, 2005b, 2005a)	Y	11 (4m, 7f)	Y	N	Compared singers & pianists TR & STM Loading levels were equivalent when loud and challenging
(Pettersen, 2006)	Y	7 (3m, 4f) compared to 8 students	Y	N	PC, STM & UTX 4 different ways that PC is used
(Pettersen and Eggebo, 2010)	Y	3 (1m, 2f)	Y	N	Ultrasound and DPH Anterior and dorsal. DPH movt varied between singers accounted for by different muscle usage
(Collyer, Kenny and Archer, 2011)	Y	5 (5f) 14 experts	Y	N	No evidence experts could hear different breathing methods
(Watson, Williams and James, 2012)	Y	6 (6f) 2 pros 4 students	Y	N	LD used for SS – lifted thorax. No LD led to less sound
(Larrouy-Maestri, Magis and Morsomme, 2014)	Y	50	Y	N	Sang with and without operatic technique – Singers formants, jitter, shimmer
(Salomoni, van den	Y	7	Y	N	Breathed identically normally. Pro's

Hoorn and Hodges, 2016)		(2m, 5f) compared to 4 nonsingers			used varying degrees of AB & RC, 2.5 x more AB than non singers
(Kang, Scholp and Jiang, 2017)		Review			Studied therapeutic benefits. Pro's had better breathing reserve, can produce sound more efficiently. TLC = the same
(Ray, Trudeau and McCoy, 2018)	N	6 (6f students)	Y	N	Strength training No improvement in sound
(Emerich-Gordon and Reed, 2018)		85 articles Lit review			Little research into pelvic floor despite being intrinsic to respiration
(Ternstrom and Selamtzis, 2020)	Y	8 (8f)	Y	N	Seeking to evidence tracheal pull. Inconclusive. Some at low pressure levels. More evidence required for effects of lung volume on sound source
(Cunsolo et al., 2022)	Y	13 pros 14 nonsingers	Y	N	Pros used 5x more AB Non-singers used more RC (thoracic breathing)
(Peultier-Celli et al., 2022)	Y	17 pros 12 non-singers	Y	N	Pros postural awareness increased when singing Variety of breathing techniques 70.6% AB 23.5% thoracic

Appendix 4
Pedagogical Flowchart adapted from Arneson (2014) and Glasner (2022)



Appendix 5

An example of an analysis form

Analysis 30

Author: Sundberg, Landerson, von Euler, Knutsson

Year of publication: 1991

Title of article/chapter: Influence of body posture & lung volume on subglottal pressure control during singing

Question: explore muscular activities underlying the control of subglottal pressure during singing for varying body postures & lung volumes

Methodologies: Quant

Role of different breathing muscles during singing was investigated by synchronously recording EMG, pressure & sound signals using lung vol & gravity as experimental parameters.

EMG signals – external & internal intercostals, diaphragm & abdom obliques = recorded whilst 2 singers performed various singing tasks associated with rapid & precise changes of subglottal pressure.

Esophageal & gastric pressures measured by pressure transducers

Lung volume by impedance plethysmography

- a) a sequence of sudden increases & decreases in loudness
- b) a sequence of alternating ascending & descending 8ve intervals
- c) a legato & staccato ascending, triad on the tonic followed by a descending triad on the dom 7th
- d) a medieval music trillo – a succession of repeated tones interleaved with unvoiced segments
- e) coloratura 16 notes performed in legato
- f) neutral & emotive speech

1. Started tasks near to 100% lung volume & repeated for as long as vital capacity allowed.
2. Body posture

What type of sample: 2 m baritone singers

Hypotheses. What is the paper setting out to prove?

Key results: The breathing system efficiently compensates for drastic differences in the mechanics of the breathing apparatus, caused by differences in lung volume & gravity induced by changes of body posture.

p.285 Diaphragm = contracting more vigorously for the high tone in the upright position.

Thus in the upright position, forceful contractions of the abdominal wall muscles create a very high gastric pressures. These pressures are then prevented from entering into the rib cage by means of a forceful contraction of the diaphragm.

Strong EMG signal in intercostal EMG.

p.290 'during inhalation there seems to be a coactivation of the inhalatory external intercostal muscles & diaphragm in both the upright & supine positions.'

Ab wall contracts much more vigorously in the upright than in the supine position.

Failures in subglottal management reveal themselves in 'singing out of tune' (290)

- The inhibition of exhalatory muscles during inhalation
- The greater diaphragm activity in supine compared with upright position

'There seems to be a general opinion among singing teachers & v therapists that the breathing muscles can be used in a number of ways, resulting in different phonatory characteristics' (291)

Key conclusions: The way the body adapts to supine & upright positions with different demands this places on the system. This is an impressive demonstration of how the central nervous system provides for an instantaneous adjustment to body movts & postural alterations so as to make immediate compensatory corrections for every minute alteration in the mechanics of the thorax & its muscles' (291)

Article Assessment

Strengths of Research. Does it advance our understanding of the subject or how to research it? Are there appropriate hypotheses, meths to test the hypotheses, sample sizes/types, controls for variables, recommendations?

- Results of diaphragmatic activated were measured in 2 different ways and generally correspondence between 2 signals is 'mostly rather good' p.290
- Uses a range of measures which substantiate each other
- Investigates a range of vocal activity

Weaknesses of research: In what ways is it limited, when & where would it not apply? What are the flaws in the study, in the hypotheses, res design, meths, sample size & type, conclusions drawn on the basis of the results?

- Only investigated certain muscles
- Only 2 male singers
- Old study
- Lacking in statistical analysis

p.283 Subglottal pressure is the main factor in the control of voice. Previous studies...shown that particular muscular patterns used in phonatory breathing may have effects on the v source & hence on the v timbre (Sundberg, Leanderson, von Euler (1989).

There are 3 main factors influencing subglottal pressure;

- a) Activity of the breathing muscles
- b) Elastic recoil of the lungs & chest wall – varies with lung volume. A strong expiratory force at high lung volumes & considerable inspiratory force at low volumes
- c) Force of gravity on abdominal content – varies with body position. When upright, gravity exerts a considerable inhalatory force. When supine, gravity = an exhalatory force.

Subglottal pressure = handles with great skill & virtuosity since it controls loudness, fundamental frequency of v. it is tailored for each note

Appendix 6
Comparison of different strategies for support

<u>Strategy for support</u>	<u>Efficacy. Pros and cons observed when teaching</u>
Hands on stomach	<u>Pros:</u> - No equipment required. <u>Cons:</u> - Students need careful cueing to avoid placing hands too high. - Even when hands are in place, they do not always use the abdominals.
Bouncing ball between teacher and student or student bouncing ball by themselves	<u>Pros:</u> - Effective and fun way to get the sound more energised and the abdominals more engaged. - Students can do this with the teacher or on their own. They can do this at home if they have access to a ball. <u>Cons:</u> - They can still do this exercise without energy from abdominals.
Dynaband	<u>Pros:</u> - Student can pull on an exercise band or a scarf to engage the abdominal muscles. - Can cause tension in shoulders. <u>Cons:</u> - Necessitates something firm to pull against such as a door handle or leg of a piano. This may not exist in the room.
Support Kite	<u>Pros:</u> - This may show student exactly what is required with very little cueing with the simple instruction to SPLAT through the centre of the kite. (Treinkman, 2022) <u>Cons:</u> - The kite requires making. - Split pins can be a little sharp.

Appendix 7

How do vocal pedagogues understand ‘support’?

<u>Name</u>	<u>Use the term ‘support’?</u>	<u>What is ‘support’ to them?</u>
Miller (1997)	Yes	“Embraces a total system in singing which includes not only support factors but resonance factors as well” (Miller, 1997, p.41) • Posture – Relaxed and poised • High sternum • Use of abdominals • Use of pectorals and neck muscles
Chapman and Morris, (2023)	Yes	“Breathing and support” • Posture – dynamic and specific • Primal sound connects body to sound • Use of abdominals. Diamond of support locates 4 muscle points • SPLAT breath • Use of pelvic floor muscles • No use of PC (p.34) • Use of Latissimus dorsi • Warns against overuse of STM, PC & TR • Subglottic pressure controlled by breath is “critical to vocalising” (p. 451)
Ragan, (2020)	No Only in referencing ‘support belt’	• Posture • Abdominals are the “gas pedal”. Warns against too much abdominal tension for belting (P.26). • “Coordination of the muscles to regulate subglottal air pressure and airflow is essential to proper technique” (p.19) • Breath – “The influence of breath management cannot be overestimated” (p.19). No one correct technique. • Pelvic floor release exercises • Xiphoid (sternum) release exercises
Obert, (2023)	No Only to explain how others use it	“The term support has generally been associated with breath but may also require stabilization of the body” (Chapter 6, p. 17) Prefers the word ‘anchoring’ – uses equipment to anchor to engage the larger muscles to support the smaller muscles in the body. • Posture • Abdominals. Highlights use of transverse abdominals but does not major on abdominal usage • Breath. Presents all breathing styles without bias. “Muscles of the back and abdomen also contribute to respiration” (Chapter 6, p.9)
Sadolin, (2012)	Yes	“Support means working against the natural urge of the diaphragm to release the air. This is achieved through an

		interaction of three muscles groups: the abdomen, the loin, and the back” (p.20). “A singer must take a conscious active part in controlling exhalation; a process known as support” (p.27) Support means holding back your breath by a) keeping diaphragm down b) Extended ribs c) Interaction of abdominals, loin and back. Support is reserved for difficult notes or passages. Inner support can be activated by using the same muscles as for coughing (p.32) Support is movement. Incorrect support is when the abdominals and solar plexus expand while phonating (p.36) Goes into detail for gauging amounts of support required. • Posture is only addressed if problematic • Abdominals – avoid keeping these tight. “the abdomen around the navel is gradually pulled in in a constant and sustained way” (p.15) • Breath - Individualised but expansion around diaphragm “Let the abdomen around the navel work by itself, it must neither be helped nor hindered”. (p.24)
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Appendix 8

KITE song

A fun song to use in conjunction with the kite which encourages use of emotions to help foster greater physical engagement to facilitate 'support' (Foulds-Elliott et al., 2000).

Music by Sherman and Sherman

Lyrics by Liz Shea

9 When we want to learn how to sing, and we're not sure where to be - gin.

16 There's a help-ful de - vice, that will sure-ly suf - fice, with our thumbs hold-ing tight

24 to the edge of our kite OH OH OH! SPLAT breath

32 through the kite! Let our voice take flight! SPLAT breath

41 through the kite, our voice goes soar - ing, Up through the at - mos

48 phere, our voice will be so clear! Oh, SPLAT

breath through the Ki - te!