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‘A study into vocal change: developing adolescent female voices’

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1. The Portfolio

Introduction and Rationale

Through this study I will examine vocal change in female adolescents. The adolescent phase is a time of change, including voice change, and it starts at the beginning of puberty. As female adolescent vocal change (FAVC) is experienced on multiple levels, from the physiological and hormonal to the psychological, social and emotional sphere, this investigation will entail a multi-disciplinary approach, involving multiple disciplines such as phonation and laryngeal physiology, speech and language development, paediatrics, music and singing education and acoustics. This is often the case with practitioner- researchers involved in voice practice (Winter, 2022). Vocal change in adolescent female singers is a field which has been only explored in the last 50 years but not investigated extensively enough, especially when compared to the more numerous research studies regarding the developing voice in male adolescent singers. Without considering the scientific research on the physiological aspects of this subject, not much literature has been published in the music education context and in qualitative studies (Sweet, 2015). This topic has

triggered my curiosity and inspired my interest as it directly relates to my professional practice. In fact, my job as a singing Peripatetic Teacher takes place in secondary schools hosting students aged from 11 to 16 years old, with some modest experience teaching Sixth Form students, and most of my students are female. Besides working in 3 different mixed-sex schools, I also teach in a secondary school for girls only, where in addition to my usual peripatetic teaching role with individuals and/or groups of 2-3 students, depending on their music needs and context, I am also leading a small singing ensemble.

This study is mainly seeking to answer three questions:

- In what way female adolescent singing students experience voice change?
- Is there a common theme regarding the nature of their experience of voice change?
- What are the possible implications for teachers?

Female adolescent voices go through clear changes during puberty (Gackle, 2006; Sweet, 2015). Gackle (1991) was the first to create a classification model of their voices development, describing changes of depth, timbre and warmth as well as pitch instability, breathiness and hoarseness amongst others. These fluctuations and the inability of reproducing stronger sounds like their favourite idols may have an impact on their confidence in singing, potentially driving them to wanting to stop singing altogether (Gend et al., 2017).

Adolescence is a phase when students usually start displaying vocal habits both in speaking and singing (Smith-Vaughan, Hooper and Hodges, 2013) and therefore it is crucial for teachers and educators to understand how to best support their students through healthy pedagogical strategies, so that they avoid adopting unhealthy habits, or they learn to replace them with consistently healthy ones. Choosing or suggesting the right repertoire to adolescent singers can be daunting for teachers: they have a very delicate role to guide students towards songs that can be performed in a healthy way, according to their vocal needs at that time, and that can also be inspiring and offering them an overall pleasant experience (Gackle, 1991). Through my experience as a singing teacher in secondary schools, I have observed that students' preferred genre is often pop music, however, I have noticed they are at times exposed to artists with poor vocal technique and/or they are drawn to sing in a style which their voices are not yet ready for, leading them to sing beyond their physical and vocal capabilities, only because they admire the artist or band. This is why it is paramount for teachers to ensure that their students' vocal health is always promoted, and the repertoire is suitable and does not have a negative impact on their voice, guarding them against vocal pain, tension and discomfort, and in order to promote this, awareness of female adolescent physiological development needs to be acknowledged and vocal limitations and potentials need to be understood. The transition from childhood into adolescence can also be a very delicate and fragile phase for these young singing individuals' self-esteem, when sometimes a discrepancy between their evolving singing abilities and a given assignment create a perception of failure, a feeling of not being good enough to be considered a singer, often caused and exacerbated by

negative comments from adults (teachers and parents) and schoolmates, which can be remembered in later years, and impacting on their singing identity and choices; if there was more sensitivity and awareness of singing development and the way it may differently affects same aged adolescents, their vocal development would be encouraged and cherished (Welch, 2006).

Through this study, I hope to expand my knowledge on this subject, better inform my teaching while looking into the literature, including past and current pedagogical research and improve on my support to my students. In fact, despite teaching in this environment for just over a year, I feel lacking in knowledge and understanding; I have relied on my intuition, empathy and previous singing studio experience with older clients; however, I have realised I need to fill the gap to better assist my students. If I become more informed about this process, I will be able to increase my sensitivity and empathy towards their vocal needs, better acknowledge their limitations and potential as well as feel more competent and capable to more effectively guide my students through their shifting vocal development, offering support and providing encouragement during this transitory process.

Planned programme of study

Aims:

- To better understand and expand my knowledge on vocal change in female adolescents
- To identify main theoretical knowledge on the subject
- To support female students through their vocal development

Objectives:

- To be aware of how female voices develop during adolescence
- To recognise the main vocal change symptoms experienced by female singing students
- To investigate into teachers' best behaviour supporting female adolescents during their singing lessons and choir workshops
- To find suitable singing strategies to be used in a school environment

Literature Review Process

I will present a narrative literature review with regards to vocal change in female adolescents, which will offer a broad summary of the main research studies, helping readers (and singing teachers like me) with not-so-great understanding of the topic, to deepen their knowledge (Byrne, 2016). Despite the absence of a refined methodological approach, the aim of my review will be to impart an expanded understanding of the main topic issues by identifying connections and broad

relevance of the subject study and its general context (Werkmeister Rozas and Klein, 2010), 'casting its net wide' (Cohen, Manion and Morrison, 2018, p.182), before data are synthesized; and allowing for converging and diverging theories and approaches (Punch and Oansea, 2014). Thus, although lacking in methodological rigour, typically provided by systematic reviews (Byrne, 2016), the ample extent of this narrative literature study, encompassing the several facets of the chosen topic, will necessitate and allow for a wider and flexible focus (Collins and Fauser, 2005), while aiming to answer my research questions; nevertheless, this study's aim is to be viewed as a structured and well-thought-out argument and not only as a descriptive synopsis (Cohen, Manion and Morrison, 2018). Narrative reviews do describe a selected topic within the literature at the time of writing (Xiao and Watson, 2019), however, they propose to intertwine understanding and awareness into a more intricate, varied, richly detailed patterned report than a single piece of research (Punch and Oansea, 2014).

This study is a primarily qualitative review even though it contains both quantitative and qualitative findings. Cooper's (1985) taxonomy of literature reviews has helped me start organising the structure of my own study and make it more manageable. Having a framework has provided me with a map and a fabric to work on while conducting my literature review. I will mainly narrow my focus to research outcomes, and, time permitting, include research with regards to practices and applications of singing strategies which can help teachers in their job and female students experiencing vocal change; at this stage, the goal will be to recognise the main central issues and critically analyse theories, finding similarities and/or contrasting views; being a narrative review, I will aim to be as neutral as possible while gathering and describing main key studies around a conceptual framework which may be useful to music and singing teachers, choral leaders, potentially other scholars in the field and pre-eminently benefit female adolescent singers. Nevertheless, reporting my study may be influenced by my own bias and experience in the field; in a narrative review, the presence of bias and lack of rigour, are more common (Xiao and Watson, 2019); and the risk of being more subjective, compared to other types of literature reviews, is more prevalent (Templier and Paré, 2015). Despite the limited research carried out to date on FAVC, my coverage will not be exhaustive due to time constraints, but representative of the main spheres of interest within the literature.

Before identifying and establishing the main themes of my study, developing its structure and having clear relevant questions, I carried out a preliminary reading of the literature, as this topic was still quite unfamiliar to me: this initial exploratory reading allowed me to go more in-depth into the development of the review and in formulating research questions (Punch and Oancea, 2014); in fact, despite my current profession and role as an insider researcher, I have not worked long enough with adolescent students to feel secure in my own knowledge and teaching. Exploring the preliminary literature studies was at first a stimulus to generate ideas and thoughts and then it helped me to better investigate the emerging themes and research questions, thus shaping my study (Newby, 2014). Because of scarce refereed research on FAVC, at least in the context of

American choral education (Sweet, 2016a) and most of all, due to the different theories and perspectives dealing with vocal change, ranging from scientific, medical sources to social and educational aspects, hence comprising both quantitative and qualitative data, the boundaries for my inclusion criteria will not be excessively rigid and narrow but instead, comprehensive and extended. This assignment will deal with female (gender assigned at birth) voice changing singers during adolescence so my review will be pragmatically defined by research studies which pertain to my study questions, hence research limited to male adolescent vocal change will be excluded from the eligibility criteria as I have the intention to investigate this field in my following study, however, some general articles regarding vocal change in both female and male adolescents will be taken into account, to look for main physiological and anatomical differences between the two sexes. As research articles on FAVC are not numerous, I will examine older as well as current papers, disregarding any restrictions related to a specific date range, and a section on the historical background will be included. Earlier research may still have an impact on more recent studies (Creswell, 2014); in fact, Gackle's studies, despite going back to 30 years ago, are still very relevant today and regarded as research milestones within the main literature on FAVC.

To collect data and create my literature review, I have browsed scholarly search engines and academic databases such as Google Scholar, ResearchGate, Academia Edu, JSTOR, ProQuest, EBSCO as well as the online library provided by the University of Wales Trinity Saint David. I have been able to find peer-reviewed publications, high-quality journals and other scholarly journals incorporating articles of a more empirical nature: electronic databases have been very helpful, since journal research literature has been increasingly moving on-line, and technology has enabled and made the literature-searching method easier (Punch and Oansea, 2014). I have prioritised peer-reviewed articles found in the British Journal of Music Education, Journal of Voice, Voice & speech review, American Choral Directors Association, Journal of research in music education, all accessed online, and aimed to report primary sources first, before locating secondary sources. Despite the Choral journal being refereed since 1959 and containing peer-reviewed scholarly articles (ACDA, 2024), I have noticed that the style of some papers to be somehow anecdotal, and that authors of scientific information provided in the publications are not always cited; perhaps some of the articles I read, were included in the column section of practical advice for choir experts and conductors. I have also been able to secure printed books in a local university library and relevant articles, which I could not find either online or free of charge, and gain access to its online catalogues through SCONUL; moreover, some data has been sourced from Google Books, which, even though presenting a few restrictions, has been helpful in some cases and has allowed me to read interesting chapters and information (Bell and Waters, 2018). Some articles could not be accessed without paying a fee or a journal subscription, so I decided not to include them on my bibliography list, whereas some papers were retrieved via my personal account when they could not be obtained via my university account's portals. Another limitation encountered, was being able to access free published versions (probably peer-reviewed) of some papers but only their preliminary studies.

A few useful search tactics used to explore a preliminary unfamiliar topic have comprised footnote chasing, whilst moving backwards through a chain of references listed in each article read, and citation searching, whilst moving forward through a chain of citations listed in an index (Booth 2008). Used to a great extent, Google scholar allowed citation tracking for authors/researchers, enabling me to find out who had been citing their articles (Bell and Waters, 2018). In addition to discovering further resources while accessing papers' reference lists, I directly searched for the main writer to find how many relevant articles on the topic had been written by the same author: all these tools were accessed until a point of saturation of information was almost met, where information became redundant, and no new conclusions could be drawn. Another search strategy, even though quite limited and out of focus in its direction, was the related articles/content section found on some databases (Booth, 2008). Moreover, reading the abstract, when available, helped me to decipher if the article was potentially interesting and worth being considered.

I began searching for the literature by narrowing the main topic to key words and their combinations such as "female adolescent", "voice change"; and by searching for key terms also found in the literature itself and research titles (Creswell, 2014). To expand on my search results, I also tried alternative and additional words and synonyms (Bell and Waters, 2018) such as "puberty", "changing voice", "vocal chance", "developing adolescent female voices", "young female singers/students", "young female voice maturation", "female young/ adolescent singing experience". Having an initial working draft title which included the main key terms has helped me in keeping the focus and direction of my study (Creswell, 2014).

The analysis, organization and synthesis of literature did not take place in an orderly and consecutive way but rather they overran with the reading and summarizing (Punch and Oansea, 2014). Carrying out a literature review ideally follows the same steps of primary research: I considered data (articles) as if I was conducting a study with real participants (Randolph, 2009), and 'coded' the main themes of research documents and established relationships amongst them, including a summary of students responses regarding their self-perceptions of vocal change. This thematic structure has allowed a neat organization of data, and it may also assist the reader to better traverse an ample amount of information (Punch and Oansea, 2014).

Sourcing and interpreting information was not always a straightforward task: for example, an article I read (Sealey and Mitchell, 2019) provided me with some information about vocal tension in female choristers whilst citing the authors (Smith-Vaughn, Hooper and Hodges, 2013); however, when I read the primary source, I could not find the same information being specifically addressed to females, but on adolescent singers in general; maybe this was their interpretation and inference.

Critical Reflection

As soon as I started working as a singing teacher in secondary schools, I realised that my knowledge of vocal change in adolescent female singers was very limited and narrow (Gackle, 2006); in fact, before reading about and exploring this subject in depth, I had been feeling 'under-prepared' (Gackle, 2000a p.814), since my previous work had focused on much older students, all of them working professionals, and with quite different vocal needs than the ones experienced by my female adolescent students. I was wondering how best to support them going through their struggles and limitations, and if they required any specific techniques to overcome their vocal issues such as breathiness or pitch instability. Hence, this literature review study has been motivated by a wish to ameliorate my teaching practice.

Upon a preliminary reading of some recent studies on FAVC, I was informed that literature on this subject was not abundant and I became anxious to find enough resources to conduct a satisfactory literature review, however, this feeling was soon replaced by some disorientation amidst a substantial amount of articles, as I became aware that this topic was potentially subject to be explored through several lenses and ramifications, from an investigation of the physical and physiological aspects of vocal change to the perceptions of female students and teachers alike with regards to their experience. It is only when I started the process of writing up my literature review, by outlining the main themes and comparing different or similar research articles, that the information overload of scattered sources gradually began to neatly tie together, chaos transmuted into order, and my confusion and sense of anxiety began to slowly dissipate as I started grouping articles relating to the same theme, similarly to coding. As a matter of fact, the whole process of extracting data and writing up the review has been quite dynamic: as new information and ideas were revealed, I became more flexible and open to change with regards to keywords and questions, as if the review was a living report (Xiao and Watson, 2019). As I gained more knowledge in this field and started feeling more empowered, I found myself unconsciously writing my own comments to the narrative literature, which I then deleted, and I felt that at times, it was challenging to present data in a detached and impartial way, as much of the information reported was relevant to my practice.

Learning several approaches on how to find valuable literature through the different Boolean search options, as well as using further searching strategies by author references and citation, has contributed to expand my skills as a researcher, however, searching and identifying the relevant literature has been time-consuming. Carrying out a literature review indeed improved my research skills such as accessing information like an 'investigator who follows leads' (Creswell, 2014, p. 96) amongst a labyrinth of data, however, I easily got lost, without a sense of order and control whilst reading several articles at once and trying to sift through useful evidence and following leads (Newby, 2014). During this process, I found annotations, as well as making use of colours to highlight read and unread resources, quite practical.

One of the valuable conclusions that findings of this study have revealed, has been to learn that vocal change may be a daunting and negatively perceived experience for female adolescent both on an emotional, and psychological and physical level, and how this may translate into a fear of being bullied, or a feeling of anxiety for potentially being criticised and judged as well as into a loss in self-worth, (Sweet, 2015): this has heightened my understanding of my students' emotional needs and the necessity of 'nurturing' them; knowing that this background may represent a barrier and obstacle to learning, has enhanced my awareness of the requirement to offer an empathetic dialogue to better connect with them and build beneficial relationships, whilst providing constructive instructions and directions. An anecdotal evidence of the embarrassment, frustration and fear of humiliation that girls feel exposed to, when singing with their peers and in public (Sweet, 2015), occurred during one of my lessons, when a student asked her female friend to put her own hands over her ears to cover them so that she would have blocked out the sound and have not be able to listen to her voice while singing a song, or when on another occasion a student told me that she did not feel comfortable singing acapella or with a backing track because she hated the sound of her voice. Perhaps if further knowledge about the female developing vocal process during adolescence was provided to them and shared, this would somehow contribute to lessening their emotional and psychological struggles and deepen their self-compassion and understanding. Indeed, some time after I started being more reassuring and disseminate the information I had learned about FAVC, I heard one student making a positive and kind comment about her voice break during the singing warm-up exercises, and even suggesting to her friend that if that would take place in the middle of a song performance, she just had to let it go, accept it and keep singing.

As a peripatetic singing teacher and singing ensemble leader, I have found Schön's (1983) and Schön's (1987) theory of the reflective practitioner quite useful in shaping my critical reflection and in better acknowledging and appreciating the knowledge I have attained through this study and my work. This was achieved through reflecting both *on action* and *in action*. The practice of reflection-on-action enabled me to comprehend how my teaching approach and instructions may at times have contributed to making my students feel disempowered, for example in labelling their voices as alto or soprano during their singing ensemble sessions, unconsciously alluding to a fixed way of categorising their voice qualities whilst disregarding the acknowledgment that this is a temporary condition. Hence, the new awareness acquired by reflecting has allowed me to learn from my experience and past mistakes, and to contemplate, plan on and develop ways to improve my practice, create adjustments to my lessons and teaching methods in order to put simple strategies into practice, aiming towards the most effective solution to a challenging situation, and then to further reflect after their implementation, while being ready for future action and interventions. Like many participants in Sweet and Parker's research (2019), I reflected and realised that it was not ideal to classify and label voice parts, both in my individual and singing ensemble lessons, so that my students would not feel frustrated; in her study, some participants also felt they had no voice

and there was no dialogue within the ensemble context, contributing to a lack of power and agency, so when I was working on harmonising their vocal parts, I referred to their voice groupings as voice 1, voice 2 and voice 3, and I started alternating their vocal roles from time to time, amending their assigned individual parts if they were too challenging; moreover, I started fostering more dialogue and promoted students' interaction within the singing ensemble, from letting them have more freedom to co-choose which songs to sing and suggest ideas for performance.

The practice of reflection-in-action was guided by a thinking and learning process while promptly acting on the spot, embedded in my daily lessons, an approach framed by a creative, intuitive and immediate use of knowledge, and by making the new understandings available to my students. For instance, this took place when I had to promptly respond to my students' complaints or worries about their voice status or about delicate issues of self-esteem, and I had to adapt the flow of the lesson and open the space to a richer and informative dialogue, in order to reassure them there and then, and find solutions. It has been crucial for my work and professional development as a practitioner to take a brief time for reflection during an activity, when 'doing and thinking are complementary' (Schön, 1983, p. 280), in order to appropriately and positively engage with my students during a particular issue, whilst implementing an impromptu response. This has fostered a dialogue of 'words and actions'... and when this kind of communication is working effectively in both teachers and students through a verbal and performing medium, 'it takes the form of reciprocal reflection-in-action' (Schön, 1987, p. 163).

Encompassing 3 simple and straightforward questions - What? So what? Now what? - Borton's (1970) model has also been a valuable and effective framework I have used to reflect on different aspects of my practice. When I started the process of conducting a literature review on FAVC, my goal was to explore the topic as much as possible, find new knowledge and learn potential practices to improve my teaching and support my students with their vocal and emotional needs. As I started to implement and to incorporate those strategies into my practice, I received positive feedback by some of my students; I recorded an increased attendance and observed a renewed commitment to both lessons and the singing ensemble; I also noticed how some students were more well-disposed to speak about their vocal struggles, limitations and embarrassment, in a more positive and self-assured attitude, at times even advocating for their peers. Looking ahead, I feel that this study may also represent an important document for teachers and educators (Creswell, 2014); perhaps it could be used to implement positive change if the findings were summarized and conveyed to general music teachers and female students in secondary schools, through the suggested creation of an informative workshop, to be delivered at the beginning of the school year. In this way, the literature investigation I carried out could be thought as a bridge connecting the main topics explored and their evidence in the literature, and the professional development brought forth by an effective implementation of learning, skills and strategies (Newby, 2014), for the benefit of all parties.

Central within choir leaders/ teachers' role towards their young singing female students is to recognise their vocal and expressive potential and to support them in developing it to their full fullest capacity, taking into account and never forgetting that each voice matures in a unique way; often beginning teachers and conductors come out of their own educational training without any preparation or knowledge toward FAVC, hence they feel unprepared and not competent enough (Gackle 1991): this was also my own experience. My learning has had a huge impact on my confidence with regards to my professional practice: reflecting on my personal journey and integrating knowledge into practice, I feel more competent in recognising my students' vocal needs and feel more empowered to provide assistance and advocacy.

2. The Assignment

'A study into vocal change: developing adolescent female voices'

Introduction:

Vocal change in adolescent female singers is an occurrence experienced in a distinctively individual and fluctuating way, and impacted by physiological and physical changes, affecting acoustic and emotional responses (Baker, Rakena, and Purdy, 2022; Sweet, 2016b). Information regarding female vocal change has historically been less researched compared to male vocal change, perhaps because the process of female vocal maturity is less pronounced and not as dramatically audibly perceived and outwardly shown as in male adolescents (Adam's apple): it was generally presumed that girls' voices merely developed instead of going through a significant change (Huff-Gackle, 1985; Gackle 2006). This transformation in females does nevertheless take place and can be better perceived by educated and attentive listeners who may notice the following main characteristics: dropping of average speaking fundamental frequency; sudden voice cracking and register breaks; enhanced breathy, husky or hoarse voice quality; lowered and unpredictable range ability; uneasy or strained singing and delayed phonation start; breathy, heavy vocal tone and/or thin voice quality and unstable pitch tone (Gackle, 2000a); fluctuating register breaks are also evident (Harrison, 1978). The purpose of this paper is to explore how vocal change is experienced by female adolescents and identify whether there is a common theme regarding the nature of their experience and investigate the significance of any potential implications for teachers and their practice.

Historical background

There have not been many significant research studies investigating vocal change in adolescent singers, and the gap is even wider for females (Welch, 2006, Sweet, 2015); many articles present

information which is repeated from earlier publications (Sweet, 2016a). 'The Child's Voice' (Benhke and Brown, 1885 cited in Poole and MacDonald, 2022) was the first book published in 1885 to address vocal development in adolescents, which also included participants' experiences survey results, however, even though female vocal change was described, the primary focal point was not the singing voice. It was not until the middle of the 20th century that Fairbanks, Herbert, and Hammond (1949) published the first acoustical study with regards to female vocal pitch: their findings reported that voice breaks are not exclusively male and adolescence-related, they also occurred in two groups of pre-adolescent children, specifically seven- and eight-year-old females. Subsequently, Cyrier's (1981) study analysed vocal register and transitional pitches in pre- and post-pubescent girls. It was Huff-Gackle (1985) though, who firstly identified the gap in knowledge regarding female adolescent vocal change (FAVC) and the need for learning and awareness, and who pioneered research in this field outlining 3 complete stages of female vocal change (see Appendix 1), mirroring what John Cooksey had achieved and published with regards to the adolescent male vocal change (Sweet, 2018). Gackle's role was key in helping to shift the focus and attention given by teachers from the adolescent male to the female changing voice.

Puberty and laryngeal development

Throughout one's life major cycles, sex hormones have an impact on the larynx, as a secondary sexual organ, and on the voice (Zamponi et al., 2021). Puberty is the transition from childhood to the adult world and is characterised by 'a hormonal earthquake' for young people (Abitbol, Abitbol and Abitbol, 1999, p.434). A current trend of an earlier pubertal age compared to the past has been documented in some studies, and it is thought this may be linked to more oestrogens found in meat, milk and poultry, cosmetics, manufactured compounds interfering with endocrinology effects and obesity (Kaplowitz, 2004) and hair products containing oestrogen and placenta (Tiwary, 1994 cited in Gackle, 2000 b); in UK, age of puberty seems to be occurring earlier than previously documented in the 1930s, almost 2-3 months earlier for every 10 years, due to changes in nutrition (Tanner, 1971) and climate (Tanner 1972, cited in Gackle, 2000b).

With regards to the larynx growth, the most evident difference between pubertal males and females, is its shape and size: before puberty starts, the larynx of boys and girls is approximately the same size, however, during the pubertal process, the vocal tract in males increases more lengthwise and in its circumference than in females (Thurman and Klitzke, 2000), whereas in females it mainly develops vertically (Kahane, 1982, cit. in Sealey and Mitchell, 2019). In fact, the thyroid cartilage mainly grows towards the anterior-posterior direction in males (shaping the Adam's apple), whereas its size in females increases less and the shape is more rounded (Weiss, 1950 cited in Gackle, 1991; Gackle 2000b); in females, the vocal tract reaches a length of mean 14.1 cm opposed to 16.9 cm in males (Zamponi et al., 2021). The growth (in height) of the female larynx causes female choristers a lengthier period of voice huskiness, lasting up to 5 years, compared to a shorter span, from 6 to 18 months, in boys (Sealey and Mitchell, 2019). Vocal folds

lengthen approximately 3-4 mm in females, much more in males (Kahane, 1983, cited in Gackle, 2000b), attaining a mean length of 1.0 in females as opposed to 1.6cm in males (Zamponi et al., 2021) and extending to their final size at the end of the puberty cycle (Abitbol, Abitbol and Abitbol, 1999), however connective tissues of the vocal folds may be subject to further growth into adulthood, hence conclusive studies to verify this are needed (Thurman and Klitzke, 2000). The singing apparatus reaches its full adult growth and size at approximately the age of 20-21 whereas hyaline laryngeal cartilages are finally calcified and ossified from 28 to 32 years of age (Hirano, 1981 cited in Thurman and Klitzke, 2000), although Baker, Rakena and Purdy (2022) assert that to specify a precise age for the female larynx to attain maturity can be confusing. A more valid factor shown to relate to adolescent growth is the developmental skeletal age, instead of depending on chronological age (Tanner, 1972 and Weiss, 1950 both cited in Gackle, 2000b): Tanner pointed out that although skeletal age of menarche in British female adolescents was from 11 to 14.5 years, the chronological bracket for menarche was from 10 to 16.5 years. Lung size and vocal capacity expand during puberty and are hypothesised to reach adult proportions from 18 to the early 20s (Thurman and Klitzke, 2000). With the increase in size of the vocal apparatus, follows a change in pitch range: voice pitch (F0) is also affected during puberty: the fundamental frequency lowers approximately one octave in males compared to around 3-4 semitones in females, from that of a child (Abitbol, Abitbol and Abitbol, 1999; Zamponi et al., 2021); the upper limit in females rises a bit whereas in males it lowers an interval of a sixth (Seth and Guthrie, 1935 cited in Gackle 2000b).

Menstrual cycle and pre-menstrual vocal dysphonia

Besides some similarities shared by male and female adolescents, the female voice is also subject to hormone fluctuations and harmonics in the voice depend on hormones (Abitbol, Abitbol and Abitbol, 1999). No definitive study has confirmed the relationship between menarche and female voice change although Brodnitz (1983, cited in Gackle 2000b) hinted that it causes a decrease of the average speaking fundamental frequency. The ebb and flow of sex hormones, especially oestrogen and progesterone, controls the menstrual cycle (Doria, 1999) and these hormonal changes greatly affect the female voice: Rai et al. (2010) found that in a 28-day menstrual cycle consisting of 5 phases (menstrual, days 1-5; follicular, days 6-12; ovulatory, days 13-15; luteal, days 16-23; premenstrual, days 24-28) it was during the ovulatory phase, when oestrogen was at its highest level, that the voice was in the best condition in opposition to the premenstrual phase, characterised by the least oestrogen but increased progesterone, when the voice presented the worst quality; this study though, included a female reproductive age group ranging from 20 to 30 years of age but excluded a much younger reproductive age group of female adolescents. Pre-menstrual vocal syndrome or dysphonia is assumed to be a consequence of sex hormones on the vocal mechanism taking place before the menses resulting in vocal folds dryness, oedema, a loss of laryngeal muscle tonicity, also accompanied by a surge in acidity made worse by oesophageal reflux, typical on that occasion, all having an effect on voice performance (Abitbol, Abitbol and Abitbol, 1999); their study showed that a third of participants had premenstrual vocal

syndrome with symptoms being vocal fatigue, reduced vocal range with loss of high notes and pianissimo notes, loss of vocal power and muscle tone, posterior chink, and although it included female vocal professionals with premenstrual dysphonia starting from age 23 and not adolescents, I argue that symptoms of vocal distress may be experienced also by younger professional female choristers. Gackle (2000b) asserted that changes reported by medical researchers such as swelling, decreased higher tones and unstable pitch before and during menstruation, are the same as those shown in post-menarcheal girls. It was for this reason and to prevent further vocal damage during their premenstrual and menstrual phase that some time ago professional opera female singers had 'grace days' and were excused from not singing (Abitbol, Abitbol and Abitbol, 1999, p. 438).

Female adolescent voice change

Based on her past direct experience with her students, Huff-Gackle (1985) distinguished 3 stages or levels for female adolescent voice development; findings are also described in Gackle (1991) (see Appendix 1); age provided for each stage is a guidance only and it should not be considered as an absolute standard for vocal classification but more as a general pattern and advice (Gackle, 2000a). Age as not being a reliable basis for vocal categorisation, has also been echoed by Cooksey and Welch (1998); Baker, Rakena and Purdy, (2022) add that voice change and the beginning of menarche should not be linked to any precise age, hence individual biological maturity expresses voice maturity more appropriately. The process of vocal maturation and change in female adolescent singers display voice symptoms such as breathiness, challenges with phonation onset, voice breaks and these factors have an influence on the songs' repertoire they can easily perform (Gackle, 2006). Girls' voices after the age of 10 temporarily lose their clear and brilliant tone which is instead maintained by young boys (Huff-Gackle, 1985; Bush 1973). It is common for the glottis of young singers whose voices are changing, to present a gap or 'mutational chink' (Vennard, 1968, p.63) in the back section, causing breathiness when vocalising and particularly during falsetto: this is caused by weak interarytenoid muscles not being able to close completely while vibrating in opposition to a complete adduction in the front part of the vocal process though it is overcome once singers are mature and those muscles are strengthened; yet at this stage, female adolescents should not be forced to get rid of their breathy tone but be allowed time for development. This may lead to hoarseness and an arduous phonation, leading to a shift in tone from loud to soft (Huff-Gackle, 1985). Sometimes students' unsteady breathy vocal production may result from their attempts to emulate their favourite artist's style rather than inherent faulty vocal quality (Harrison, 1978). Breathiness can be a more distinguished issue in bigger and lower voices and females with lower voices seem to be subject to being more perceptible to shifting changes in their vocal quality (Monks, 2003). Williams (1990) investigated the difference in vocal range, the quality of the singing voice and speaking fundamental frequency in pre-and post-menarcheal girls (age ranging from 11 to 15 years old) as well as including both their speaking and singing self-perceptions: her dissertation reported a higher rate of breathiness in post-menarcheal

singers compared to the pre-menarcheal group and they resulted being more aware of their fluctuating vocal issues. Burdick (2005) explains how the 'speaking quality' in the low/middle register is challenging for female students with breathy voices and weak chest voice, caused by the chink or gap in the vocal folds, common at that age. Pool and MacDonald (2022) have not found vocal challenges such as breathiness or pitch instability in their own students, perhaps because professional girl choristers are more efficiently trained through individual vocal lessons so they can better master vocal change challenges typical of their age in comparison to amateur singers, however, change in register especially in older girls has been noted. In Cyrier's (1981) observation about vocal range and register of pre- and post-pubescent girls, it was noted that the upper transitional pitch was higher in older girls (14-15 years old) than in their younger peers (10-11 years old); this event was also observed in Gackle (2006): during their vocal development, female adolescents have one noticeable register break from note F to A above middle C, however, during the latter phases of vocal change, this becomes more subtle whereas a higher transition note, similar to a soprano quality (from d² to f^{#2}), becomes more audible. Female adolescent changing voices do not always permanently shift to a new vocal range, like for the boys: they present fluctuating register breaks: at times, they may switch singing parts, from soprano to alto or vice versa, as one part becomes uncomfortable (Harrison, 1978). Bush (1973) describes how important it is for teachers and choir directors to wisely utilise young adolescent singers' voices in mixed choirs as sometimes students get wrongly classified; when girls sing below middle C yet struggle an octave above, this does not imply they are alto and it would be wise for them to learn and alternate soprano and alto parts, so that they do not get classified into the wrong vocal range and experience singing only one voice section for years, risking vocal problems in the future. More recently, the protocol of a future longitudinal study on cathedral girl choristers by Poole and MacDonald (2022) will entail, along with interviews, checks on female singers' voices (aged 11-15, from Y7 to Y11 of UK secondary school) over a period of 12-18 months so that their experiences of vocal change will be compared against more scientific data: this may be the 1st study of this nature in the UK, finding out if Gackle's phases of vocal changes can be mirrored in UK female adolescent singers.

Singing, choirs and strategies

Miller (2010) suggests for young female singers wanting to sing and take private singing lessons to start approximately at the age of 14, not only because at that age they would display increased vocal stability compared to their male peers but also because they would normally be mature enough, although, in order to avoid injuries, he recommends for lessons to focus mainly on their vocal middle range, sporadically testing the upper and lower but refraining from extreme ranges in either directions, and for singers not to sing for prolonged times and at an intensely loud volume. Gackle, (2014) emphasises the importance of safely vocalising throughout the range for vocal improvement and flexibility. According to Miller (2010), healthy vocal instruction is paramount for the developing female singers so as not to create a bad singing habit or damage the vocal

apparatus and as well in case the student's choice of musical style puts her voice at risk of strain. Sometimes students' unsteady breathy vocal production may result from their attempts to emulate their favourite artist's style rather than inherent faulty vocal quality. Smith-Vaughan, Hooper and Hodges (2013) found that laryngeal tension in adolescents was more likely when they were singing music theatre and gospel in contrast to a classical style, hence they recommend teachers to exercise prudence when teaching these singing genres, however, there is disagreement whether singing techniques such as belting, which may be required by many schools having musical shows at the end of the year, can be instructed to developing young voices (14 to 22 years old) in a healthy way: as maintained by Burdick (2005), who taught singing techniques for music theatre to young students (aged 15-17), they can learn to belt if helped by a skilled and knowledgeable teacher, carefully leading them during this process, whereas other voice teachers and pedagogues think belting may be causing harm to their voices.

Most studies focusing on FAVC have been conducted in the UK, USA and Canada in the choir context and with trained voices (Gend et al., 2017). Symptoms of vocal change in females are similar to males but less obvious, however, in students' trained voices, the *passaggio* may be less marked, which entails that singing lessons and/or choir involvement are beneficial to female adolescents and promoting a better vocal tone (Gackle, 2006). In a longitudinal study case study of 3 female choristers' musical development over time during puberty, Howard et al. (2018) found that singers were more able to refine on their singing and being in tune, and more competent in blending voice for choirs purposes, honing on vocal control and output as well as improving their listening skills. Previous longitudinal studies regarding female choristers, have been carried out by Howard and Welch (2002) and Howard, Welch and Himonides (2017), also suggesting that the engaging musical environment positively impact on their vocal flexibility and development. Siple's (1994) study revealed that by combining singing exercises and information regarding the vocal process, female adolescents 's perceptions and attitudes improved, by feeling less tense and more comfortable. Baker, Rakena, and Purdy's (2022) findings regarding participants attending choirs and individual singing lessons, highlighted a better vocal function in students involved in one-to-one lessons than in a group context, possibly due to more time allocated and better dedicated training; having experience with both individuals and singing ensembles, I have found that 'Individualised attention' and 'individual focus support' (Sweet, 2018, p.145) are not always possible during a choir session, for time restraints, especially if the choir includes many singers, however, support may come in the form of one-to-one lessons. Mercado and Draut (2023) recommend having singing students attending an ensemble depending on their same ongoing vocal ability, however I argue whether this is achievable when dealing with smaller choirs or singing ensembles. Sealey and Mitchell's (2019) new choral compositions were experimented in order to help both adolescent female singers during their vocal change and teachers delivering the choir sessions: these choral compositions imply that the different parts are given to individual singers according to their phase of vocal development, and not to the customary choral voice classification. In mixed choirs, as young girls start losing brightness in their voices and struggle to sing an octave above middle C, Bush's (1973) advice to reach vocal brilliance on soprano parts, is

for unchanged boys' voices to accompany girls' voices which may have a limited range, no brightness on top notes (nor rich depth on lower notes), whereas in female-only choirs, Gackle (2000a) suggests placing standing or sitting singers with opposing voice qualities together, such as light against heavy voices, in order to obtain a homogenous sound but also to pair a much younger singer with her more vocally developed, usually older, matching student, so that she can blend with and simultaneously be inspired to develop further. In Manternach, Schloneger and Maxfield's (2019) pre- and post-tests research investigated vocal efficiency and effort of two matched female choir groups, one using straw phonation and the other one using an open vowel: instead of previous research focusing on a pre- versus post-test single group (the outcome of the latter may result in a 'placebo effect'), the outcome of this test showed that performing a SOVT exercise using a straw prior a song performance led to higher spectral energy of the choral sound compared to using an unoccluded vowel; if further tests keep confirming the benefit of SOVT, this may become a significant warmup strategy towards voice efficiency and economy, which may be used by teachers/leaders for their choirs. However, this study involved participants belonging to a lower and upper division of a 2-year college and although age was not reported, I assume it may have involved students in their late adolescent phase (Smith, and Coleman, 2021). In a similar study but applied to individual female students aged 12-13 years old and representing the first pilot study on straw phonation applied yet to female adolescents, Manternach, Clark and Sweet (2023) found that this SOVT warm-up had better effects than the unoccluded 'ah' vowel. It would be useful to find out whether other SOVT exercises and strategies have been tested on female adolescents, however, I have not explored exhaustively on this topic due to time constraints. The singing warm-up exercises provided by Pool and MacDonald (2022) seem quite challenging in pitch for my students (who are mainly amateur) but may represent useful for elite girl choristers leaders and conductors. Challenges affecting female adolescents' voices are not only related to singing but also to drama and speech training: Hardie (2013) proposes a syllabus suggesting a list of principles to assist learners through their vocal change.

Awareness, shared knowledge and self-identity

One of the roles of teachers and educators is to nourish an environment which promotes a singing developmental continuum, where students of all ages, from children to adults, are not classified either as singers/no singers but more as developing/developed singers and where information of all aspects of singing, including vocal anatomy, physiology and vocal health are shared, enabling students to become empowered and co-responsible for their own singing development (Welch 2000). Awareness of FAVC is vital as not to cause misleading classification and most importantly, voice injury: during this phase, girls ordinarily have a typical soprano voice (Huff-Gackle, 1985), however, because of their ongoing vocal development during secondary school, they should not be readily classified as either soprano or alto but more appropriately as having a 'light... or rich midvoice' (Gackle (2000a, p. 816). Cooksey and Welch (1998) describe how the National Curriculum for Music should take into account the many hindrances which female and male

adolescent singers have to face in their lessons, performances and exams, amongst which their range and registers, during their individual vocal development phases, and they address how pivotal is the outline of a differentiated singing curriculum for such students age group, compatible with their growth phase, capacity and prospects, which should include the distinctive needs of female singing adolescents, as well as nurture an awareness amongst students of their own physiological and vocal growth, so that they can enjoy the process in a favourable and constructive way. Whereas teaching singing was found to be well established and a robust feature within primary schools music curricula, Ofsted (2023) observed that this was not so common in UK secondary schools where no substantial development on voice work was secured and built for students; moreover, in approximately a third of schools, as leaders expected and considered music teachers to be expert in their sector, they concluded there was no need for specialist and subject-specific training, which resulted in conspicuous knowledge gaps not being dealt with, for example teaching singing techniques, unless music hubs and professional music associations teamed up with the schools. The inadequacy of teachers with respect to their preparation and lack of information on how best to help adolescents (and particularly female) with their changing voices had been flagged by Gackle approximately twenty years earlier, when she reported that during FAVC female adolescent vocal development, a teacher's role should be to enable students to a healthy, enjoyable and rewarding singing involvement, to have some knowledge of the process of vocal change/ its different stages and symptoms and of their student voices' latent abilities and limits, to discern unhealthy vocal delivery during their maturation and if choir leader, they should be able to choose suitable music and allocate music parts according to their students' needs (Gackle, 1991; Gackle, 2006). Though her constructivist qualitative research approach, Sweet (2018) gathered rich information from older female participants who described their perceptions and singing experiences during vocal change: participants recalled that their singing role was assigned according to the need of the choir at large and depending on their vocal quality, strengths or weaknesses, and teachers did not focus on their personal vocal challenges, restricting their development for the entire school duration and beyond; a much more positive approach and outcome would have been having their vocal role changed with their prior consent, their voice challenges acknowledged and being reassured that this is normal for their age, being reminded of being persistent, patient and hopeful. As expressed in Sweet (2018), findings were representative of that specific school context so they are not generic, however, another article highlighting the key role of studio vocal teachers explaining voice change to students is an exploratory study by Baker, Rakena and Purdy's (2022), whose findings on students' perceptions and learning experiences disclosed how being made aware of vocal change allowed them to learn and understand better this vocal phenomenon and consequently improved their beliefs about themselves and self-efficacy. The importance of the need to instruct adolescents about their voice development had been advocated by Harrison (1978) who stated that vocal change may not be recognised or identified by the girls themselves, however findings in Monks (2003) showed that adolescent singing students (including girls) had a rich awareness of their changing voice and its consequences on their performance, even when they could not understand the reasons behind their vocal unpredictability.

The consequences of vocal change on adolescent singers' psychology are complex and need to be further investigated: in her longitudinal study of female and male students, Monks (2003) describes how the sense of self may be emotionally linked to the status of one's voice; findings hinted that students had more desire to vocally improve for self-satisfaction than to excel in exams or performances, indicating a possible connection between vocal identity and self-identity; reassuring those singers experiencing breathiness in their voice that it is a natural and temporary event and part of their adolescent growth, may reduce their frustration and feelings of being defeated with regards to the unpredictability of their tones. It is also beneficial for female students to be informed about vocal change led by the monthly cycle so that they do not worry about it or feel disappointed with regards to their voice fluctuations (Poole and MacDonald, 2022). Teachers need to be aware of their students' needs during a delicate phase of emotional and physical upheaval and be very supportive, understand when a student may want to stop singing due to lack of vocal confidence, feel embarrassed or not accepting the current situation; they should help students celebrate their voice uniqueness during this transitory phase and promote students' awareness of vocal health (Harrison, 1978). Awareness of FAVC from parents also seems to be significant, in order to encourage their daughters further (Sale, 2022).

Conclusion

From the literature evaluated, there seems to be a general consensus that teachers and educators need to be aware about FAVC: vocal needs, potential and limitations are all important factors to be considered during this time of ongoing fluctuations and uncertainty and that this is a natural transitory process, and sudden vocal improvement of any symptoms should not be forced upon but nurtured. Another important theme that has emerged is that knowledge regarding FAVC should ideally be imparted to students and awareness should be shared by all parties. The different ages for each phase of voice change initiated by Gackle, have not been agreed by all authors, yet they can represent a useful guideline, keeping into account that vocal phases are experienced in a unique way by each adolescent. Vocal change symptoms impact not only singing techniques and choice of repertoire but also relate to challenges with self-perceptions (Gackle, 2014). In the context of choirs, it has also been highlighted that the standard choir song repertoire is not always appropriate during vocal change, and it is paramount to continue and check the individual student's vocal status to find out what phase she currently belongs to: recently, I have observed quite dramatic improvements in some students' voices in a relatively short timeframe. This study has allowed me to increase my understanding of FAVC and deepen a topic little known to me, and it has enhanced my skills as a singing teacher, increasing my confidence in my work. Information on FAVC has increased in the recent past, although there is abundant information of studies in relation to the choir context and data of many articles are still predominately choir-related, so perhaps further research is also needed to accommodate for peripatetic singing teachers working with individual students. In order to expand my knowledge on voice change experienced by all

adolescents, I can envision how a further area of valuable investigation would be solely related to the topic of male adolescent developing voice.

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Appendix 1

Summary of Lynne Gackle's (1991) characteristic phases of female adolescent vocal development

Vocal Development Stage	Speaking fundamental frequency	Range	Tessitura	Vocal Characteristics	Age (guideline only)
Stage I Unchanged (pre-pubertal)	C4-D4 260-290 Hz	A3#- F5	D4- D5	Clear, flute-like tone; Flexible; soprano quality; no breaks	8-10 (11)
Stage IIA (pubescent / pre- menarcheal)	B3-C4# 245- 275 Hz	A3- G5	D4- D5	Breathiness; register breaks; singing in lower register becomes difficult; singing may become uncomfortable and with not much volume in middle and upper range	11-12 (13)
Stage IIB (puberty/ post- menarcheal)	A3- C4# 225 - 275 Hz	A3- F5	B3 - C5	Peak of voice mutation; huskiness, hoarseness and register breaks still present; heavier timbre; challenging phase; limited and narrowed range; lack of clarity in tone	13 - 14 (15)
Stage III Young adult (post- menarcheal)	G3# - B3 210- 245 Hz	A3- A5	A3 - G5	Increased overall range; richer and deeper tone; decreased breathiness; registers more consistent; voice breaks still present during passaggio; volume, agility and resonance improved; presence of vibrato	14- 15 (16)

