INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Faculty of Education

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Master's thesis

Laryngeal physiology and terminology in CCM singing

A thesis investigating research on the underlying laryngeal physiology of CCM singing techniques, and experiences of teaching CCM genres to adolescents

Stemmefysiologi og terminologi i CCM/rytmisk sang

En studie av forskning på stemmefysiologi knyttet til sangteknikker i CCM/rytmiske sjangere, og erfaringer med å undervise ungdommer i CCM/rytmisk sang

Master in Culture and Language

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ABSTRACT

As a singing teacher, one may find that thorough and consistent descriptions of the laryngeal physiology underlying various CCM singing techniques are hard to come by. Books, blogs and magazines concerned with such issues seldom include exhaustive accounts of how the laryngeal structures and muscles are used on a detailed level, and the applied terminology regarding various types of voice production varies greatly.

The two research questions of this study focus on the terminology and laryngeal physiology of healthy and stylistically correct CCM singing techniques, and on how to teach such CCM singing techniques to adolescents, respectively. The former question is explored through a thorough document analysis of peer-reviewed articles and books on the topic. The latter is investigated through semi-structured qualitative interviews with four singing teachers sharing their experiences of teaching CCM singing techniques to 15- to 20-year-olds.

The findings include descriptions of how the laryngeal musculature and other structures engage in various types of voice production, with a particular emphasis on the issue of voice registers. Due to the inconsistent use of terminology in the field, specific guidelines regarding English terms are suggested, and two Norwegian terms are proposed (*randmiks* and *fullmiks*). Aspects specifically relevant to the teaching of 15- to 20-year-olds are presented in the interview findings, which highlight issues such as *basic technique* and *vocal health.*

The findings in this thesis may be employed as a basis for further development of our understanding of CCM voice production.

Keywords: *singing technique, registers, voice qualities, CCM, adolescents, singing terminology.*

SAMMENDRAG (IN NORWEGIAN)

Som sangpedagog kan det være vanskelig å finne grundige og konsistente beskrivelser av stemmefysiologien som er knyttet til ulike sangteknikker i CCM/rytmiske sjangere. Bøker, blogger og blader som tar for seg disse temaene inneholder sjelden uttømmende og detaljerte redegjørelser for hvordan ulike strukturer og muskler i strupen fungerer, og terminologien tilknyttet ulike typer stemmebruk varierer.

Studiens to forskningsspørsmål fokuserer henholdsvis på terminologi og stemmefysiologi knyttet til sunn, hensiktsmessig og stilistisk korrekt stemmebruk i CCM/rytmisk sang, samt hvordan undervise ungdommer i rytmiske sjangere. Det første forskningsspørsmålet utforskes ved en omfattende dokumentanalyse av fagfellevurderte artikler og bøker skrevet om emnet, og det andre spørsmålet besvares gjennom en intervjuundersøkelse der fire sanglærere som har erfaring fra å undervise ungdommer i alderen 15 til 20 år deltar.

Funnene i denne studien viser hvordan strupehodets ulike bestanddeler fungerer i forskjellige typer stemmebruk, og det er lagt vekt på å beskrive forhold som har relevans for forståelsen av stemmens ulike registre. Med utgangspunkt i den inkonsistente bruken av terminologien på området, foreslås det konkrete retningslinjer for hva som bør ligge til grunn for eventuelle valg når det gjelder den engelske terminologien, samt inkorporering av to norske begreper, *randmiks* og *fullmiks*. Når det gjelder undervisning av 15 til 20-åringer i CCM/rytmiske sjangere vektlegges temaer som *grunnleggende sangteknikk* og *stemmehelse*.

Funnene i denne masteroppgaven kan brukes som basis i videreutviklingen av en forståelse for særegenhetene ved CCM/rytmisk stemmeproduksjon.

Nøkkelord: *sangteknikk, registre, stemmekvaliteter, CCM/rytmisk sang, ungdommer, terminologi i sangundervisning.*

PREFACE

First of all, I would like to express my sincere thanks to my supervisor, Sidsel Karlsen. Thank you for understanding, for encouraging me to trust my own judgement, and for your honest comments when I needed guidance. Your knowledge and expertise have inspired me, and not one time did I leave our counselling sessions feeling the weight of the work ahead of me, rather, you have helped me see what should be done in a way that made me excited for the tasks at hand.

A special thank you also goes to my four interviewees. Thank you for taking your time, for sharing your reflections, your knowledge, and your opinions. I have learned a lot from you and look forward to employing more of your ideas into my own teaching practice.

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My special thanks are extended to the singing teachers who helped me develop as a singer, who laid the foundations for my interest in this thesis' topics, and inspired me to follow their examples.

Finally, I would like to express my appreciation for the people I work with, both my students and colleagues at Stange videregående skole, for facilitating a positive and creative work environment where one is allowed to try out new things, engage in interesting discussions, and develop as a teacher.

Stange, May 12, 2018
Ingvild Vestfall

1 INTRODUCTION

I work as a singing teacher in a music program at the upper secondary school level (*videregående skole*, in Norwegian), teaching students from 15 to 20 years old. As part of the program, all students study voice, either as their main instrument throughout the three years of schooling or as a second instrument during the first year. Through this job, I daily meet students with a range of musical preferences, but as my education is mainly based on classical singing technique, I sometimes find the students' wishes to learn techniques and stylistic features of other genres to be a challenge. However, this is a challenge I am happy to take, and for this reason I have worked, for the last ten years, trying to acquaint myself with the field of CCM[1] singing.

In my endeavor to learn more about how to sing and teach CCM genres, I have followed various strategies. I have taken singing lessons with CCM teachers, I have listened to and imitated CCM singers, I have learned a lot from my own students and colleagues, and I have read whatever I could find on the matter.[2] So before I started working on this thesis, I had already read a lot about CCM singing, and I found that thorough descriptions of *what happens* in the larynx, for instance when belting,[3] were hard to come by. By 'thorough descriptions,' I mean images and texts describing the physiology of this or that type of CCM vocal production on as detailed a level as possible. An example of literature describing such issues is *Complete Vocal Technique* (Sadolin, 2008), developed as part of the Complete Vocal Institute. The teachings of this educational institute have become very popular in Norway, but the CVT book (Sadolin, 2008) is a good example containing descriptions that I found *not* detailed enough.[4] Thus, I knew that I had to dig deeper, perhaps even go to scientific sources to educate myself on the matter.

[1] CCM is an abbreviation for *Contemporary Commercial Music*, coined by renowned singing teacher and researcher Jeannette LoVetri. She has proposed the term as an alternative to *non-classical genres*, and it includes "pop, rock, country, R&B, dance, rap, jazz, musical theatre, and numerous associated sub-styles" (Bartlett, 2014, p. 27). I will hereafter use CCM when referring to such styles.

[2] According to Romme (2009), these strategies are commonly used by classically trained singing teachers who want to learn more about teaching CCM genres.

[3] A form of vocal production that is typically associated with a brassy, loud, and speech-like sound.

[4] The Complete Vocal Institute has recently updated its online presence to include a separate website, the *CVT Research Site* (Complete Vocal Institute, 2017), where it presents its research findings. In my opinion, the

As will be presented below, a majority of this master's thesis consists of a document analysis of research literature describing the physiology underlying CCM singing techniques. While all my work on this thesis is geared towards learning and understanding more about this, understanding the physiology related to these techniques is not the *overarching* goal. I simply want to know *what* and *how* to teach my students when they come into my singing studio eager to learn whatever genre has sparked their curiosity, be it soul, rock, or jazz. To be able to teach these genres, I am convinced that I must know the physiological differences between what I was taught as a singing student and what CCM singers do. Further, I must be able to recognize and make all these vocal sounds with my own instrument, as well as being familiar with all the stylistic features of the relevant genre. The two latter issues will not be discussed further in this thesis, the emphasis of which is on the physiology *enabling* singers to sing healthy and stylistically correctly in CCM genres. I also find it interesting to focus on the teaching of CCM singing to 15- to 20-year-olds, since the majority of my students are in this age group. In other words, this thesis can be seen as a preliminary work, and as an essential step towards my understanding *what,* and *how,* to most fruitfully teach my students.

1.1. RESEARCH QUESTIONS

As presented above, I want to know *what happens* in the larynx when singing CCM music. Additionally, I am interested in understanding how singing teachers who teach CCM genres to 15- to 20-year-olds talk about these issues. From these related interests, I have developed two research questions. The first concerns the issue of *what happens,* pointing in the direction of natural sciences and peer-reviewed articles. The second is also directed towards *what happens,* but on a more practical level as it happens in singing lessons seen from the teachers' perspectives. By using the word practical, I mean to signal that I am interested in answers based on, and related to, real-life situations with students, as opposed to published articles deriving from research studies conducted in laboratories. Consequently, the research questions of this thesis are as follows:

> *What can be learned from research on the singing voice about the terminology and underlying laryngeal physiology of healthy and stylistically correct CCM singing techniques?*

descriptions of everything above the vocal folds (what they call levels 2 and 3) are interesting, but the vocal folds and their muscles (level 1) are still poorly described.

What can be learned from singing teachers' talking about their experiences of teaching healthy and stylistically correct CCM singing techniques to 15- to 20-year-old students?

By "stylistically correct*"* (Hoch, 2018, p. 9), I mean voice use that is considered appropriate in a chosen genre, whereas the word *healthy* (LeBorgne & Rosenberg, 2014) relates to singing that does not damage the vocal folds, thus ensuring longevity for the singer.

The two research questions above prompted two quite different research strategies, which will be described further in the methods chapter of this thesis. I chose a document analysis to investigate the first research question, and to find answers to the second question, I conducted four qualitative interviews with singing teachers who had experience teaching CCM genres to 15- to 20-year-old students.

1.2. Structure of the thesis

This thesis consists of five chapters, and in most ways, it follows the 'typical' order of an academic thesis, except that the methods chapter and the theory chapter have switched places. Both the descriptions of the laryngeal anatomy and physiology, the explanations of phonation, and all the sections about various singing issues (such as registers, register breaks, mix, and belting, to name a few) are included in, and may be regarded as parts of, the findings derived from the document analysis. Thus, the detailed research literature review, and the theoretical framework of the investigated phenomena are merged into the same chapter, and making it necessary for the methods chapter to come first. The findings from the interviews are presented in a separate chapter called "Interview findings: Singing teachers' experiences of teaching CCM genres to adolescents," and a more thorough discussion and a combining of the findings from the two investigations are presented in the final chapter.

1.3. Definitions and conceptualizations

I must point out that even though I have used the word 'practical' both when describing the nature of my interviewees' responses and later when describing the structure of the chapter presenting those responses, this thesis is not concerned with *how* to teach CCM genres exactly, and does not contain a 'how-to' list with recommended vocal exercises for the CCM singer. Rather, as described above, this thesis can be thought of as a thorough theoretical examination and a foundation for further exploration of how to sing and teach healthy and stylistically correct CCM singing techniques to adolescents.

In singing pedagogy, one often divides the singer's instrument into three different parts: *the activator* (breathing), *the vibrator* (vocal folds), and *the resonator* (the remaining part of the vocal tract; see Arder, 1996). As this thesis focuses on what happens on vocal fold level, in other words in the vibrator, it is also necessary to include some discussion of the resonator. However, I do not thoroughly describe this part of the instrument, and it is mentioned only secondarily to other issues presented throughout the text. I consider knowledge about respiration in singing to be a large and important topic for singers, not fit for limited and short descriptions. As I wanted to present a broad and in-depth examination of what happens on the laryngeal level when singing however, there was no room for a similarly broad treatment of the activator, and consequently this vital part of the singer's instrument has not been studied or described at all. This does not mean that I find the activator to be of less importance to the singer than the vibrator or resonator, only that I had to set some limits to the scope of the project.

Descriptions of, and discussions related to, stylistic and genre-specific musical choices also fall outside the scope of this thesis, which addresses technical issues related to the functions of the larynx only.

1.4. Previous research on CCM singing in Norway

As the earlier hegemony of European classical music in academia has given way to other genres as well, the number of master's theses and doctoral dissertations about CCM genres in general has steadily increased throughout the last forty years (see Dyndahl, Karlsen, Nielsen & Skårberg, 2017, p. 444). This also applies to studies on vocal CCM music, but although the number of theses has increased, I have not been able to find many studies investigating *vocal technique* in CCM genres. Still, *some* studies that are of interest in relation to this thesis' topics can be found, and they will be described below.

I found four studies dealing with the similarities or differences between classical and some kind of CCM/'rythmic'[5] singing and/or vocal teaching traditions, and in these, anatomy,

[5] The term 'rhythmic' (*rytmisk*, in Norwegian) is used in Scandinavia, and may include a variety of genres such as "pop and rock, world music/ethnic music, Afro-American popular music, fusion/Latin and jazz" (Tønsberg, 2007, p. 19), while other authors simply state that "'Rythmic music' is synonymous with 'popular music'" (Christophersen, 2009, p. 3).

technical issues, and terminology are discussed as parts of more overarching issues (see Halvorsen, 2007; Romme, 2009; Svela, 2013; Teigen, 1995). Technical aspects in these studies are usually explored through descriptions, often quite brief, of actual techniques and related terminology from one or more 'schools'[6] customized to teaching CCM genres. Furthermore, the knowledge presented from these schools are often considered in relation to presentations of similar areas of interest, as approached from the classical singing tradition.

Technical and terminology issues are also covered in theses concentrating on more stylistically or socially constructed aspects of CCM singing (Bjørlykhaug, 2015; Schei, 2007), and the authors exhibit the understanding that "there are not only one but several parallel conceptual frameworks at work at the same time in CCM [*rytmisk*] singing" (Romme, 2009, p. 89, own translation). In the studies mentioned here, Complete Vocal Technique (CVT), and Estill Voice Model (EVM) are the most frequently described schools, perhaps with an emphasis on CVT (see Bjørlykhaug, 2015; Randa, 2007). CVT terminology is also used in two of the Norwegian studies as a conceptual framework for analyzing soul (Bekkemoen, 2013; Brekke, 2008).

However, closest to the topic of my own thesis are perhaps the works of Dahl (2012), Nilsen (2010), and Thomassen (2013). The latter two authors make use of various types of CCM terminology, and they also include terminology and frameworks for understanding from the field of musical theater. Common to all three theses are the considerations regarding vocal health and the level of detail in their descriptions of issues related to singing techniques.

Finally, I would like to mention Romme (2009) again, as well as Augdal (2012), as they both write about how to teach CCM music to students at the upper secondary school level, exactly the same age group as is in focus in the second research question of this thesis.

Though some of the studies mentioned above partly share the same areas of interest as my own work, they have not been included in the document analysis of this thesis. This is because I have mainly focused on scientific peer-reviewed articles in this particular analysis (see page 11), and where the CVT and EVM schools are described, I have used information from original and primary sources, such as "The Estill Voice Model: Theory and Translation" (Steinhauer et al., 2017) and the official CVT book (Sadolin, 2008) and Research Web Site (Complete Vocal Institute, 2017) from CVT.

[6] By 'schools' I mean privately owned singing institutes teaching their own developed methods, terms, or techniques. Popular institutes of this kind are CVT (by the Complete Vocal Institute) EVM (by Estill Voice International), Speech Level Singing (by Seth Riggs), and Somatic Voicework (by Jeannette LoVetri).

2 METHODS

Ideally, I would have liked to have a clinic with modern measuring instruments, solid funding for at least ten years, lots of eager test subjects who would all be singers, and, of course, the medical, engineering, and acoustical knowledge needed to conduct studies on a scale that could produce groundbreaking and useful answers to still unanswered questions in the research field of 'the singing voice.' These wishes are, of course, way beyond anything resembling realistic in my case, so to answer the research questions of this thesis, I chose to look to the work of those who actually operate based on several of the abovementioned specifications. This led me into an extensive and time-consuming document analysis, which has become the main part of this work. To be able to look at the chosen topic from a pedagogical point of view, I also conducted four interviews with "elites," or *experts* (Brinkmann & Kvale, 2015, p. 171) in the field of vocal pedagogy. The latter term will be used in the following. Both document analysis and interviews are inductive qualitative research methods; I use them here to obtain in-depth knowledge on what to teach CCM singers, emphasizing healthy and stylistically correct singing techniques.

2.1. QUALITATIVE RESEARCH AND CHOICE OF METHOD

In our attempt to understand humans' experienced reality, qualitative research methods provide us with tools that allow us to study social phenomena like emotions, meaning-making, and cultural discourses. A range of methods can be used in this area, including interview, observation, and action research, to name a few; all of these methods are suitable for finding answers to questions asking *why* and, most importantly for this thesis, *how* (Befring, 2015, p. 41). The qualitative researcher is interested in knowing why and how something happens, and in these research processes, the researcher is not confined to a hypothesis like one is in quantitative studies but may change course, for example by altering interview questions or other parameters to follow up on new meanings or categories emerging during the research process. This is a typical inductive approach, letting the gathered knowledge and information guide the way. An inductive qualitative study investigates a matter in an open-minded manner, and rather than being static due to a set hypothesis, for instance, meaning emerges from the collected data, either in the final processing of the study results or through analysis done along the way (Inglar, 2011, p. 70; Kvale & Brinkmann, 2012, p. 210). "Qualitative methods include a flexible, dynamic structure" (Kvarv, 2014, p.

138, own translation), and hence the researcher may be seen as a *bricoleur* (Denzin & Lincoln, 2011, p. 4) or a quilter, always sewing bits and pieces into new formations. The modern qualitative researcher knows that an objective view on reality is unlikely to be revealed, and so he or she may choose the next best thing. While triangulation,[7] which means studying a phenomenon using two or more methods (Befring, 2015, pp. 36-37), cannot validate a study completely, it may be seen as an "alternative to validation" (Denzin & Lincoln, 2011, p. 5). The methods and techniques chosen for triangulation determine what the bricoleur's product will look like, and this may shift, as it is situational and steered by the initiated methods and techniques (Denzin & Lincoln, 2011, pp. 4-5).

The whole process of working with this thesis has been characterized by an inductive approach. In the beginning, I was not exactly sure what I wanted to know; I only knew where to look for the answers. In other words, I knew there was a specific area where my professional understanding was in 'imbalance,' a topic on which my knowledge and perception as a singing teacher were incomplete. One is, of course, never finished learning, but at some point, one may feel content, finding one's acquired knowledge to be adequate. However, regarding registers and the underlying physiology of CCM singing techniques, I was *not* satisfied. I felt a definite pull towards this field, and as I did not know exactly what was at the core of this 'instability,' I acquainted myself further with the field, and let the questions emerge as the work progressed. Though I did not know what the precise nature of my research questions should be, I knew what kind of knowledge I was after. To gain the type of information I was interested in, I soon decided that a document analysis was the best option, as it enabled me to research vocal physiology in a broad and in-depth manner. I was further interested in understanding how CCM teachers talked about, and related to, similar issues in their teaching of 15- to 20-year-olds. To gather the latter kind of information, I chose to conduct semi-structured qualitative expert interviews, as this method facilitates exactly what I was looking for, namely the teachers' own understanding and thoughts put into words in a less formal setting, without students present. Both the process of document analysis and the interviews will be further described below, but first I will present some considerations regarding the hermeneutic processes embedded in my research.

[7] Triangulation is a term borrowed from the discipline of land surveying where distances are measured by calculating two angles and one line in a triangle.

2.2. HERMENEUTICS

Hermeneutics has been defined as "the art of interpretation" (Kramer, 2011, p. 1), and for many years it only dealt with the interpretation of *written words* (Ricoeur, 1981, p. 44). Nowadays, hermeneutical questions are transferred to the generation of meaning in other mediums as well, facilitating new and interesting angles from which to study music, visual arts, and other types of products (Bruhn, 1996 [1998]; Kramer, 2011; Kvarv, 2014, p. 76). Central to hermeneutics are questions concerning what meanings one generates when interpreting a phenomenon, and as a basis for all hermeneutics lies the idea that one is never able to understand the world objectively but always acts based on a set of known, and unknown, *pre-understandings* (Kvarv, 2014, p. 73, Alvesson & Skjöldberg, 2009, p. 121). "Readers approach a work with a wealth of preconceptions" (Bruhn, 1996[1998], p. 1), and in this process there is also a fusion of the author's and the reader's *conceptual horizons* (Kramer, 2011, p. 4; Riceur, 1981, p. 61). The conceptual horizon is the total of what a person receives from dealing with a work, and pre-understandings are a part of this. The moment of interpretation, the fusion, is not a fixed situation; rather, it is always changing because the reader constantly is influenced by both the text and other external and/or internal aspects. A related concept is the *hermeneutical process* or *circle* (Kvarv, 2014, p.76), which presupposes that the interpretation of a work is seldom, if ever, a linear process. Instead readers tend to look at the details and the whole alternately, in a circular or spiraling motion. The reader, who interprets various bits and pieces, continually seeks to form a conceptually greater whole, as well as imposing other already existing 'wholes' onto the read material. In musicology, one speaks of *hermeneutical windows* as different 'packages' of conceptual discourses, techniques, or methods, and the meaning formed in the reading of a text will depend on what hermeneutical window is opened. "We open … a hermeneutic window through which our interpretation can pass" (Kramer, 1990, p. 6).

All the aforementioned aspects of hermeneutics have influenced my work on this thesis, infiltrating every level of my investigation. Throughout this work, we can see how my own perception is constantly engaged, from my background, which led to my curiosity for this field, to my selection and analysis of articles and choice of interviewees and interview questions, to the *being* from which the singing teachers and myself expressed ourselves. Furthermore, hermeneutical aspects have influenced my transcriptions and analyses of the interviews, and my inclusion of articles and of the interviewees' descriptions in the narrative of this thesis; finally, the whole package hopefully becomes packed with meaning in meeting you, the reader. In my opinion, aspects like these are always at play as long as humans are

involved, making hermeneutical questions important in both quantitative and qualitative studies.

Keeping this in mind, yet another hermeneutical aspect with overarching characteristics is of relevance here. While the abovementioned aspects influence all levels of a work like this thesis, the 'hermeneutical arc' (Ricoeur, 1981, p. 161) is specifically relevant in relation to the type of triangulation I have conducted. Ricoeur (1981) introduced this concept as a way of oscillating between *explanation* and *interpretation*, thus integrating "the opposed attitudes of explanation and understanding within an overall conception of reading as the recovery of meaning" (p. 161). Alvesson and Skjöldberg (2009) write about Ricoeur's hermeneutical arc as another version of the hermeneutical circle (p. 92), but instead of alternating between smaller parts and the greater whole, one oscillates between "scientistic and humanist methods in the social science process" (p. 92). I understand this combination of scientific approaches and humanist interpretation to be an accurate description of what I have done in this thesis, as I have tried to merge the information stemming from the analysis of documents conveying results from studies most often conducted in the field of natural sciences with findings derived through qualitative interviews giving accounts of teachers' life world experiences.

An introduction to the document analysis as a method is found below, followed by thorough descriptions of the process and strategies used in the document analysis.

2.3. THE DOCUMENT ANALYSIS

Document analysis as a method is concerned with documents in various forms. Historically, it was conducted on law texts and biblical material, facilitating the development of hermeneutics (Bruhn, 1996 [1998], p. 1; Kvarv, 2014, p. 74-75). Today, however, a document analysis may include all sorts of written texts. The overarching issue relevant for all texts is that they have a content that must be analyzed in order to generate meaning (Duedahl & Jacobsen, 2010, p. 53), and this may be done by following different types of analytical procedures and strategies.

The articles reviewed in the document analysis of this work are either studies published in journals, such as the *Journal of Voice* and the *Journal of the Acoustical Science of America*, or proceedings from conferences and symposiums in relevant research areas. Examples here are the *International Symposium on Musical Acoustics* and the *Congress of the European Society of Biomechanics*. In addition, I have used books and published doctoral theses, as well as having sought inspiration and information from master's theses.

For the purpose of this thesis, a content analysis (*innholdsanalyse,* see Duedahl & Jacobsen, 2010, pp. 79-82; Flick, 2006, pp. 323-327) was relevant because I was interested in

the specific information in the articles reviewed. Additionally, I was looking for data regarding terminology—both the meaning of the terms in a broader sense and the actual underlying vocal setup associated with them—so I also chose to do a semantic concept analysis (*begrepsanalyse*, see Duedahl & Jacobsen, 2010, pp. 86-91). The major focus has not been on the terms as such, but on the question of *what happens* in various types of vocal production. This question was a guiding determiner in choosing articles. Before describing the process of finding and choosing material further, I would like to include some critical considerations regarding the process of analysis, as well as some reflections on the validity of the articles.

2.3.1. A critical look at the analysis and validity

When reading articles for this thesis, I tried to be conscious about some issues concerning reading documents in general, and scientific literature in particular. These issues are described below.

Document analysis may be seen as a 'safe' way of doing research because the researcher, the *subject*, does not interact directly with the studied phenomenon. He or she is at a 'safe' distance from the *sender*, perhaps being many miles or even hundreds of years away, but this distance does not necessarily result in a more objective analysis (Duedahl & Jacobsen, 2010, p. 74). Regardless of the gap between the researcher and the author of a document, the former relates to how the message is written—the layout and state of the document—as well as taking into account all the aspects of being a *receiver* who partakes in constructing the meaning of the written text (Duedahl & Jacobsen, 2010, pp.73-74; see also the section on hermeneutics above). This is the case for the reading of documents in general, but as a large number of my sources are scientific documents, another issue is also relevant: I had to be especially careful and critical when reading, coding, and interpreting the articles because the language used in such literature is quite formal and thus appears credible and rational. Errors or misleading phrases may often be well hidden; "indeed, scientific texts belong to the group of the least transparent documents … The scientific language [is] a stylistic form, which … is able to lift any text from being the purest form of navel-gazing to become a credible and invincible authority" (Duedahl & Jacobsen, 2010, p. 72, own translation). Thus, I had to take extra care, often thinking twice before deciding on what I perceive the meaning of a text to be and its credibility.

Another issue prompting a critical mindset is that a great deal of the studies I refer to are pilot studies that only investigate a handful of subjects, meaning that the selection, and,

accordingly, the generalizability, is limited. As stated by Kochis-Jennings et al. (2012), such studies dominate the research on CCM singing styles: "Most studies investigating commercial singing in women have either been single subject or small group studies, making the findings difficult to generalize" (p. 184). Though the selection often is small in these types of studies, I find the results to be of interest to the extent that they support and/or contrast dominant assumptions held by singers and singing teachers.

I would claim that there exist a number of widely accepted and strong opinions among singers and singing teachers, advocated by proud keepers of 'the truth' in singing pedagogy and singing generally. This results in the discipline being thought of by some as somewhat 'stuck' within traditionally fixed ideas and not open to change, even though scientific results occasionally warrant such changes. It is not self-evident that the world of singing uses scientific information, even though such knowledge (the kind of knowledge singers and singing teachers are, or perhaps should be, interested in) may be present. As one of my interviewees declared, "Sometimes I wish that the development was more linear. I get a bit surprised sometimes that our discipline still is not able, as they are in other disciplines, to implement for instance a more scientifically based terminology." There is reason to believe that this challenge creates a gap between researchers and those practicing in the field.

2.3.2. Finding relevant material: About the selection of documents

Being interested in the work of researchers from the field of science on the singing voice, as well as the work of researchers from other disciplines, I used various strategies to search for the articles included in the document analysis of this thesis. First, I meticulously examined all the titles in the *Journal of Voice* from 2000 to 2018 and read the articles I believed had something to do with one or more of my areas of interest, namely *registers*, *voice qualities*, *laryngeal mechanisms and physiology*, *phonation*, *vocal production*, *musical theater*, *CCM*, *mix*, *vocal modes*, *vocal terminology*, *rock*, *vocal health*, *singing technique*, and so on. Some of these articles were spot on, whereas others did not make it into the thesis. Examples of excluded articles include studies looking at more instrumental issues, such as how to measure particular phenomena, studies I found to be exclusively concerned with issues relevant for the classical singing tradition, and studies dealing with speech pathology issues rather than singing. I also read the reference lists in the chosen articles in an effort to find more publications through other channels. In addition, I looked at books that were either recommended to me by colleagues or frequently mentioned in the articles that I read. A discussion of the inclusion of some of these books follows further below.

Proceeding in this way, I developed a 'tree' of literature, with many branches. Some articles showed 'core qualities,' meaning that they presented knowledge and findings that were central to the topics of my work, while other articles had more of an 'interest' value, highlighting nuances of specific aspects. I saved all relevant articles that were not already in print form[8] as PDF files on my computer, ready to be analyzed. At some point, I stopped actively searching for more articles, having gathered a significant amount of literature. However, some specifically relevant and interesting articles emerged and found their way to my 'tree' even after I had started the analyzing and writing process. One such an article was Titze's (2014) paper "Bi-stable vocal fold adduction," and though it was late in the process, I found the article to be of such interest that I had to find room for it in the thesis' narrative.

For the document analysis, I sought research-based knowledge, meaning that I aimed to ground that particular chapter (chapter 3) on peer-reviewed papers and articles rather than books written by singing teachers based on their own experience. This is not because their contribution is not relevant or meaningful, but to answer the question of *what happens*, I had to read articles by people who actually research this matter using measuring instruments such as MRI,[9] fiberoptic laryngoscopy,[10] EGG,[11] or EMG,[12] to mention a few. Even though many such articles included explanatory, and sometimes comprehensive, information in the introduction, I found books to be of great help in understanding the various aspects researched in this thesis. Whereas the articles I read were informative, giving more or less straight answers to various questions, the books were full of descriptions and explanations needed to understand the whole picture of what is presented in some of the chosen studies. This is why I have included texts written by singing teachers in my document analysis, even though I initially wanted to avoid this type of literature. The inclusion of selected books is based on critical considerations; all of them were written by teachers who are either both scientists and singing teachers or whose writings are based on scientific results to such an extent that I found them to be interesting for this study. Examples in this category are *Singing and the*

[8] Some of the articles had to be ordered from the library, and I received them printed on paper.

[9] MRI = magnetic resonance imaging. MRI scanners generate sagittal images of tissue and the nervous system.

[10] Fiberoptic laryngoscopy is done by inserting a thin flexible tube with a small camera lens at its end through the nose and down through the velopharyngeal port.

[11] EGG = electroglottography. Two electrodes are placed on the front of the neck on the thyroid cartilage. This method measures vocal fold contact.

[12] EMG = electromyography. Small hooked-wire electrodes are inserted into the muscles to measure muscle contraction.

Actor by Kayes (2004), *The Vocal Athlete* by LeBorgne and Rosenberg (2014), and *So You Want to Sing Music Theater* by Hall (2014). Other books included in this analysis are books used in other disciplines, such as *Gray's Anatomy* (McHanwell, 2008) and *Speech and Voice Science* (Behrman & Finan, 2008). I find these last two to be legitimate choices, possessing credibility in their respective disciplines.

The document analysis encompassed a total of 17 books and 121 articles (see appendix 5 for a complete overview). Some of these publications are not referenced directly in the narrative of chapter 3, but they must still be regarded as part of the analysis since they have contributed to me having an understanding of 'the whole picture.'

2.3.3. Categorization of documents

The process of categorizing all the literature involved more than one step. First, I read the abstract (and most often more) of all the articles I had collected, choosing and excluding material consecutively. I used the highlighting option in Preview[13] for this work, marking text material in different colors. The chosen articles were then downloaded into EndNote[14] where I entered the information needed to create references. Early in the process, I tried to categorize the articles in this program, but I soon found that I needed a more tangible approach if I wanted to categorize the large number of articles in a way that worked for me. I printed and cut the references into many strips of paper and sorted them by putting them in piles according to overarching categories such as 'vocal health,' 'belting,' 'vocal folds,' and so on. The categories were chosen on the basis of the topics in each article, but I also invented new categories as needed. Here is an overview of the categories I decided on during this process:

- Belting
- Musical Theater
- Classical
- Different genres
- Terminology
- Overarching literature
- Registers
- Vocal health
- Ventricular folds
- Vocal folds
- Vocal tract
- Miscellaneous

As the reader will see in the section below, I did not follow these categories strictly in the analyzing and writing process, but used them as 'places to look' when I needed something

[13] Preview is a Macintosh program used to view and edit PDF files and other types of files.

[14] EndNote is a reference management software developed by Clarivate Analytics.

specific in my text. The books were read in parallel with the articles, but I did not actively categorize the books as I knew I could consult the table of contents and word lists at the back of the books when needed.

2.3.4. Analysis of the documents

Because I wanted to understand the specifics of register and voice quality phenomena, as mentioned above, the process of analysis was characterized by a search for *content, meaning* and *concepts* (Duedahl & Jacobsen, 2010, pp. 79-95). I have already described some of the process, as it took place parallel to the search for and overarching categorization of the articles. In addition, I went through a period when I oscillated between the modes of analysis and writing.

First, I wrote the section about anatomy and physiology, and because I wanted to narrate it my own way, I started writing about what I already knew. I located and added references consecutively, usually looking them up in books or using the search function in PDF files I presumed contained the relevant information. This way, the writing and the integration of the information in the articles went hand in hand. I had also highlighted interesting paragraphs and made comments in the margins of the paper articles, which I consulted when needed. Second, I wrote the sections about phonation and registers. However, these chapters were built less on what I already knew and more on what I found in the literature. The composition of this part was logical to me; I followed a structure often seen in books about singing pedagogy (see e.g. Doscher, 1994; LeBorgne & Rosenberg, 2014; Sadolin, 2008) where specific structures are often explained first, since they are needed to understand later descriptions. Since I had read and categorized the articles quite thoroughly before I started writing, the content had become so familiar to me that I often knew where to look if specific issues had to be clarified. Through the process of reading and categorizing, I also consecutively made up my mind about which articles to focus on specifically based on how relevant I found the studies to be. Examples of such studies were "Investigation of glottal configurations in singing" (Herbst, 2011) and "Laryngeal evidence for the first and second passaggio in professionally trained sopranos" (Echternach et al., 2017).

My investigation not only includes a document analysis, but interviews as well. These will be described in the following section.

2.4. THE INTERVIEWS

The researcher doing *qualitative interviews* is interested in knowing the ways in which interviewees talk about specific phenomena. Again, *content* and *meaning* are central, but subjectivity is also a major component. Interviews are characterized by having two or more subjects, meaning that both the researcher and the interviewee(s) are active participants in the same dialogue, as opposed to document analysis, where the reader is the only active subject at the time of the reading[15] (Brinkmann & Kvale, 2015). Though the researcher usually tries not to influence the interviewee's responses, he or she will always affect the interviewee and the interview situation in some way or another. This calls for an alertness and self-awareness on the part of the researcher, who must constantly try to avoid steering the interviewee in a particular direction, except for when this is desirable (Befring, 2015, p. 75).

This resembles a *semi-structured* interview, an interview where the researcher asks questions and creates the opportunity for reflection and consideration by the interviewee. "This kind of interview aims at letting the subject describe as freely as possible, [but] it is not completely without presuppositions" (Brinkmann & Kvale, 2015, p. 29). Such interviews are planned by deciding on some specific questions or areas around which a flexible dialogue may evolve. This gives the researcher a window through which he or she may obtain "descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena" (Brinkmann & Kvale, 2015, p. 367).

For this thesis, I conducted interviews with subjects that may be regarded as *experts* in their field (Brinkmann & Kvale, 2015, p. 171). In an ordinary research interview, the power balance between the researcher and the interviewee tilts towards the researcher possessing more power, but in the case of expert interviews, this balance has a tendency to either be levelled or tilted towards the expert. This may be due to the power conveyed by an expert's extensive knowledge in the field of interest. Thus, such interviews usually require special preparation on the part of the researcher to mitigate "the prevailing power asymmetry of the interview situation" (Brinkmann & Kvale, 2015, p. 171). However, I did not perceive this change of power balance as a 'threat' in these interviews, for two reasons: First, I was already familiar with the terms and concepts that we were to talk about, meaning that I did not feel at any point that I was 'left behind,' lost the interviewees' respect, or lost the power to control how the interview evolved so as to stay on the topic at hand. Second, though I consider the

[15] There is of course the discussion whether or not the text in itself is 'sort of a subject,' being written by an author at some point, but I find this to be outside the topic here.

interviewees experts in their field, they do not hold positions that for instance make them frequent interview objects in official media; thus, their answers did not seem to be planned and practiced beforehand. Both these reasons contributed to establishing a power symmetry that I perceived to be beneficial for the study. I would describe the positions of the interviewer and the interviewee as quite equal in terms of power in this particular case, making it possible to have fruitful discussions. I must also mention that at some points in the interviews I bordered on Socratic dialogue by prompting the interviewee in specific areas and by sharing my own conceptions on certain topics when this was necessary to achieve a common ground for understanding (Brinkmann & Kvale, 2015, p. 172).

The purpose of the interviews was to gather life world descriptions related to specific topics, but I also aimed at conceptual clarification (Brinkmann & Kvale, 2015, p. 176) in some areas, as mentioned above. This called for both a semantic concept analysis and content analysis of this material (as was the case with the document analysis, see section 2.3.). The findings of these life world and conceptual interviews depended on the sampling, which will be described below.

2.4.1. Sampling of interviewees

Because I wanted descriptions from more than one interviewee, I decided to interview four singing teachers. I also wanted to interview teachers who were not frequently in contact with each other, thinking that such relations might influence their practice to a degree that their answers might cohere more than they usually would. This is why I chose to interview teachers working in three different areas of Norway: two in eastern Norway, one in inland Norway, and one in western Norway. Other features I looked for included working with 15- to 20-year-olds in their day-to-day job as singing teachers and teaching CCM genres. It was also preferable that they be specifically knowledgeable regarding singing physiology and anatomy, but this was not a requirement. After a careful selection process, I ended up interviewing four teachers, presented here with their fictive names: Hilde has worked at a school for 16 years; Eva has taught for 10 years in her own larger private practice; Solveig has worked at a school for 21 years; finally, Morten has also worked at a school for 21 years. Three of the teachers mostly or exclusively teach CCM genres, and one participant mainly teaches classical music but has ample experience guiding CCM singers seeking to improve their technique. I would characterize the sampling as a purposeful selection, as it is based on pre-selected criteria connected to the research questions of this study (Befring, 2015, p. 129). To maintain the anonymity of the participants, I refrain from sharing how I came to know about them.

Table 1. Overview of the four participating interviewees

Fictive name	Years of teaching experience with 15- to 20-year-olds	Teaching genre	Genre background[16] and certification
Eva	10	CCM	Jazz and folk Long experience with Alexander technique
Hilde	16	CCM	Jazz Authorized CVT Teacher
Morten	21	CCM (some classical)	CCM and Classical Certified Master Teacher of EVT
Solveig	21	Classical (some CCM)	Classical

2.4.2. Interview planning and procedures

The interview guide was developed at the beginning of September 2017 and attached to the notification to NSD (Norwegian Center for Research Data) (see appendix 3 for the interview guide [appendix 4 for the Norwegian version] and appendix 1 for approval from NSD). The interview guide was created based on questions relating to the research questions, and since I had not yet decided specifically from which angle to approach the central topics of this work, I chose to ask a fairly wide range of questions in the interviews. Further, the process of constructing the interview guide was influenced by what I had already read of the chosen literature, as well as by my familiarity with the field through my own education and teaching practice. At this time, I had read some literature promoting the terms *thyroarytenoid-dominant* (TAD) and *cricothyroid dominant* (CTD; see page 58 for further explanations), and found them to be very useful. Thus, they were included in the questions in the interview guide. Only much later in the process did I discover that these terms were not as 'safe' as I had first thought (see section 3.4.10.), however, I it was too late to remove them from the interview guide as some of the interviews had already been conducted.

During the period in which the notification to NSD was pending approval (this normally takes a few weeks), I contacted the four interviewees to make preliminary agreements. All four willingly accepted, and when I had the NSD approval, we decided on when and where to meet. The interviews were conducted in the morning, the afternoon, or the evening, depending on what worked best for each interviewee. Three of the interviews were conducted

[16] By genre background, I mean the teachers' main genres both as performers and in which they have their educational background. By certification, I mean the special authorizations offered by EVT, CVT, and others.

at the interviewees' workplaces. The fourth interview took place in the interviewee's home. All interviews lasted about 1 ½ to 2 hours, which was the time predicted in advance, and I recorded them using two different sound recorders. Nothing special happened during the interviews, meaning there were no interruptions of any kind. The information on the memory cards from the recorders was downloaded onto my password-protected and encrypted computed hard drive straight after each interview and then deleted from the memory cards.

2.4.3. Transcriptions

The transcription of interviews is often an overlooked issue in qualitative research literature (Kvale & Brinkmann, 2012, p. 186), and Kvale and Brinkmann even describe transcription as a *translation*. They talk about it as a translation from spoken language to the distinctly different written language. Spoken phrases usually do not work the intended way when they are written down, and this is also the case the other way around; written language does not always sound good when read out loud. The reason for this is that we communicate meaning not only through words, but also through the tone of our voice and bodily expressions (Brinkmann & Kvale, 2015, pp. 203-204). This has consequences for the transcription process, and researchers must decide on what information they are after. An interview for a study seeking insight into a child's liking of school subjects, for example, requires a transcription where as much information as possible about their sighs, laughter, and pauses is preserved. This may call for a verbatim transcription. A report on how singing teachers talk about singing technique, on the other hand, can be transcribed in a way that more resembles the written language because 'mmhs' and the like are not that relevant (see Brinkmann & Kvale, 2015, pp. 206-208). Since I planned on doing a content analysis, I chose the latter kind of transcription and transcribed in "a more formal, written style" (Brinkmann & Kvale, 2015, p. 207). This being said, I left a few indicators in the transcription so as to reveal that the interview excerpts come from spoken dialogues. These include preserving some phrases exactly as they were said and carefully placing punctuation marks where there were meaningful pauses in the recorded material.

All interviews were transcribed using Microsoft Word, and the texts were then imported into the computer-assisted qualitative data analysis software HyperRESEARCH, in which they were categorized and coded. Before describing this process further, I will write about the translation of the chosen interview excerpts.

2.4.4. Translations

The translation of a transcribed interview into a foreign language must be done with utmost care. Because meaning may already be lost or changed on its way from spoken to written language, the danger of more meaning to 'disappear' becomes even bigger when translating that meaning into another language. This is described by Brinkmann and Kvale (2015), who note that "translators are traitors" (p. 204). I understand this to indicate a foundational skepticism towards all translated material, and this skepticism may very well be called for. Nevertheless, in many situations, translations must be carried out, and the translator has a great responsibility. I will not go through all aspects of such a process but will emphasize that the person translating must know both languages well enough so that he or she is able to generate similar meanings in the target language.

The interviews for this thesis were conducted in Norwegian, and all translations were made by me, the author. I did not translate all the transcribed material, only the excerpts that I wanted to use in the final text. While translating, I stumbled on some issues that made the translation process somewhat challenging, but I consider the final product to be trustworthy. The main issue that troubled me while translating was that the subjects at times used language that was not easily translatable to English, and I sometimes had to reconstruct these sentences in such a way that the original phrasing was almost completely lost. Nevertheless, I made all translations as carefully and attentively as possible, prioritizing *meaning* and English language structure over word-for-word translation.

2.4.5. Categorization, coding, and analysis of the interviews

As mentioned above, I used HyperRESEARCH in the coding process. I started to code the transcriptions into categories based on headlines from the interview guide, but I soon discovered that I needed many more categories and changed my approach from a somewhat deductive to an inductive one (Kvale & Brinkmann, 2012, pp. 224-225). This means that instead of using already established categories to order the text, I read all the interviews through and coded the entire text into meaningful units that I invented as I went along (see also section 2.1.). I chose this approach because the interviewees shared so much interesting information, and I could not just put all the 'good stuff' into an 'other' category, as I had not yet decided what to highlight in the final thesis. In the end, I had 111 codes, and these were merged into larger categories as I copied specific paragraphs from the coded material into separate Word documents. I only copied what I found to be specifically interesting or important, thus categorizing the whole of the transcribed material once more, ending up with

seven main categories. These are listed below and are also the titles I have used for the seven main sections in the chapter "Interview findings: Singing teachers' experiences of teaching CCM genres to adolescents":

1. Terminology
2. Technique and music-making
3. Basic technique
4. Vocal health
5. 15- to 20-year-olds
6. Mix
7. Belting

Incorporating excerpts from the transcriptions into the final narrative was easy as I had already decided on a structure resembling the order of events in a typical singing lesson, thus emphasizing the 'practical' touch of this particular chapter. One seldom starts a lesson by doing the most extreme exercises; as will be mentioned in chapter 4, the basics are activated and 'found' before heading on to more advanced singing material. This structure underlies the organization of chapter 4.

2.5. Ethical considerations

In line with current regulations, the project reported in this thesis was approved by NSD (see appendix 1) before I conducted any of the interviews. All participants signed an informed consent letter (see appendix 2), and confidentiality precautions have been strictly followed. For example, I use fictive names for interviewees throughout the thesis, I refrain from linking interviewees to a geographical area, as well as not mentioning what city they work in, and I have kept contact information and the recorded interviews secure on an encrypted computer with a personal password. All identifiable personal information will be deleted when the study is finished.

Another ethical issue that I reflected on both before, during, and after the interviews was my way of *being* in the interviews (Kvale & Brinkmann, 2012, p. 87). As described earlier, the interviewer affects the interviewee, and whether or not I influenced the interviewees in the most beneficial way has repeatedly been on my mind. This continued consideration is in line with all ethical considerations, as they "are embedded in all stages of an interview inquiry" (Brinkmann & Kvale, 2015, p. 83).

2.6. TRIANGULATION OF DOCUMENT ANALYSIS AND INTERVIEWS

Combining the information from the two different research methods may perhaps be regarded as the most hermeneutical process of all the work done with regard to this thesis. In this operation, I tried to merge two quite different entities into one meaningful structure, and the hermeneutical circle (see page 8) was at work constantly. As mentioned before, my motivation for doing this work came from an experienced 'imbalance' or shortcoming in my understanding of the physiology behind singers' registers and voice qualities, and from this base—knowing that I only understood pieces of a larger whole—I sought to complete the circle. I also understood that the larger whole consisted of knowledge both from the singing studio and the field of academic research; thus the idea of doing a methods triangulation (Befring, 2015, pp. 36-37) was born. Throughout the various parts of the process, I have had the overarching consciousness that the bits and pieces should blend into a larger whole, and I have tried to place fractions of understandings or ideas into specific places in this whole, as well as to let the whole develop by itself 'in the background' of my mind while working on smaller parts. This type of hermeneutical process characterizes all the work on this thesis.

3 *Document analysis: Terminology and underlying laryngeal physiology of CCM voice production*

3.1. Anatomy and Physiology

Inside our body lies a complex system enabling us to sing beautifully, to shout for joy or to cry out in pain. It is the delicate coordination of the respiration muscles, our vibrating vocal folds, and the resonating possibilities in our vocal tract, mouth, and nose—all of which are initiated and activated by electrochemical firings in the brain (Behrman & Finan, 2018, p. 140)—that make up this highly personal and communicative instrument. Whether we are using our voice in speech or singing, it is, oddly enough, largely the same set of muscles coordinating the whole process. How can it be that such dissimilar sounds can come from one and the same instrument? And why, as many beginners have commented in voice lessons, does it feel like there is another set of vocal folds in action when you sing, compared to when you use your normal speaking voice (Arder, 1996, p. 135; Brown, 1996, p. 50)? To get closer to an understanding of the answers to these questions, a map of the anatomical and physiological terrain is needed. For this purpose, I will describe the human larynx and selected surrounding muscles, bones, cartilages, membranes and ligaments in the following section.

Though breath management plays an extremely important role in voice production, I have chosen not to discuss this matter in this thesis because I consider it to be outside the scope of the topic at hand. For further details about the singer and breathing I recommend chapter 2 in *The Vocal Athlete* (LeBorgne & Rosenberg, 2014). Another important part of voice production is resonance tuning[17], but this will have a secondary role in this text. The main focus is on the vibrating part of the instrument, the glottis, and on structures close to this vitally important system.

[17] The vocal tract can be modulated, for instance by changing the space at the back of the throat. The various cavities in our vocal tract facilitate reinforcements of particular overtones or harmonics. This means, that when a harmonic of the voice is very close to the resonance in the modulated cavity at the back of the throat, the sound levels of the specific overtones in the produced sound are increased. "This effect is known as *resonance tuning"* (Chantziara, 2015, pp. 1-2).

3.2. THE LARYNX

The larynx can be found in the throat. Holding your fingers towards the front of your neck, you can clearly feel the rising and descending of your larynx when you swallow. What you feel is the front of the thyroid cartilage and the cricoid cartilage moving upwards and downwards in a swift motion. Swallowing, making food go into the correct tube, the esophagus, is one of the larynx's two vital purposes. Its other primary function is coughing and clearing the throat, preventing foreign objects from entering the lungs (McCoy, 2014, p. 29). In addition, the firmly closed vocal folds assist us in increasing abdominal pressure, which is necessary when lifting heavy objects, for instance, or giving birth (Sundberg, 2001, p. 28). Communication is, in fact, a secondary function of the larynx (Steinhauer, Klimek & Estill, 2017, p. 51).

3.2.1. Cartilages and membranes

3.2.1.1. The cricoid cartilage

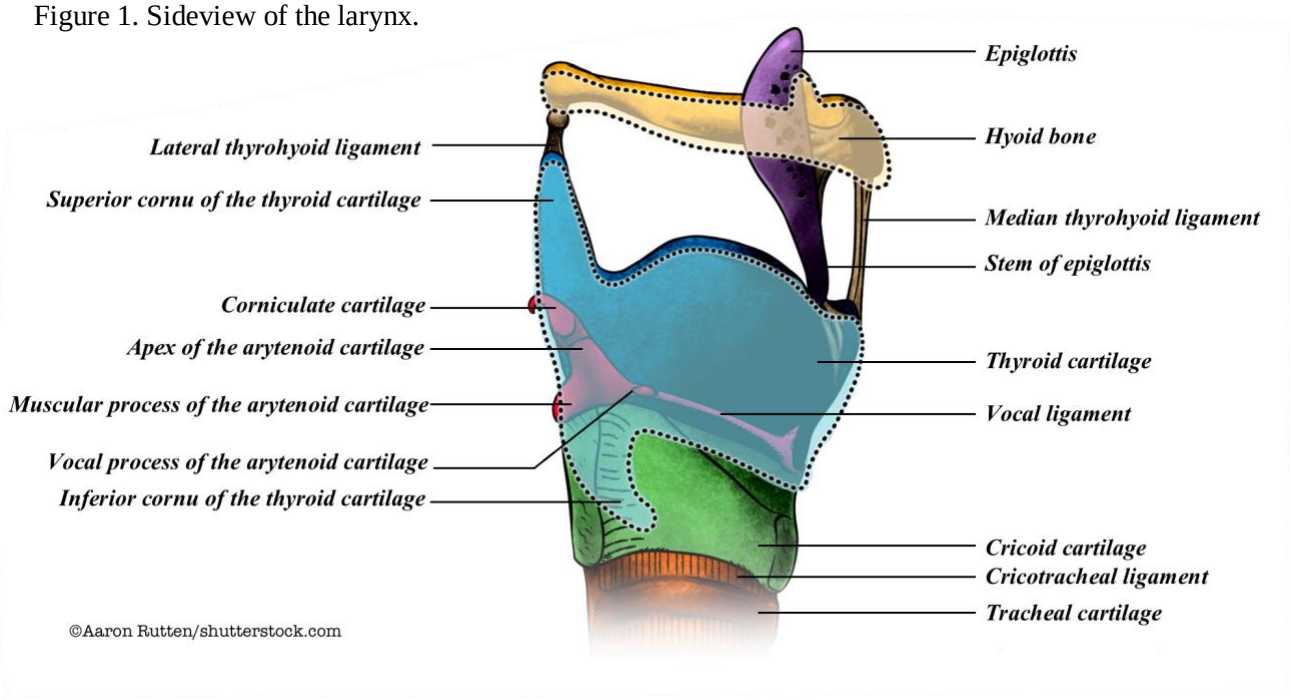
If we start at the bottom of the larynx, we find the *cricoid cartilage* forming a ring with an expansion posteriorly, almost like a signet ring. Like the thyroid and the arytenoids, the cricoid is made of hyaline cartilage that usually ossifies with age (Drevet, Conti, & Deslauriers, 2016). The cricoid can be seen as a continuation of the *tracheal cartilages*, which are also made of hyaline, but the cricoid differs from them by being a completed ring. The tracheal cartilages are C- or U-shaped, with muscle tissue closing the gap at the back. They are separated from each other by annular intercartilaginous ligaments, which make the trachea flexible. Between the last tracheal cartilage and the cricoid is the cricotracheal ligament. The cricoid serves as a stabilization point for the rest of the larynx (Drevet et al., 2016), but can, according to the Estill Voice Model (Steinhauer et al., 2017, pp. 103-114) be tipped downwards anteriorly. This is called a *cricoid tilt* and is presumed to be important for safe belting. This issue will be further examined later on. Posteriorly on top of the 'signet part' of the cricoid, we find the facets for each of the two arytenoids, and laterally on both sides of the cricoid are the facets for articulation with the inferior horns of the thyroid cartilage.

3.2.1.2. The thyroid cartilage

The *thyroid cartilage* is a movable cartilage, made up of two plates that have grown together frontally, almost like the bow of a ship. It is the larynx's largest cartilage and is connected to the cricoid cartilage on both sides laterally at the cricothyroid joint. It also connects to the cricoid by the *cricothyroid membrane*, which will be described below. Posteriorly on either

side of the thyroid cartilage, we find two 'horns.' One pair faces upwards and the other downwards. It is this downward facing horn, the *inferior cornu*, that connects to the cricoid at the cricothyroid joint. The *superior cornu*, the other paired horn, is attached to the hyoid bone by the *lateral thyrohyoid ligament*. This ligament forms the posterior margin of the larger *thyrohyoid membrane*, which runs along the upper border of the thyroid and extends up to a bursa, a small fluid-filled sac, that is attached to the hyoid bone. This bursa "facilitates the ascent of the larynx during swallowing" (McHanwell, 2016, p. 590).

Figure 1. Sideview of the larynx.



The whole larynx is enlarged during puberty, but especially the thyroid cartilage where the sharpness of the thyroid's anterior angle is enhanced. This projection at the front of the neck is also known as the Adam's apple, and is usually much more prominent in men than in women. It is because of these larger-sized larynges and thus longer vocal folds that men usually have a deeper speaking voice than women and children. Somewhat further down on the other side of this projection of the thyroid's anterior surface, inside the larynx, we find the articulation point where the vocal folds are attached. A more detailed description of the vocal folds follows in due course, but for now it will suffice to mention that they stretch backwards horizontally from the thyroid's inside and connect to the vocal processes of the *arytenoid cartilages*, which will be described below.

3.2.1.3. The arytenoid cartilages

The *arytenoid cartilages* are a pair of pyramid-shaped cartilages, with two processes on each cartilage. The vocal process projects forward, and this is the corner where the vocal ligament and thyroarytenoid muscle are attached. The second of the two processes projects out laterally and is called the muscular process. This is the attachment point for abducting and adducting musculature which will be described on pages 39-40. The third low corner of the pyramid is the base, and this is the contact point between the arytenoids and the signet part of the cricoid cartilage, on which they are situated. The contact point between them is called the cricoarytenoid joint and facilitates the rotating and gliding motion necessary for phonation (McHanwell, 2016, p. 589). On top of each arytenoid, on the apex, there are two smaller elastic cartilages called the *corniculate cartilages*. Somewhat higher and laterally we also find the elastic *cuneiform cartilages.* These paired fibrocartilages are found in the tissue of the aryepiglottic fold and follow the arytenoids' motions. They support both the vocal folds and the lateral aspects of the epiglottis.

3.2.1.4. The epiglottis

The *epiglottis* is a leaf-shaped elastic fibrocartilage fastened inside the thyroid by the *thyroepiglottic ligament,* just above the vestibular folds, which will be described further below (Drevet et al., 2016). From this stem-like shape, the epiglottis projects upwards obliquely and folds out like a heart-shaped leaf or tongue. If we look at the epiglottis from the side, it is slightly curved, and midway on the anterior surface it is attached to the hyoid bone by the hyoepiglottic ligament. The epiglottis' shape and curvature vary from person to person but it is often slightly concave when seen from above through a mirror or fiberscope. Generally, children's larynges have more of an omega-shaped epiglottis, when seen from above, but this may also be just a variation in normal human anatomy (Colton, Casper & Leonard, 2006, pp. 379-380). Regardless, the epiglottis' upper margin is free, and it 'bows' over the rest of the larynx when we swallow, thus closing the airway passage conjointly with the closed vocal folds and the vestibular folds. In addition to this mechanism, the *aryepiglottic fold* helps seal off the area so that food and liquid pass into the esophagus. In singing literature, the tube made by the aryepiglottic fold has many names. It is called the *epiglottic funnel* in Complete Vocal Technique (CVT) (Sadolin, 2008) and the *aryepiglottic sphincter* in the Estill Voice Model (EVM) (Steinhauer et al., 2017). Titze (as cited in Sundberg, 2003, p. 11) refers to it as the epilaryngeal tube. This tube can be wide open or narrowed until completely shut; this motion can be done at will and is recognized by some authors as *twang*

(Sadolin, 2008, pp. 51-52; Sundberg & Thalén, 2010, p. 654). In the EVM, this 'bowing' motion, the *narrowing of the aryepiglottic sphincter* (Narrow AES), is a necessary trait in the "Voice Quality" called "Twang" (Steinhauer et al., 2017, pp. 115-126). In other words, the EVM does not use the word twang to describe this specific motion, the narrowing of the AES, but as a label for a more complex setup that includes a special soft palate position, positioning of the vestibular folds, and so on. Because twang implies special characteristics of the sound that are not always present even though the AES is narrowed, the EVM has chosen not to use the term for the AES narrowing. A twangy sound "is often identified as a feature in … Country, Broadway mix and belt styles" (Steinhauer et al., 2017, p. 125), but a dramatic operatic tone is rarely thought of as twangy. Nevertheless, narrowing of the AES has been shown to be present in resonant and ringing operatic tones, making the term twang somewhat confusing.

In my opinion, it does not make any difference whether the teacher uses the term AES narrowing or says to the student, 'Add more twang,' referring to the twanging of the epiglottic funnel (CVT). Both terms work equally well, provided that the teacher and student agree on which terms to use.

Inside the aryepiglottic fold we find the upper margin of the larger *quadrangular membrane.* This membrane is attached on both sides of the epiglottis and stretches backwards and downwards. Posteriorly it connects to the corniculate cartilages and the upper half of the arytenoids above the vocal processes. This forms a free upper border, with the stabilizing cuneiform cartilages embedded in the tissue. This area between the epiglottis and the arytenoids also encompasses the aryepiglottic muscle, which will be described further below. Along the epiglottis' lateral edges, downwards and towards the front, the quadrangular membrane continues and attaches to the inside of the thyroid cartilage, above the true vocal folds but below the thyroepiglottic ligament. This forms a line between the thyroid and the two arytenoids, and this free, lower and thicker border of the quadrangular membrane is called the *vestibular ligament*.

3.2.2. Vestibular and vocal folds

3.2.2.1. The vestibular folds

The vestibular ligament is the innermost part of the *vestibular folds*, thus making the vestibular folds part of a 'continuum' that is closely connected to the surrounding structures by being part of the larger quadrangular membrane. The vestibular folds are also called the ventricular folds, or the false vocal folds. The latter name dates from a time when it was

believed that these folds did not contribute directly in 'normal' voice production. The vestibular folds are "usually composed of muscular, glandular, adipose [fat] and connective tissues that contribute to its phonatory and non-phonatory maneuvers" (Moon & Alipour, 2013, p. 561), but we still lack a complete understanding of their histologic structure. Nevertheless, the presence of muscle bundles in the lateral parts of the vestibular folds has been confirmed, and because of these, the folds are in fact involved in vocal articulation such as glottal stops and pressed phonation. They are also found to vibrate during Mongolian throat singing (Moon & Alipour, 2013, p. 561). Despite this information, there is a lack of general agreement on the topic of 'vestibular fold vibrations.' One source postulates that

> the ventricular folds are not used in human phonation …. Neither their mass nor their stiffness promotes self-oscillation in the same way as the true vocal folds. In extraordinary cases of laryngeal pathology, the ventricular folds can be set into motion, producing a very low-frequency pulsing sound due to their large mass. In general, however, the voice disorder known as ventricular phonation refers not to actual vibration of the ventricular folds but to medial squeezing of the false vocal folds into the airway, so that they impede vibration of the true vocal folds and absorb acoustic energy of the glottal wave. (Behrman & Finan, 2018, p. 114)

It is important to bear in mind that the authors of this paragraph come from the field of speech pathology, where the focus naturally is on the healthy voice as a voice that works well, with near to no visible pathology. From their perspective, phonation by the vestibular folds is only seen in rare voice disorders, but I find it surprising that they open the paragraph by saying that ventricular folds are not used in human phonation when serious researchers have found vestibular fold phonation in Mongolian throat singers (Lindestad, Södersten, Merker & Granqvist, 2001, p. 78). Another recent and more common style of singing where vestibular fold phonation is central is the rock genre. It is debatable whether extreme rock singers can maintain vocal health, but again the perspective is of interest. For singers who love to sing hard metal, for instance, a healthy voice may have other features than a healthy voice in the eyes of speech-language pathologists. This is even the case for classically trained singers, who also may show vocal pathology despite their self-perceived vocal health. A study by Castelblanco et al. (2014), showed that, "Laryngeal appearance alone does not dictate nor fully explain the sound or apparent health of a professional singer. Sustaining good vocal health is complex, and even experienced singers may not reliably assess the presence of pathology" (Castelblanco et al., 2014, p. 608). The majority of the 47 professional singers

they studied were specialized in classical, choral and opera genres, and 95,7% of all subjects were classically trained. This puts the vocal pathology of rock singers in another light, and means that for the rock singer, a healthy voice might be a voice that endures long gigs and tours and that shows longevity, even though it may show some irregularities ([Cross], 2008). In other words, leading metal singing teachers are confident that vestibular fold vibrations are normal in some genres and that they can be done correctly without really damaging the voice.

I have also found details about the vestibular fold interaction in Complete Vocal Technique (CVT) and in the Estill Voice Model (EVM). CVT postulates that the effect known as *distortion* "is created by vibrations of the false folds. The false folds do not have a flexible and excess mucous membrane as do the true folds which means that they do not vibrate as fast and delicately as the true folds and therefore they produce a distorted sound" (Sadolin, 2008, p. 179). In this model, the distorted sound can be produced in a healthy manner if the singer follows the rules applied to the different modes[18] (Sadolin, 2008, pp. 179-186).

In the EVM, vestibular fold positions are categorized as 'options for False Vocal Fold control.' These are placed on "a continuum along which the distance between the false vocal folds can be varied" (Steinhauer et al., 2017, p. 61). At one extreme we have the constricted false vocal folds with the retracted vocal folds at the other extreme. The former option is not made by actual vibrations of the vestibular folds, rather "the false vocal folds come together *almost completely* [emphasis added], causing chaos at the level of the true vocal folds, as they disrupt the flow of breath through the glottis" (Steinhauer et al., 2017, p. 64). Steinhauer et al. (2017) talk about a positioning resulting in grunt-like, distorted and scratchy sounds made by extreme constriction, which may be the same sound and vestibular fold positioning taught in CVT. In mid position, the vestibular folds are halfway between the two other positions. This position is recognized in authentic, untrained and speech-like tones, and is thus found in "folk songs and contemporary vocal styles when a natural tone quality is the artistic choice" (Steinhauer et al., 2017, p. 68). The retracted false vocal fold option has vestibular folds that are opened widely towards the sides of the larynx (Steinhauer et al., 2017, p. 65). It is possible that this is done by the vestibular fold-controlling muscles but there is no clear agreement on this point. Some suggest that the thyroepiglotticus (TE) contributes to this motion, but Steinhauer et al. (2017) have the following to say on the subject:

[18] In CVT, the singer always sings in one of four modes. These are called neutral, curbing, overdrive and edge. I advise the reader to visit their web page (Complete Vocal Institute, 2017) for more in-depth information.

> Some sources postulate that scattered fibers [the thyroepiglotticus] ranging up and out from the lateral thyroarytenoid might participate [in the outward and opening movement of the vestibular folds]. Evidence for extrinsic laryngeal muscle involvement is more compelling. Contraction of the sternothyroid muscle has been linked to widening of the space above the true vocal folds. (pp. 65-66)

Independently of what muscles are activated in the retracted vocal fold option, it is suggested that retraction is very important for healthy opera and belting tones (Kayes, 2004, p. 13). It "produces resonances that evoke ease, relaxation, and …. appear not only in classical performance, but cross over into all musical and dramatic styles" (Steinhauer et al., 2017, p. 68). Retraction of the vestibular folds can be achieved in what the EVM calls "the silent laugh" (Steinhauer et al., 2017, pp. 59-69), which will be explained further on page 69.

3.2.2.2. The laryngeal ventricle and saccule

Beneath the vestibular folds on both sides lie pockets called the laryngeal ventricles. These run almost all the length of the vestibular and vocal folds, but anteriorly they turn upwards and as the opening gets narrower, the cavity continues conically and bends slightly backwards. This narrower and bent part is called the laryngeal saccule, and it contains around 60 to 70 mucus glands (Behrman & Finan, 2018, p.114; McHanwell, 2016, p. 592). When the thyroepiglottic muscle, which will be presented below, contracts, it "compresses the saccule, expressing its secretion on to the vocal cords [folds] … to lubricate and protect them against desiccation and infection" (McHanwell, 2016, p. 592).

3.2.2.3. The cricothyroid ligament

Beneath the saccule and ventricle sits another important laryngeal ligament. Like the vestibular ligament, the *conus elasticus* or *cricothyroid ligament* is fastened inside the thyroid in front and stretches backwards to the two arytenoids, where it is attached to their vocal processes. The conus elasticus is quite thin and continues laterally downwards and is fastened to the cricoid. The free upper border between the arytenoids and the thyroid is thickened and called the *vocal ligament.* This is an extremely important ligament for singers and is situated inside the vocal folds, as will be described below. The *median cricothyroid ligament* is centered vertically in front, between the cricoid and the thyroid. Here the ligament is thick and broad.

3.2.2.4. Mucosa

All the membranes and ligaments mentioned above are covered in mucosa, a laryngeal epithelium that is continuous with the pharyngeal cavities above and the trachea below. Even the ventricle and saccule are covered in this ciliated, pseudostratified respiratory epithelium[19], and it is the chief component of the outer layer of the vestibular folds (McHanwell, 2016, p. 591). In addition to the above-mentioned epithelium, the vocal folds have a margin of non-keratinized, stratified squamous epithelium at the rim next to the *rima glottidis,* the space between the vocal folds. This protects the tissue from drying, and "from the effects of the considerable mechanical stresses that act on the surfaces of the vocal folds" (McHanwell, 2016, p. 591). The vestibular folds also have a small area covered by this type of epithelium.

From my perspective, singing teachers often describe the phonating part of the instrument incorrectly, for instance describing the vocal folds merely as muscles vibrating. To state that the vocal folds are simply muscles is a very superficial way to explain this complex structure, especially when thinking about how little sound would be produced if there were only muscles vibrating. As will be described below, the mucosa and superficial layer of the vocal folds are essential for voiced sounds. A more detailed description of this crucial part of the singer's instrument follows here.

3.2.2.5. The vocal folds

The vocal folds are multilayered structures (McCoy, 2014, p. 30; Steinhauer et al., 2017, p. 72), and all the layers contribute to the fine and intricate process of phonation (Cochereau, Bailly, Orgèas, Bernardoni & Chaffanjon, 2016). This being said, not all phonation is dependent on vibrations in all the layers. I will come back to this in section 3.3. As mentioned before, the outer layer is thin epithelium, but underneath this is the three-layered lamina propria, which is divided into the superficial, intermediate and deep layers. The superficial layer is quite loose and is of the utmost importance for singing (Sundberg, 2001, p. 25). "It is this layer that moves most markedly during vocal fold vibration" (Hirano, 1988, p. 52). McCoy (2014) makes it clear that producing voiced sounds with only muscles is futile:

[19] "Pseudostratified epithelium is a single-layered (simple) columnar epithelium in which nuclei lie at different levels in a vertical section" (McHanwell, 2008, p. 28) Moreover, "Cilia sweep a layer of mucus and trapped dust particles etc., from the lung towards the pharynx in the mucociliary rejection current, which clears the respiratory passages of inhaled particles" (p. 28).

"During phonation, the outer layer of the fold glides independently over the inner layer in a wavelike motion, without which phonation is impossible" (p. 30).

The intermediate and deep layers of lamina propria form the thick upper border of conus elasticus, called the vocal ligament[20] and present a clear connection between the cricoid and the vocal folds. This membrane is "a strong supporting structure of the vocalis muscle and the vocal fold" (Dayme, 2009, p. 99), stabilizing and holding the surrounding tissue in place despite strenuous maneuvers. The fifth and innermost layer is the thyroarytenoid muscle, which some sources divide into the medial and lateral bundles (LeBorgne & Rosenberg, 2014, pp. 57-60; Zhang, 2016). The medial bundle is popularly called the vocalis muscle. McHanwell (2016) explains that: "Relaxation of the posterior parts of the vocal ligament by the vocalis muscles, combined with tension in the anterior parts of the ligaments, is responsible for raising the pitch of the voice. Vocalis can change the timbre of the voice by affecting the mass of the vocal cords" (p. 597). Zhang (2016) supports this to some extent: "Each [thyroarytenoid] bundle is responsible for a certain vocal fold posturing function. However, such functional division is still a topic of debate" (p. 2615). In addition, the interaction of the layered structure of the vocal folds during phonation is hypothesized to be as follows: "The more dense the collagen fiber, the less elastic the tissue is, making it more resistant to changes in length" (LeBorgne & Rosenberg, 2014, p. 59). This means that the vocal ligament is considerably more resistant to changes in length than the more pliable superficial layer. They have different combinations of mechanical properties, thus resulting in "different voice characteristics" (Zhang, 2016, p. 2615). This is also mentioned in LeBorgne and Rosenberg (2014): "The interaction of the cover and the body[21] of the vocal folds are critical for fine control singing and registration" (p. 59). This is obviously an interesting and relevant issue, but "because of lack of data of the mechanical properties in each vocal fold layer and how they vary at different conditions of laryngeal muscle activation, a definite understanding of the functional roles of each vocal fold layer is still missing" (Zhang, 2016, p. 2615).

Dividing the vocal folds into five layers works well from an anatomical point of view, but mechanically it is more suitable to divide them into three parts, thus showing more clearly the functions of the various layers: first, the vibrating part which consists of the epithelium and

[20] See p. 29 for a reminder of what the vocal ligament is.

[21] The body of the vocal folds can refer to the muscular part only, or both the muscle and deep layer of lamina propria. Different authors use different terminology (LeBorgne & Rosenberg, 2014, p. 59).

superficial layer of the lamina propria; second, the two layers that are also called the vocal ligament; and third, the muscular component (LeBorgne & Rosenberg, 2016, p. 59; McHanwell, 2016, p. 592.e1).

"The layered structure also presents some variations along the length of the vocal folds" (Hirano, 1988, p. 53), meaning that the described layers are not identically proportioned all the way from front to back. This slightly variant tissue is often called the membranous part of the vocal folds, and it stretches from the thyroid approximately three-fifths of the way along the glottis. The remaining two-fifths posteriorly is generally identified as the cartilaginous part of the vocal folds and is the lower edge of the vocal process of the arytenoids (Herbst, 2011; McHanwell, 2016, p. 592). The tip of the vocal process is made of an elastic cartilage, making it less stiff than the body of the arytenoids, which consists of hyaline cartilage. When the vocal folds are fully closed, both the membranous and cartilaginous parts meet and closes the rima glottidis (see page 62).

In this overview, I have presented the nine cartilages of the larynx, in addition to describing some important membranes and ligaments and the mucosa of the laryngeal structures. Before I describe the muscles involved in vocal production, I will give a short description of the hyoid bone.

3.2.3. Bones

3.2.3.1. The hyoid bone

The *hyoid bone* is not a part of the larynx but plays a major role in the main laryngeal functions. It is a horseshoe-shaped bone structure that moves freely when we swallow, and it is not connected to any other bone by joints[22]. Instead it serves as a hub, with muscles connecting upwards to the root of the tongue, the floor of the mouth, and the jaw. These are called the suprahyoid muscles. Below it connects to the thyroid, as mentioned before, and also to the sternum and shoulders further down with the infrahyoid muscles (Dayme, 2009, p. 96; McCoy, 2014, pp. 38-39). When we sing, both infrahyoid and suprahyoid muscle contractions have an impact on the sound we make. The suprahyoid muscles control the articulating part of our instrument, for instance by regulating the tongue position and jaw opening/closing, and tension in the infrahyoid muscles can result in an unrelaxed larynx with adverse constriction. "Tension in one area is easily passed along to another" (McCoy, 2014, p. 39), and when so

[22] There are only three bones in our body that are not connected to other bones by joints. These are the hyoid bone and the two kneecaps (McCoy, 2014, p. 38).

many important muscles are interconnected through the hyoid bone, it can be quite difficult "to determine the primary offender in this kind of chain reaction of tension" (McCoy, 2014, p. 39).

3.2.4. Laryngeal muscles

In the following, I will present the anatomy and physiology of laryngeal musculature. The laryngeal muscles necessary for phonation are generally divided into two groups: one group containing muscles connecting the laryngeal cartilages to neighboring structures, the extrinsic muscles, and the other group containing the muscles encased within the larynx, the intrinsic muscles (LeBorgne & Rosenberg, 2014, pp. 49-55; McHanwell, 2016, pp. 594-595).

3.2.4.1. Extrinsic muscles

The extrinsic muscles are found outside the larynx and can, as mentioned above, be further divided into two groups: one containing muscles fastened superior to the hyoid bone, called *suprahyoid muscles*, and the other containing muscles with attachments at or inferior to the hyoid bone, called *infrahyoid muscles*.

The suprahyoid muscles "allow for movement or stabilization of the hyoid bone" (LeBorgne & Rosenberg, 2014, pp. 50-51) and include the *stylohyoid*, *mylohyoid*, *digastric* with an anterior and posterior belly, and *geniohyoid muscles.* These muscles are not essential to understanding the topics discussed in this thesis, and I will therefore go more in depth into the names and connection points of the infrahyoid muscles.

The *sternohyoid* is fastened on sternum[23] and clavicle[24] inferiorly, and into the hyoid bone superiorly. When contracting, it pulls the hyoid bone downwards and depresses the larynx (LeBorgne & Rosenberg, 2014, p. 50). Yet another muscle, the *sternothyroid*, starts at the sternum but ends at the thyroid cartilage, pulling it down when it is contracted. Just above this muscle's attachment point on the thyroid, another muscle is attached and extends up to the hyoid bone. This is called the *thyrohyoid muscle*. The remaining muscle, the *omohyoid,* is fastened to the hyoid bone and runs all the way out to the shoulder blades, facilitating stabilization and depression of the hyoid bone (LeBorgne & Rosenberg, 2014, pp. 51-52).

Though contractions in extrinsic laryngeal musculature may be a condition for safe voice production in higher or louder vocal qualities (Estill, Baer, Honda, & Harris, 1983), I will not

23 Breastbone.

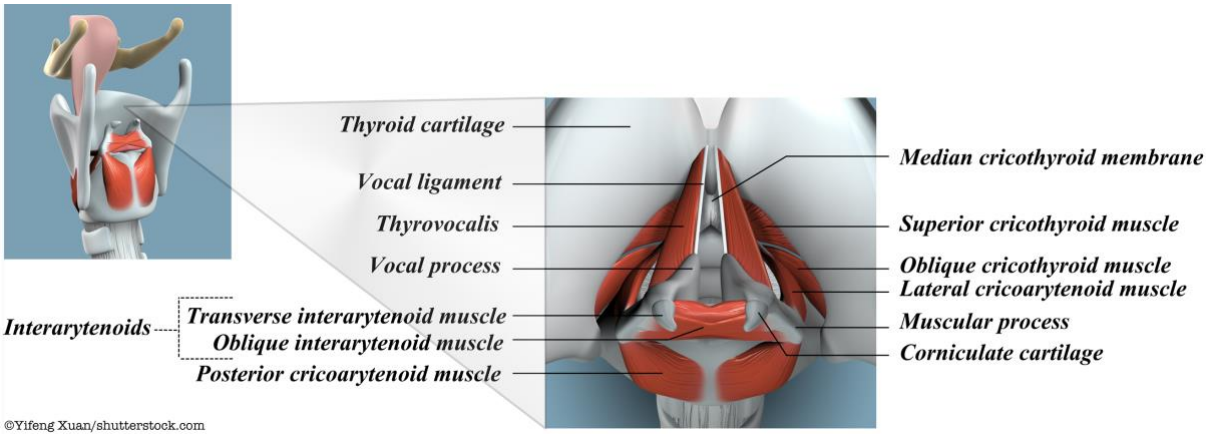
24 Collarbone.

give a thorough account of these muscles in this thesis, as I choose to focus on the intrinsic musculature.

3.2.4.2. Intrinsic muscles

The intrinsic laryngeal muscles are found inside the larynx and are among the fastest in the human body, second only to the eye muscles (Behrman & Finan, 2018, p. 116). Below follows a presentation of these muscles.

Figure 2. Intrinsic laryngeal muscles.



3.2.4.3. The thyroarytenoid muscle

If we start at the very heart of the larynx, it is natural to begin with the thyroarytenoid (TA) muscle. This is a paired intrinsic muscle situated laterally to the lamina propria in the vocal folds. As mentioned before, we can divide the TA muscle into the lateral bundle and the medial bundle/vocalis muscle. I find the alternative terms thyromuscularis and thyrovocalis (Behrman & Finan, 2018, p. 116; LeBorgne & Rosenberg, 2014, p. 53) both simple and explanatory and choose to use them in the following.

The TA muscles are fastened to the thyroid cartilage at its lower half anteriorly, on the inside, close to the vocal ligament. Posteriorly they are attached to the vocal processes of the arytenoids. Though the thyrovocalis and thyromuscularis often are grouped together as the TA muscle, this designation is not necessarily correct. As mentioned on page 31, the functional division of the thyrovocalis and thyromuscularis is debatable, but they seem to have quite dissimilar functionalities. The thyrovocalis is, along with the cricothyroid muscles, one of the two main tensors of the vocal folds. The thyromuscularis, on the other hand, "is categorized as a relaxer of the vocal folds" (Behrman & Finan, 2018, p. 116), and when it contracts, it releases tension in the neighboring thyrovocalis, the vocal ligament and the other

layers of the vocal folds. It is also suggested that contraction of the thyromuscularis contributes to sphincter function, along with other adductory muscles (Behrman & Finan, 2018, p. 116). Further the lateral edge of the thyromuscularis has fibers stretching upwards, and some of these fibers are thought to constitute the muscles recently discovered in the vestibular folds (Behrman & Finan, 2018, p. 114) (see page 26). The muscle fibers stretching upwards from the thyromuscularis also stretch up into the aryepiglottic fold, and some of the fibers extend all the way up to the margin of the epiglottis, where they are called the thyroepiglotticus or thyroepiglottic (TE) muscle (Behrman & Finan, 2018, p. 117). As mentioned earlier, contraction of the TE muscle is important for vocal health because it presses down on the saccular glands, causing them to lubricate the vocal folds during phonation. The vocal folds have no glands and are therefore dependent on this moisturizing to function well.

As described above, the outer layer of the vocal folds is quite loose, and when the TA muscle contracts and shortens, this outer layer slackens even more (Behrman & Finan, 2018, p. 153; Hirano, 1988, p. 55). You can picture this by holding out your open hand and touching the skin on top of your hand with your other index finger. It is quite loose and flexible compared to the tight skin of a closed fist (Dayme, 2009, p. 102; McCoy, 2014, p. 30). When the TA muscle is contracted, the vocal fold also gets thicker and bulges in its membranous part. This bulging is responsible for some of the closure at the membranous part of the vocal folds (Hirano, 1988, p. 54). In addition, the TA muscle enacts a pull on the arytenoids, making them slide a bit forward and towards each other. This contributes to vocal fold adduction, as well as making the vocal folds thicker if the cricothyroid muscles (which will be described below) are not opposing the TA contraction. The sliding on the cricoarytenoid joints also slightly lowers the posterior part of the vocal folds horizontally, as the arytenoids move downwards slightly when sliding (Hirano, 1988, p. 54). For the glottis to close fully, the posterior chink, the posterior opening between the cartilaginous parts has to be closed as well. A description of the muscles involved in this action is found further below.

3.2.4.4. The cricothyroid muscle

Another important paired intrinsic muscle is the cricothyroid muscle (CT). This muscle, which acts as an antagonist to the TA muscle (Hirano, 1988, p. 61), starts at the anterior surface of the cricoid cartilage. The median cricothyroid membrane is situated in front, with the CT muscles fastened on each side. The CT muscle splits into two parts, the lower *oblique CT* muscle attaching to the inside of the thyroid cartilage just in front of the inferior cornu,

and the straighter *superior CT* muscle that stretches somewhat upwards and connects to the thyroid cartilage along its insides laterally. When the CT is activated, it executes a rotating motion of the thyroid cartilage at the cricothyroid joints, thus lowering the thyroid cartilage towards the cricoid anteriorly (Behrman & Finan, 2018, p. 128). The oblique CT also pulls the thyroid forward in a more horizontally gliding motion (Brown, 1996, pp. 175-176). Because the vocal folds are attached both to the thyroid cartilage frontally and to the arytenoids sitting on the cricoids dorsally, this tilt of the thyroid stretches the vocal folds and makes them longer, thinner and more tense, if the arytenoids are stabilized (LeBorgne & Rosenberg, 2014, p. 54; McHanwell, 2016, p. 597). Stabilizing of the arytenoids may be facilitated by the posterior cricoarytenoid muscles, but because the posterior cricoarytenoid muscles are abductors, adducting forces will have to be added to maintain the intended vocal fold vibrational pattern (Sundberg, 2001, p. 29). If the CT muscles are activated with no TA involvement, the vocal folds become very thin, but if they are activated combined with contraction of the TA muscles, the TA opposes the activity in the CT and secures a thicker vocal fold vibration despite the elongation (Behrman & Finan, 2018, pp. 152-154). Often this is associated with a richer and fuller sound, compared with the thin and often unstable sound of CT contraction with or without a small degree of TA involvement (Hirano, 1988). I will further explain this combination of CT and TA contractions later in the thesis.

Contraction of the CT muscle has been proven to increase vocal pitch because of the elongation, thus heightening the tension and thereby also the frequency at which the vocal folds vibrate (Sundberg, 2001, p. 30). In other words, the CT muscle plays a key role in pitch-regulating tasks (Behrman & Finan, 2018, p. 150).

It is also interesting to note that while the CT muscles are the main tensors in vocal production, they are also important in some abducting activities. Hirano (1988) discusses how the CT muscles can abduct the vocal folds when they are already at the midline and how the "simultaneous increase in LCA [lateral cricoarytenoid] and VOC [vocalis muscle] activity during F0 [fundamental frequency[25]] increase should be necessary to prevent vocal fold abduction passively caused by the increased cricothyroid activity" (p. 61). When the CT muscles are already in the abducted position, their contractions contribute during sniffing and inhalation (Behrman & Finan, 2018, p. 121). It is common for singing teachers to ask their

[25] F0 is an abbreviation for fundamental frequency, which is the lowest tone in a spectrum. The other tones in the same spectrum are called overtones. Overtones can be seen in a frequency spectrum or sound spectrum (Sundberg, 1987, p. 19).

students to ‘breathe in through your nose as if you are smelling something nice,’ and perhaps there are more benefits to this sniffing than just the activation of the breathing system allowing a deep and expanding breath. As will be mentioned later in the thesis, the act of sniffing might help lower the larynx position[26], but I will also suggest that voices in need of CT strengthening might benefit from nose inhalation exercises. It might be that the CT muscles are more readily activated in phonation tasks if they are contracted in a sniffing motion just before phonation starts.

There is not enough room in this thesis to present thorough descriptions of nerve supply, but a brief explanation is necessary. The CT muscle is the only intrinsic muscle innervated by the external branch of the superior laryngeal nerve. All the other intrinsic muscles are innervated by the recurrent laryngeal nerve (Hirano, 1988, p. 54; McHanwell, 2016, p. 597). This sets boundaries for which muscles we can activate independently at will without extensive training (McCoy, 2014, p. 39). For example, if you have never played an instrument or trained to lift your fingers separately, you will probably have difficulty lifting solely the ring finger on your non-dominant hand. This does not mean that it is not possible, you just have to practice a lot. It is the same with our laryngeal muscles, except that muscle tension in this area is much harder to isolate because the muscles are very small and intricately connected (Hirano, 1988, p. 54). Not being able to see with your eyes what you are doing does not make it any easier. Scott McCoy (2014) gives a clear picture of the technical complexity involved in trying to understand and master the art of singing:

> You have sixteen muscles in your tongue, fourteen in your larynx, twenty-two in your throat and palate, and another sixteen that control your jaw. Many of these are very small and lie directly adjacent to each other, and you often are required to contract one quite strongly while its next-door neighbor must remain totally relaxed. Our brains need to develop laser-like control, sending signals at the right moment with the right intensity to the precise spot where they are needed. When we first start singing these brain signals come more like a blast from a shotgun, spreading the neurologic impulse over a broad area to multiple muscles, not all of which are the intended target … [With] practice and training we learn to refine our control, enabling us to use only those muscles that will help, while disengaging those that would get in the way of our best singing. (p. 39)

[26] A low or lowered larynx position is upheld as a primary parameter for the classical or operatic sound (LeBorgne & Rosenberg, 2014, p. 104).

Knowing this makes it seem hardly possible to activate only one intended pair of muscles at a time (Sundberg, 2001, p. 117); indeed Kayes (2004) finds this is so difficult that she instead recommends that singers "aim for a sensation of balanced effort" (p. 77). Nevertheless, a large number of amateur and professional singers around the world make progress with their voice every day, proving that we are able to activate our laryngeal muscles in slightly different and new patterns. These changes do, of course, also involve vocal tract settings, but as Hirano (1988) states, "There is no doubt that varying singing techniques are associated with different muscular control, and slight differences in muscular activity can cause subtle variations of voice quality" (p. 58). How some sounds are dependent on glottal source adjustments and others are made in the vocal tract will be discussed later in the thesis.

Before discussing the last four intrinsic muscles, I will quote Hirano's (1988) simple overview of some TA and CT characteristics:

- The edge of the vocal fold is sharpened by the cricothyroid, whereas it is rounded by the vocalis.[27]
- The body of the vibrator is passively stiffened by the cricothyroid and actively stiffened by the vocalis, that is, the body itself.
- The cover of the vibrator is stiffened by the cricothyroid, whereas it is slackened by the vocalis. (p. 57)

3.2.4.5. The interarytenoid and aryepiglottic muscles

Lastly, we have the four different muscles connected to the arytenoid cartilages, of which one is unpaired. This is the *transverse interarytenoid muscle* (TIA), situated between the arytenoids and fastened "at the back of the muscular process [on each arytenoid]" (McHanwell, 2016, p. 595). This muscle is sometimes considered to be a part of the more superficial *oblique interarytenoid muscles* (OIA), and they are often grouped together as the *interarytenoids* (IA). The OIA muscle is fastened to the muscular process of one arytenoid, and crosses posteriorly, attaching to the apex of the other arytenoid cartilage. This resembles a cross when seen from behind. Some muscle fibers also extend further over the apexes and upwards into the aryepiglottic fold, forming the *aryepiglottic muscle* (AE). This muscle runs along the quadrangular membrane inside the aryepiglottic fold and attaches to the margin of epiglottis. When the AE and the OIA muscles contract, "they act as a sphincter of the laryngeal inlet by adducting the aryepiglottic folds and approximating the arytenoid cartilages

[27] Thyrovocalis.

to the tubercle[28] of the epiglottis" (McHanwell, 2016, p. 595). This motion done halfway is the twanging motion described on pages 25-26. The TIA muscle is the main 'closer' of the posterior chink, which was mentioned in the paragraph about TA activation, but the OIA also assists as a stabilizer in this motion. When the TIA muscle contracts, the two arytenoids slide towards each other, thus closing the cartilaginous part of the vocal folds (Herbst, 2011; Sundberg, 2001, pp. 26-27).

3.2.4.6. The lateral and posterior cricoarytenoid muscles

The remaining paired intrinsic muscles are the *lateral* (LCA) and *posterior* (PCA) *cricoarytenoid muscles.* The LCA muscles are fastened to the arytenoids at their muscular process and run forward laterally, attaching to the cricoid's upper border. The PCA muscles are also fastened to the muscular process of the arytenoids, but instead of going forward laterally like the LCA muscles, they run backwards and cover a larger area of the posterior cricoid cartilage where they are attached. The LCA muscles, aided by the IA muscles, are the main *adducting* muscles, whereas the PCA muscles are the main *abducting* muscles (LeBorgne & Rosenberg, 2014, pp. 53-54; Sundberg, 2001, pp. 27-28). Adduction is the process of vocal fold closure, needed for phonation and other glottal sounds, while abduction concerns glottal opening, the normal position for relaxed breathing.

When the vocal folds abduct, the PCA muscles make the arytenoids slide slightly down to either side of the signet part of the cricoid, increasing the distance between them. The PCA muscles also pull on the muscular process of the arytenoids, making them and the vocal process with the attached vocal ligament rotate outwardly. This opens the glottis even more, like when you take a really deep breath (Anatomy Guy, 2018). Even though the PCA muscles are considered to be abducting muscles, they also probably assist other laryngeal muscles during phonation. The role of the PCA muscles in this regard is not fully understood (Hirano, 1988, p. 61), but they appear to assist the CT muscles in elongating the vocal folds by exercising a backwards pull on the arytenoids, thus acting as a stabilizer of the arytenoids as mentioned on page 36 (Hirano, 1988, p. 57; McHanwell, 2016, p. 595). PCA muscles are also contracted when we make unvoiced sounds (McHanwell, 2016, p. 595), and this contraction elevates the level of the vocal folds (Hirano, 1988, p. 57).

[28] The tubercle of the epiglottis can be compared to the stem of a leaf, rising vertically along the epiglottis' midline.

When the LCA muscle is contracted, it pulls on the muscular process of the arytenoids, making them rotate towards each other. This moves the vocal processes and the attached vocal ligament towards the glottal midline, and lowers the vocal fold level (Hirano, 1988, p. 57). This closes the membranous part of the glottis, an action sometimes called medial compression (Dayme, 2009, pp. 105-106; McHanwell, 2016, p. 597) or membranous medialization (Herbst, 2011). The LCA muscles also exercise a "shortening and relaxing of the vocal folds" (McHanwell, 2016, pp. 595-597). If they are contracted without the IA, the posterior chink mentioned earlier will not be fully closed, a configuration associated with whispering. This is because the vocal folds move towards the midline but do not meet fully along their whole length, letting air flow continually through the posterior gap (Dayme, 2009, p. 104; McHanwell, 2016, p. 595; Sundberg, 2001). A whispery sound can also be produced simultaneously with voiced sounds, what is known as breathy voice productions. These sounds may be a result of airflow being "too fast and/or under so much pressure that it prevents the vocal folds from coming together properly" (Dayme, 2009, p. 104).

I have now given an overview of the anatomy and physiology of the larynx and will continue with a description of what happens in voice production.

3.3. PHONATION

When we sing or speak, our vocal folds collide at an incredible speed. Singing A4 (or a1 according to the Norwegian system), the vocal folds vibrate 440 times per second (LeBorgne & Rosenberg, 2014, p. 61), and higher pitched sounds vibrate even faster (Sundberg, 2001, p. 28). For these vibrations to result in sounds we recognize as song or speech, we are dependent on our resonating cavities. Without these, the sound from our vocal folds would only be a buzzing sound, much like the sound of someone blowing a trumpet mouthpiece (American Academy of Otolaryngology, 2018). The chambers responsible for the transformation from buzz to sonorous tones are the cavities from our vocal folds to our lips and nostrils, in other words the pharynx, which continues from the lower rim of the cricoid cartilage to the back of the mouth and nose, in addition to the oral and nasal cavities (LeBorgne & Rosenberg, 2014, p. 44; McHanwell, 2008, p. 561-568).

When we breathe out normally, the throat is open and air flows unhindered from the lungs through the trachea, passing the abducted vocal folds on its way up and out into the air surrounding us. When there is audible sound, this air encounters a hindrance. The hindrance can occur, for example, at the level of the glottis or vestibular folds, at the level of the

velopharyngeal port,[29] because of articulations made by our tongue or by semi-closed lips or lip-trills. Airflow can be obstructed at one or more 'stations' as it travels through the throat, nose and mouth, but only the vocal folds are responsible for phonation (Behrman & Finan, 2018, p. 114). Phonation happens when the vocal folds chop up the airstream that comes from the lungs, and these puffs of air travel through the vocal tract, up and out of the mouth. On a more detailed level, the brain sends the necessary signal and, as stated by the myoelastic aerodynamic theory,[30] the vocal folds approximate at the midline in accordance with the hardness or softness of the sound we mean to produce. Shortly after, the subglottal pressure[31] (P_{sub}) raises, initiating vocal fold vibrations.

3.3.1. One vibratory cycle

A pressed sound normally has a pressed or glottal onset, which means that the vocal folds are fully closed when the air comes rushing upwards. The glottal onset starts with the voluntary action of adducting the vocal folds, followed by an increase of the P_{sub} (Sundberg, 2001, p. 78). When the pressure gets high enough, the air that pushes on the vocal folds from beneath causes the vocal folds to slip away from each other. However, it is just the vibrating folds that are pushed to the sides; the adducting muscles are still active working to close the glottis. As the air gets in between the vocal folds, we get a negative intraglottal pressure and the vocal folds start to close again at their lower edge. At this point, a coronal view of the space between the vocal folds has the shape of a triangle with the broader end upwards, and as the motion continues upwards, sucking the tissue together, the triangular space is flipped upside down, meaning that when the upper part of the vocal folds is closed, the mucosa at the lower end already have allowed in a new puff of air (LeBorgne & Rosenberg, 2014, p. 62). This unfolds as a rolling motion, a mucosal wave that always starts below and moves upwards. Another term for the mucosal wave is vertical phase difference (Behrman & Finan, 2018, pp. 142-143; Henrich, 2006, p. 9). Vertical phase difference happens when the vocal folds are thicker and more of the body meets, as with the chest voice for instance, but when the vocal

[29] The velopharyngeal port is the opening between the velum, also called the soft palate, and the nasal cavity known as nasopharynx (LeBorgne & Rosenberg, 2014, p. 235; McHanwell, 2008, p. 563).

[30] Myoelastic aerodynamic theory: Myo – muscle, elastic – stretch, aero – air, dynamic – constantly changing (LeBorgne & Rosenberg, 2014, p. 60).

[31] Subglottic pressure ($P_{sub)}$ is the air pressure just below the vocal folds. 'Sub' means under, and 'glottic' refers to the glottis. The reader may consult *Science of the singing voice* by Johan Sundberg (1987/2001) for further explanations.

folds are very elongated and thinned and only the upper rims of the vocal folds are vibrating, as with a light head voice or falsetto, vertical phase difference is not an issue. Here was mentioned light head and falsetto, in other words typical high-frequency phonation, but during all soft phonation where the thyroarytenoid is not active, it is only the vocal fold cover that vibrates (Behrman & Finan, 2018, p. 152). Many sources hold the Bernoulli effect[32] to be of utmost importance in self-sustained vocal fold vibrations, but recent studies show that this negative intraglottal pressure may not be as critical as previously supposed. Already in 1980, Titze (Behrman & Finan, 2018, p. 138) discussed how the Bernoulli effect by itself cannot sustain self-oscillation. To delve deeper into this goes beyond the scope of this thesis, but I recommend reading the work of Zhang (2016) for further insight.

3.3.2. Onsets

I have now described one vibratory cycle initiated from the glottal onset. In this setting, the TA, LCA and the IA muscles are activated to "close the glottis and hold back the airflow" (Steinhauer et al., 2017, p. 51), and if the brain gives the signal for these muscles not to give in, we are able to lift very heavy objects and do other strenuous tasks as mentioned on page 23. In addition to the glottal onset, we have two other onsets that are frequently described in the singing literature. First, we have the softer onset, often called simultaneous onset (LeBorgne & Rosenberg, 2014, p. 67), or smooth onset in the Estill Voice Model (Steinhauer et al., 2017). In this onset the vocal folds are approximated at the midline simultaneously with the onset of airflow, and the airflow is neatly adjusted to the chosen tension in the TA, LCA, IA and CT muscles, which are all initiated "in a gradual manner prior to voicing" (LeBorgne & Rosenberg, 2014, p. 67). This gentle onset is usually regarded as favorable because the vocal folds are neither exposed to the hard 'clashing' of the pressed onset, nor 'the drying wind' of the breathy onset which will be described shortly. That being said, there are lots of genres in which glottal and breathy onsets are preferred because they are stylistically appropriate. Although they are not often used constantly throughout a song, in some cases these extreme onsets are used frequently. This is associated with bigger risk, and the singer who wants a long career needs an advanced understanding of the balance between breath and tone to tailor the P_{sub} (see above) to the chosen onset and phonation mode (Arder, 1996, pp. 141-142). The hard glottal attack, in particular, should be used judiciously and with caution,

[32] The Bernoulli effect "is the occurrence of a drop in pressure created when a liquid or gas increases in velocity as it passes through an area of constriction" (LeBorgne & Rosenberg, 2014, p. 60).

preferably only by "thoughtful and healthy singers" (LeBorgne & Rosenberg, 2014, p. 68). Some sources divide the glottal onset into a softer glottal onset or a glottal stroke, and a very hard glottal attack (Arder, 1996, pp. 140-142; Steinhauer et al., 2017, p. 55). Lastly, we have the breathy or aspirate (Steinhauer et al., 2017, pp. 51-52) onset, in which the air already flows between the vocal folds when the adducting muscles are activated (Sundberg, 2001, p. 78). Here the Estill Voice Model (Steinhauer et al., 2017) distinguishes between abrupt and gradual aspirate onsets, referring to onsets that start with an aspirated sound and continue with either a glottal-like onset (abrupt) or a sigh (gradual). As mentioned, the glottal onset, sometimes called the glottal attack, is regarded by many voice professionals as being traumatizing. Nevertheless, Steinhauer et al. (2017) maintain that glottal onsets "can be found in almost every language on the globe in the form of glottal strokes" (p. 55). We use them every day, with the muscular effort and breath support in perfect harmony.

As outlined above, the extremities of glottal attack and breathy onset are only marks on a continuum with a number of variations in between, including simultaneous onset somewhere in the middle. In other words, there are subtle gradations of onsets, as clarified by the Estill Voice Model's effort numbers (Steinhauer et al., 2017, pp. 39-42). These are numbers chosen beforehand to monitor perceived muscle contraction, and which demonstrate clearly how one type of onset can be done with various levels of effort. The higher the effort number, the more energy is invested in the onset or the tone afterwards.

In addition to the three described onsets, I wonder why vocal fry, or creaky voice, is not regarded as a separate onset. Some people use it frequently, others more seldom, but this type of onset is undoubtedly a natural part of our speech pattern. Vocal fry or creak can be used at the start or the end of a sentence, in the middle of a word flow, or even throughout whole sentences. It can be used in everyday speech but is perhaps even more widespread as a feature of a sleepy voice or an exhausted or ill person. Vocal fry or creaking, as described by Švec, Schutte and Miller (1996), is created at the vocal fold level, with vibratory patterns that differ from the three other onsets. It is often used to help the vocal folds into more efficient vocalization, for instance when singers have an insufficient glottal closure. It is also a well-known stylistic feature in popular music (Herbst, 2011, p. 29). To me it seems like none of the three described onsets fit the onset of vocal fry or creak, and I have not come to an understanding as to why the relevant literature I have read does not refer to the creaky voice, or vocal fry, with their very distinct vibratory patterns, as separate onsets.

Though Steinhauer et al. (2017, pp. 43-57) also give interesting descriptions of the various *offsets,* or tone endings, I have chosen not to go into this issue because I have not found it to be emphasized in other literature.

The onset is, of course, also closely related to the registration or phonation type[33] deliberately or unconsciously chosen by the singer. Either the onset is sustained as a tone with similar quality, for instance when a breathy onset is continued with a breathy tone, or the singer may change the tone's character after it is initiated, for instance when a pop singer starts a soft verse with a creak, or a classical singer starts a heartfelt word beginning with a vowel by clearly accentuating the vowel. Regardless of the combination of on-set and phonation type, the quality of the sound usually increases when a melody line is prepared beforehand. This is done by matching the onset and amount of energy and breath support vested in the tone's beginning to the challenges encountered in the phrase. This is a well-known procedure and helps the singer to endure both long phrases and demanding repertoire, regardless of genre (Arder, 1996, pp. 140-141).

I have now described the various onsets and shed some light on the ongoing oscillating process. In the following sections, I will discuss the somewhat confusing landscape of registers.

3.4. REGISTERS

There are several ways to approach the world of registers and its variants. For centuries, the European classical singing tradition has tried to understand why the voice has these gear changes and varied sound qualities throughout the range, leading to ongoing disputes about what these registers should be called and what their defining criteria should be. I will not go into this history here, but instead recommend the reader consult Henrich's (2006) article: "Mirroring the voice from Garcia to the present day: Some insights into singing voice registers."

The definition of what a register is depends on the angle from which it is approached. Some time ago, singers and singing teachers mainly relied on the perceived placement of resonance in the body, thus calling the voice felt resonating in the chest chest voice and the voice that resonated in the head head voice. These terms, as they refer to the effect of the tone, often were, and still are, combined with the auditory approach, which emphasizes

[33] Here I refer to phonation type as it is used by Sundberg (2001). He defines four types of phonation on a gradient scale: breathy–flow–neutral–pressed (see page 62 for further presentation).

similarity of tone color and quality. Another approach to the singing registers is based upon laryngeal findings and uses a letter combined with a number, or some other quite neutral label, to designate registers. Examples are systems such as M0–M3[34] and Register 1–4[35]. They can be defined solely on laryngeal conditions or be combined with similarities in the perceived tone quality (Sundberg, 1987, pp. 49-57). "While some authors consider a vocal register as a totally laryngeal event, others define it in terms of overall voice quality similarities" (Henrich, 2006, p. 3). In the following I will cover all three approaches.

In a presentation at the 12th Symposium on Care of the Professional Voice in 1983, Hollien cited a study on vocal registers that included contributions from physicians, scientists and voice pedagogues. They managed to agree on four distinct registers and decided that it would be best to set aside the old terms (such as chest and head), suggesting a system of registers numbers from 1 to 4 instead. The registers were presented as follows:

> Register 1: The very lowest of registers, probably used only in speaking (old terms: pulse, vocal fry, creak).
> Register 2: That (low) register, which is used for most speaking and singing (old terms: modal, chest, normal, heavy).
> Register 3: A high register primarily in singing (old terms: falsetto, light, head)
> Register 4: A very high register usually found only in some women and children and not particularly relevant to singing (old terms: flute, whistle). (Hollien, 1983, p. 5)

At that time, there was no agreement as to the ranges of the different registers, and it seems there is still no consensus on this point (Dayme, 2009, p. 110). Though some things are still unclear, we know a lot more today than thirty years ago, and many of the assumptions, specifically regarding Registers 2 and 3, have proven to be reliable.

Many serious researchers agreed to use the terms R1–R4 in the 1980s, but very few of them are using these labels today. Most now use some variant of the chest/head/falsetto-terms, but few are consistent. In the following, I have chosen to use the terminology M0 (mechanism 0), M1, M2, and M3—which correspond to Register 1, R2, R3 and R4 respectively—because it is based on laryngeal mechanisms rather than audible or kinesthetically perceived input. I find the M0–M3 terminology to be a clear and scientifically based way of talking about registers, in contrast to 'the singers' way' which, in my opinion,

[34] Henrich (2006) often uses the mechanism M0-M3 in her work.

[35] R1–R4 as proposed in Hollien (1983).

often blurs and complicates the discussion because of all the possible interpretations based on subjective experiences. Roubeau, Henrich and Castellengo (2009) clarify why mechanisms are a good terminological choice in singing and voice science:

> It seems that the concept of laryngeal mechanism may be used for a better understanding of the laryngeal level of production of a register, as it proposes a homogeneous mode of observation, applicable to all subjects and all styles of vocal expression. It is physiologically defined, and it is common to all subjects, male and female, singers and non-singers, in singing and in speech. (p. 436)

Whether the concept of laryngeal mechanisms is as universal as they claim is up for discussion, as the reader will see below, but regardless of the criticism, I feel confident that this terminology is less thorny and confusing than many others because of the scientific measurability of these mechanisms. Open and closed quotient values are found using electroglottography (EGG) (Barlow & LoVetri, 2010; Herbst, 2011, pp. 18-22; Roubeau et al., 2009), and the differences in open quotient values between M1 and M2 provide scientists with a measurable indicator that can tell us a great deal about what register is used (Henrich, 2006, p. 8). Put this together with stroboscopic examinations, P_{sub} measurements and sound spectra analysis, and the results should be even clearer. However, to what extent this terminology is preferable in singing tuition is quite another question and will be discussed further in the final chapter. I must also mention that, although I mainly use the terminology M0–M3 in the following, I have chosen to include both chest and head/falsetto where I find this to be clarifying, and where these terms are used in the study reviewed.

Presentations of the four registers follows below, and although M0 and M3 are not used to a great extent in singing (Kob, 2011, 363), I have included descriptions of them because I find them to be a natural part of vocal training.

3.4.1. M0

M0 is characterized by a long, closed phase, often with irregular vibrations. The thyroarytenoid, probably just the thyromuscularis, shortens and thus thickens the vocal folds. The thyrovocalis, CT and IA muscles, on the other hand, are barely contracted, which makes the vocal folds very slack. The pliant layers of the vocal folds produce the lowest frequencies, with the anterior part of the vocal ligaments vibrating (Henrich, 2006, pp. 8-10). M0 is used in creaky-sounding voice qualities, referred to as “Slack True Vocal Folds” in the Estill Voice Model (Steinhauer et al., 2017, p. 79) and as creak or creaking in CVT (Sadolin, 2008, pp.

187-188). In addition, it is used by "some teachers … to release tension in the vocal folds" (Dayme, 2009, p. 110). This is the mode or register I referred to on page 43 where I suggested a possible fourth type of onset. Though both the CVT and the EVM refer to this register as creak, Švec et al. (1996) have divided vocal fry and creak into two separate modes, with good reason. They found that the creaky voice has a subharmonic vibratory pattern making a noisy sound an octave lower than the sung tone. In other words, creak can be used in all frequencies as long as the mucosal wave or vertical phase difference[36] is present. The mucosal wave is imperative for creak to happen, and because M2 has no mucosal wave, girls trying to creak[37] in their 'head voice' consequently make no progress. This is not to be confused with a creaky *onset*, which can be followed by a tone in any register or type of phonation. The vibratory pattern of creak is dissimilar to the aperiodic vibratory patterns associated with vocal fry. Vocal fry has no clear pitch and may be categorized as just noise. At low frequencies, it is presumably very hard to tell the difference between a very low creaky note and vocal fry. As I understand the EVM, its Slack True Vocal Fold option is similar to the register Švec et al. (1996) categorize as vocal fry. The CVT, on the other hand, reports this phenomenon as something applicable to all pitches, and must thus be describing what Švec et al. (1996) categorize as creak.

3.4.2. M1

Contraction of the TA, LCA and IA muscles indicate phonation in M1. These contractions make the vocal folds thick, and the pliable surface meets with great vibrating mass. M1 is closely related to speech (Herbst, 2011, p. 29), and has a large vibratory amplitude[38], long closed phase and short opening time. This results in open quotient values (OQ) ranging from 0.3 to 0.8, "depending on vocal intensity" (Henrich, 2006, p. 11). In M1 the frequency spectrum is characterized by strong mid, and even stronger high, harmonics which tend to yield a bright and brassy sound (Kochis-Jennings, Finnegan, Hoffman & Jaiswal, 2012, p. 183; McCoy, 2014, p. 34). If the harmonic energy produced at the larynx is used as a 'register-navigator,' it is worth mentioning that women traditionally speak in a register

[36] The mucosal wave and vertical phase difference are two terms for the same phenomenon: The rolling motion where the vocal folds let air pass from bottom to top. See page 41 for more information.

[37] When I write about creak here, I refer to sung tones in various frequencies that have the creaky character to them the whole time, and not just in the beginning.

[38] Vibratory amplitude refers to how far away from the midline the vocal folds move laterally (Dayme, 2009, p. 111).

between the male modal and male falsetto. This indicates that there might be a difference between the modal registers used by women and men (Titze, 2014, p. 2091). Further, M1 has higher P_{sub} than, for instance, M2, and when singing in M1, it is important to regulate the P_{sub} in accordance with the chosen muscle tension, thus tailoring it to the adduction strength of the vocal folds. This is because a P_{sub} that is too high or too low for the intended vocal mode or phonation type is associated with vocal disorders (Arder, 1996, pp. 170-171). Two phonation strategies that often result in vocal trauma are strongly adducted vocal folds with low P_{sub}, called hyperfunctional voice, and poorly adducted vocal folds with high P_{sub}, resulting in a hypofunctional voice. Hypo- and hyperfunctionality may be an issue in M2 as well, but there is reason to believe that these ineffective types of phonation are more damaging in M1 because a larger area of the vocal folds meets and there is a higher collision force at work.

3.4.3. M2

M2 has thin vocal folds, due to the activated CT muscles. The thyrovocalis can be contracted, but it does not take part in the vibration (Roubeau et al., 2009, p. 341). This means, among other things, that there is a reduction in vibrating mass and thus a lower vibratory amplitude compared to M1. "The open quotient values are high, ranging from 0.5 to 0.95 depending on the fundamental frequency" (Henrich, 2006, p. 11), and this relates to a strong first harmonic (F1)[39]. I understand M2 to relate to what is often categorized as the male falsetto, and what is thought of as the lightest most feeble type of head register in the female voice. Perhaps it is closest to compare M2 to the untrained female head voice occurring in voices that mainly use the mode M1, or in other words voices that have become used to a divergent glottal configuration. I will explain more about the divergent shaped glottis on page 50.

3.4.4. M3

There have not been many studies on the phonatory mechanism of M3 (Henrich, 2006, p. 12; Švec, Sundberg & Hertegård, 2008, p. 347), but recent studies (Roubeau et al., 2009, p. 431; Švec et al., 2008, p. 352) show that anterior-posterior vibration differences are not apparent, and that the vocal folds vibrate along their whole length in M3. This register is sometimes

[39] As may be remembered from page 22, the various cavities in our vocal tract facilitate reinforcements of particular overtones or harmonics. This means, that when a harmonic of the voice is very close to the resonance in the modulated cavity at the back of the throat, the sound levels of the specific overtones in the produced sound are increased. F0 is the fundamental frequency, the sung pitch, whereas F1 is the first overtone to be reinforced due to the modulation of the vocal tract (Chantziara, 2015, pp. 1-2; Sundberg, 2001).

difficult to detect by EGG, which might be due to the possibility of no contact between the vocal folds during phonation. Henrich (2006) writes that F0 "typically ranges from B5 to F6" (p. 12), and she refers to Walker (1988), who states that the first harmonic is dominant in M3, with the number of overtones reduced. This reduction in overtones is also mentioned in Garnier et al. (2012), who found "reduced energy in harmonics above the first two producing a *flutier* quality" (p. 959). Švec et al. (2008) second the notion of first harmonic dominance, and they refer to the findings of Miller and Schutte (as cited in Švec, 2008) who state that "the whistle register results when F0 passes F1" (p. 352). The investigations of Švec et al. (2008) also show no, or a very short, closed phase, and a smaller amplitude of vibration in M3 than in M2. A decrease in vibrational amplitude is normally associated with weaker sound output, but this study (Švec et al., 2008), in which one subject sang ascending scales and pitch glides, showed an audio signal output that was much larger in M3 than before the register transition. "Such a paradox suggests that a vocal tract resonance plays an important role here" (Švec et al., 2008, p. 352).

I have now presented the four registers acknowledged by scientists as registers detectable at the voice source. A larger study by Echternach et al. (2017) offers evidence that "noteworthy vocal fold oscillatory registration events occur in both the first and the second passaggio[40] even in professional sopranos" (p. 2), a finding that further supports M1, M2 and M3's having vocal fold vibration patterns corresponding to each register. This study is very interesting, because they had access to ultra-high-speed videoendoscopy showing 20,000 frames per second, and with this equipment they could rule out the possibility that the transition from M2 to M3 is entirely a matter of vocal tract resonance. There are "changes in vocal fold oscillations patterns" (Echternach et al., 2017, p. 11), and it seems like this is also true for the M1 to M2 transition. However, we do not yet know why these laryngeal oscillatory adjustments happen. What initiates these changes? Echternach et al. (2017) narrow it down to two main causes. It may be because of "changing laryngeal biomechanical properties induced by intrinsic laryngeal muscles" (p. 12) or because of "vocal tract resonance effects having a strong influence on the sound source" (p. 12). As will be described in the next section called *Bi-stable vocal fold adduction*, there is a very interesting theory combining these two causes, showing how both may be right. Additionally, a well-known film made in 1960 by van den Berg, Vennard, Burger and Shervanian (1960) shows how an abrupt register transition occurs in an excised larynx with no vocal tract, in other words in a larynx with

[40] First passaggio is the transition from M1 to M2, and second passaggio is the transition from M2 to M3.

practically no resonating potential. I will also mention studies where the glottal configuration seems to be stable while there still is an audible register shift. I understand that both phenomena are confirmed, the trouble is finding out what initiates them and how they are related. In other words, according to Echternach et al. (2017), we are not sure what initiates the transition changes, but there is strong reason to believe that the changes are manifested both at vibratory level and in the vocal tract resonance.

3.4.5. Bi-stable vocal fold adduction

Titze (2014) has contributed vastly to the research on the singing voice, including hypothesizing frameworks on the vocal registers based on subglottal interaction (Titze, 1988). In 2014, he publicized a computational model theorizing what happens in register breaks and in mixed registers, providing a possible solution to the aforementioned uncertainties (Titze, 2014). I will give a short introduction to his findings in the following.

A sudden change from one register to another may be triggered by any of the three main regulators of voice production. Both the subglottic pressure, laryngeal musculature and vocal tract resonances, for instance via vowel adjustments, may cause swift register shifts, even when the changes are small (p. 2092). That register changes occur because of vocal fold surface pressure "brings in the entire register dependence on F0, vocal tract configuration, and lung pressure" (Titze, 2014, p. 2100). Immediately after leaving the vocal folds, the acoustical pressure travels through a quite narrow space, the supraglottal vocal tract. A narrow supraglottal vocal tract is the same as the AES narrowing or twanging of the epiglottal funnel described earlier. This small space, as compared to the larger trachea below, and the wider and larger pharynx above and to the sides, has proven to be much more significant for registration control than previously understood. It also has more effect on registration than the subglottal acoustic pressure (p. 2092), which could mean that changes in vestibular fold positioning or twanging of the epiglottic funnel may have more impact on registration than, for instance, if the subglottic pressure were to change.

In his model, Titze operates with convergent and divergent glottis positions. These terms reference the triangle I described on page 41. "When the top of the vocal folds is more adducted than the bottom, the glottis is referred to as convergent …. When the bottom of the vocal folds is more adducted than the top, the glottis is said to be divergent" (Titze, 2014, p. 2092). The middle position, called rectangular glottis, where the vocal folds are near rectangular in shape, has only been shown in studies with physical models, but here we find

the lowest oscillation threshold pressures,[41] thus making this shape a position to aim for. In real life, the configuration nearest to this may be with vocal fold surfaces slightly convergent (p. 2100).

Titze (2014, p. 2100) also explains how muscle contractions shape the glottis into the convergent and divergent vocal fold shapes. As we have seen, the TA muscles adduct the body of the vocal fold, sometimes referred to as membranous medialization (Herbst, 2011). In addition to this longitudinal closing, the vocal folds close horizontally. In this regard, the TA muscles adduct the bottom of the vocal folds, in addition to making this lower part with less ligamental tissue, stiffer. As CT contraction increases vocal fold length, the the ligament at the top of the vocal fold stiffens. The LCA muscle adducts the top of the vocal folds, and in particular the anterior part of the vocal processes, as mentioned earlier. Full closure happens only when the IA muscles are adducted as well, but for now we shall focus on the horizontal closing regulators of the vocal folds. In simpler terms, TA contraction controls stiffness and closing of the bottom of the vocal folds, while the CT muscle controls stiffness in the upper layers and the LCA muscle controls closing of the vocal folds in general, but only the membranous part, not the cartilaginous part.[42]

While supra- and subglottal acoustic pressures or sound pressures are important in human phonation, the transglottal pressure is just as important in Titze's (2014, p. 2100) model. This is the pressure in between the vocal folds, and it is affected by both the sub- and supraglottal pressures. Titze (2014) writes that if the transglottal pressure is not reduced with a supraglottal back-pressure, "a sudden register 'break' can occur" (p. 2100). This means that, for instance, a narrowing of the AES, or, in CVT terminology, a twanging of the epiglottic funnel, facilitates a supraglottal back-pressure that helps reduce and stabilize the transglottal pressure. Reduced and stabilized transglottal pressure is associated with fewer register breaks, as is the case with a near-to-rectangular glottal configuration. This glottal setup is achievable by adjusting stiffness and balancing the upper and lower portions of the vocal folds, making convergent or divergent shaped vocal folds into a more rectangular glottis. Titze (2014) puts it this way: "Surface pressures on the vocal folds can alter the adductory state produced by the

[41] The oscillation threshold pressure or, more commonly, phonation threshold pressure (PTP) is the minimum lung pressure needed to sustain vocal fold oscillations at a certain pitch. Low PTP is associated with vocal ease, whereas high PTP values might be connected to dryness in the throat, fatigue, trouble reaching high pitches due to an undeveloped range, and so on (National Center for Voice and Speech, s.a.).

[42] The cartilaginous part is the section of the vocal folds where the arytenoids meet. The membranous part is the section anterior to the cartilaginous part.

muscles" (p. 2100). If none of these strategies are used, net displacement of the medial surface of the vocal folds can change very swiftly, meaning that the medial surface configurations can go from convergent to divergent and vice versa in a very fast manner. This is used as an aesthetic effect, for instance in yodel, where the bi-stable adduction is *exploited*, as opposed to the mixed registration where bi-stable adduction is *mediated.*

Wolk, Abdelli-Beruh and Salvin (2012) and Irons and Alexandre (2016) have studied a contemporary phenomenon where register instabilities are a concern. They report an increase in the use of vocal fry, especially among younger women. I will not elaborate on their findings but skip to Titze's (2014) mentioning of a consequence related to this topic. Register instabilities in the speech voice resulting from pubertal changes have traditionally not been a concern for most women, but this is changing. With the so-called glottal fry trend, "lower-pitched female voices are beginning to show register instabilities similar to those in many male voices" (p. 2091). This is something for today's singing teachers to be aware of when working with young teenagers and young adults who are still in their 'developing years,' as vocal patterns learned during this time may stick for life. The balancing of tissue stiffness, and thus the reduction of transglottal pressure, is not only effective when avoiding voice breaks but is just as important in training mixed registration.

Titze (2014) writes that "males and females who habitually speak in mixed register seem to have worked out the laryngeal motor pattern to avoid the stark register contrast due to tension imbalances, but acoustic pressures above and below the glottis may still trigger register shifts" (p. 2092). This is a reminder that even if a singer has figured out the laryngeal muscle contractions resulting in a relatively stable glottal setup, variations below or above this setup may trigger unwanted register breaks. Because "mixed voice seems to be less stable than either of the extreme registers *in some individuals*" (Titze, 2014, p. 2091), some singers may experience mixed registers to be quite fragile and easily disturbed. Further, the argument that mixed registration has the lowest PTP because of slightly convergent-shaped vocal folds fits well with the notion that keeping a mixed voice configuration, a slight convergence over a wide range of pitches, requires training for those who have become used to one of the extreme registrations (Titze, 2014, p. 2100). I understand extreme registrations to mean phonation patterns where the vocal folds are either very convergent, as in M2 phonation, or very divergent, as in M1 phonation.

While Titze (2014) uses the term mix or mixed voice in his findings, until this point I have mainly concentrated on the registers as they occur separately. In the following section I will look at the transition area between M1 and M2.

3.4.6. 'In between' two registers

As discussed earlier in this section, the registers can be measured, for instance using EGG. If the M1 and M2 registers are detectable and clearly designated as two separate registers, what then happens in between them? The opinion that there clearly must be something negotiated in between M1 and M2 (Bourne & Garnier, 2012), a 'register' used to bridge the transition between M1 and M2, is strongly supported among singers and singing teachers, and it is common to talk about a 'register' used to smooth out the transition between M1 and M2. "Indeed, vocal registers have an acoustic and perceptual reality for singers, which cannot be ignored" (Henrich, 2006, p. 6).

Similar to studies on M1 and M2, various studies on this in-between register may not have been based on the same premises. Common names for this register include middle, mix, light mix, chest mix, head mix, voix mixte, voce mista, medium and so on (Henrich, 2006, p. 12), and, needless to say, these terms, which come from musical theater, the classical European music tradition and the broader field of CCM, do not refer to the exact same sound. This may be true even for studies that use one and the same label (Echternach et al., 2017, p. 2; Roubeau et al., 2009, pp. 425-435). The diversity of terminology and the even more divergent explanations behind the various terminologies make mapping this area a hard task. I cannot claim to have left no stone unturned on this subject (because that would have been beyond the scope of this work), but I will present a selection of studies and discuss them. I must mention that most voice scientists do not consider this so-called in-between register a true register, but they recognize it as a phenomenon important to singers and therefore strive to identify it either at vocal fold level, as a kind of mixing of two registers, or purely as a vocal tract resonance occurrence (Castellengo, Chuberre & Henrich, 2004, p. 1). The mixed register is not as apparent in speech, making the body of research done on this field a bit smaller than the amount of research done on registers in general.

3.4.7. Transitions

Until this point, I have only hinted at the different frequency regions of the registers. As demonstrated by Hollien (1983, pp. 4-5), the various sources do not concur on this point, and ranges also vary highly between individuals (Castellengo et al., 2004, p. 1). I have therefore chosen not to emphasize this point but will mention some frequency ranges in relation to the transitions. Both M1 and M2, as well as M3, have large overlapping ranges, extending over at least one octave (Garnier et al., 2012, p. 953; Hall, 2014, p. 695), and "the exact position of

this intermediate zone varies across singers; it is found somewhere between 200 and 400 Hz [ca. G3-G4]" (Castellengo et al., 2004, p. 1). The frequency regions where the overlapping occurs are the same for men and women, as long as both use M1 as a base for mixing (Castellengo et al., 2004). Because men usually phonate an octave lower than women, it is easy to believe this octavation to be the same for the transition areas as well, but this is not the case, as will be described further below. In the following sections I will focus on the transition between M1 and M2.

3.4.8. Two studies looking at transitions

Castellengo et al. (2004) have demonstrated that transitions between M1 and M2 are laryngeal occurrences, even for professional classical singers who sound like they sing seamlessly through their range. Their findings are interesting because the transition is negotiated in two different ways. Three of the subjects (two baritones and one soprano) were clearly singing in M1, but they heightened the sound intensity and modified the sound spectrum[43] as to feign or mimic the M2 mechanism. The EGG also showed higher OQ values than what is normal in M1, but not to the extent that it could be categorized as M2. The two singers who demonstrated transition patterns in M2 (one soprano and one countertenor) had a slightly increased sound intensity and showed a greater harmonic richness in the overlapping area. This shows that both men and women can do a mix originating in either M1 or M2, though Henrich (2006, p. 12) points out that women (at least in the classical tradition) have easier access to first passaggio transitions based on the laryngeal mechanism M2 and men very easily use M1 as base for the same transition. What laryngeal mechanism is used in the transition may be a voluntary or involuntary decision made by the singer (Henrich, 2006, p. 9; Titze, 2014, p. 2099). As I understand this source compared to Titze's (2014) theory of bi-stable vocal fold adduction, it may be that M1 equals what Titze calls divergent glottal configuration, whereas M2 may equal the convergent type of adduction.

On page 49 I described some of the findings by Echternach et al. (2017), but I will present more of their study in this section. Ecthernach et al. (2017) both support and differ from Castellengo et al.'s (2004) findings regarding the transitions. They (Echternach et al., 2017) studied ten professional classical sopranos, and "participants utilized different laryngeal strategies for mastering the transitions through their *passaggio* regions, an impression that is also corroborated by inspection of the vibratory patterns" (Echternach et al., 2017, p. 9).

[43] See the footnote on page 36 for more information about frequency or sound spectrums.

Interestingly, they found phonation strategies where vocal fold oscillations changed gradually with increased F0, something that contradicts the hypothesis seen in the work of Castellengo et al. (2004), where a register transition was either in M1 or M2, in other words categorized as a distinct and binary event (Echternach et al., 2017, p. 11). On the other hand, the 2017 study also contains data supporting the fact that transitions were clearly made in either M1 or M2. This is, however, only reported for the subjects whose register transitions were audible. "The more audible a register transition, the greater the variations of vocal fold vibration when singing through the *passaggio* region" (Echternach, p. 10). Interestingly, Henrich (2006) has stated that "even when a singer is skilled enough to smooth the transition, so that no break or timbre change can be noticed, the vocal register transition can be detected on the EGG signal" (p. 8). I am not sure why Henrich's (2006) study showed that even the perfectly smoothed register transitions were detectable using EGG, while Echternach et al. (2017) found undetectable register transitions in their more recent study. One reason for the difference may lie in the equipment used; the researchers at Freiburg Institute for Musicians' Medicine,[44] as mentioned before, had access to ultra-high-speed videoendoscopy with 20,000 frames per second. Perhaps this vast amount of data has made it possible to detect important details that are not detectable by EGG. This could explain how they were able to find more seamless transitions at vocal fold level, but the issue might also be affected by the training of their subjects. As the reader will see later in this thesis, there are several ways to use the voice to achieve approximately similar voice outputs. Obviously, this results in diverging outcomes.

Echternach et al. (2017) further note that "the absence of a clear register boundary, as found in our data, calls the definition of registers based on distinct laryngeal mechanisms into question, at least for the professional singers analyzed in this study" (p. 11). This last notion is an important inclusion because in their ten subjects, they found four different phonation strategies. This suggests that there are *at least* four different ways in which singers can navigate the transition between M1 and M2 on a glottal level. For highly trained or elite singers one must consider "the possibility of gradual adjustments of laryngeal mechanisms" (Echternach et al., 2017, p. 11), and I find this approach corresponds with the results demonstrating that less trained singers, or singers with another type of training, phonate in either M1 or M2, though the transition may be masked by vocal tract adjustments. Echternach et al. (2017) clearly support Castellengo et al. (2004) and other previous studies (van den Berg et al., 1960) by providing evidence that the registers or mechanisms originate from vocal

[44] https://www.uniklinik-freiburg.de/musikermedizin-en.html

fold oscillatory changes and are not just occurrences based on vocal tract configurations, but they do not come to exactly the same conclusions as to how the transitions are achieved.

3.4.9. Singers and registers

Before continuing with the investigation of what happens between M1 and M2, I will take a slight detour, picking up a thread from the introduction of this section. I quoted Henrich (2006) who stated that register cannot be ignored due to the importance it has among singers and others in the field of singing, and I want to share some thoughts as to why singers and other voice specialists use different types of register labels and categories.

As many of my sources describe (Echternach et al., 2017, p. 2; Miller, 2000; Roubeau et al., 2007, p. 425; Titze, 2014, p. 2091), there is much confusion regarding registers. While some of this confusion is due to a lack of good descriptions, some is rooted in reader misinterpretation. Roubeau et al. (2009, p. 433) point out that there is a basis for misunderstandings as far back as in the writings of Garcia II,[45] who is responsible for the most cited definition of registers. Although, if one takes into consideration the follow-up of his work, he was undoubtedly referring to configurations at glottal level when speaking about consecutive and homogeneous tones, he is often misinterpreted, hence references to the homogeneity of sound to identify registers as "the acoustical phenomenon … [originating] at the level of the resonance cavities" (Roubeau et al., 2009, p. 434). Some also define registers as originating from both the larynx and resonating cavities.

From a singer's point of view, it is obvious that the voice has various registers. Most singers are very conscious about their registers and feel the register differences quite strongly in their instrument. Sometimes this makes it hard to believe or accept study results that show patterns of a register other than the one the singer experiences. For instance, it is not uncommon that singers recognize more registers than are detectable at vocal fold level (Henrich, 2006). This, however, does not mean that the singer is wrong in her or his experienced reality. Neither does it necessarily mean that the science is at fault. Although scientists do not yet fully understand the phenomena of registers, it is possible that we are closing in on an understanding of why it is natural for singers to operate with more registers

[45] Garcia II (1805-1906) was the first to successfully use a laryngoscope to look at the vocal folds both in rest and phonation. He was a singing teacher and devoted much time to experimenting with and observing the human voice, being interested "not only … in the voice sound quality but also in the underlying vocal physiology mechanisms" (Hernich, 2006, p. 3).

than the limited number easily detected at vocal fold level. Several studies suggest that the formant tuning done by advanced singers can create credible register similarities, thus masking the transition between registers perfectly. That the voice can be transformed to a very high degree is common knowledge for singers, but theoretical knowledge of how this is done, the physics and acoustics behind the action, is to my understanding less common among singers. Of course, not everybody can improve their voice and artistic abilities by knowing such things, but I believe the knowledge should be available for those who are interested. Because of this, I will share some relevant information from a study done by Roubeau et al. (2009).

In the study in question (Roubeau et al., 2009, p. 436), the renowned singer and teacher Richard Miller sang sustained tones on C4. First, he changed from chest voice to falsetto and the EGG data clearly showed an M1 to M2 transition. Then he changed from chest voice to mixed voice, but this time only the acoustic signal was modified, not the EGG signal. This is "in fact a change of register such as singers describe it, without any change of laryngeal mechanism" (Roubeau et al., 2009, p. 436). Finally, he changed from voce finta[46] to falsetto, and while the EGG detected the classic characterizations of M1 to M2 transitions, the acoustic signal showed no noticeable change. These three examples neatly demonstrate a singer's ability to make one mechanism sound like another. However, it is not yet clear to me whether this can be done to the extent that the singer no longer feels which mechanism he or she is using, or if the perceptive singer with advanced kinesthetic awareness always will know which mechanism is being used.

Taking all this into consideration, it would be quite misleading to say that the term 'mechanism' is equivalent to the term 'register' on all occasions. In contrast to register, the definition of mechanism is relatively clear and does not contain a lot of mixed meanings. As long as register has such a large number of various connotations attached to it, I find it advisable to clarify what one means by register when discussing register issues with colleagues or students.

So, what frames of reference do we meet when talking with students or colleagues about registers? I have already shared some views on how to talk about registers, and in the section below I will address ways of speaking about this phenomenon that do not necessarily translate directly into the traditional labels of registers or mechanisms. This is not an exhaustive

[46] Voce finta is also called 'feigned voice' and is a male phenomenon where a sound made in M1 sounds light and has characteristics resembling the falsetto voice (Miller, 2004, pp. 148-149).

overview; I have chosen the following perspectives because of their popularity and/or relevance.

3.4.10. Thyroarytenoid-dominant (TAD) and Cricothyroid-dominant (CTD)

Among singers and singing teachers, a trend has emerged towards using the terms thyroarytenoid-dominant (TAD) and cricothyroid-dominant (CTD) when talking about certain vocal qualities or registers (Hull, 2013, p. 1; Kochis-Jennings, Finnegan, Hoffman, Jaiswal & Hull, 2014, p. 652.e28; Trudeau, 2011, p. 103). These labels are frequently used by authors, singers and singing teachers, and coaches in the field of musical theater and CCM singing and refer to phonation where either the TA muscles are dominant over the CT muscles, or vice versa. This assumption appears to be both logical and simple, and I have been introduced to similar descriptions through my classical education. One problem, though, is that "these terms have not evolved from the direct measurement of laryngeal muscle activity during singing but from perceptual judgment based on pedagogical experience and physiological measurements that provide only indirect measurements of laryngeal function" (Kochis-Jennings et al., 2014, p. 652.e28). The study done by Kochis-Jennings et al. (2014) sheds some light on this. They took EMG[47] measurements, although they do not clearly state where in the thyroarytenoid the hooked wire was placed. The information they share suggests that the thyrovocalis was the target and measured muscle bundle. This is also in line with previous reports that point to the thyrovocalis as the register controller. Their subjects were female singers, and they measured the dominance of TA activity versus CT dominant activity throughout their ranges in the registers chest, chest mix, head mix and head.

They expected to find TAD phonation in the chest and chest mix registers, and CTD phonation in the head mix and head registers. Instead, they documented TAD productions only in the chest, head mix and head registers at pitches below approximately D4-F4; on all pitches higher than these, the singers produced CTD phonation or phonation where CT and TA contractions were nearly equal, regardless of register. In other words, all the chest and chest mix phonations above F4 were CTD. These findings might be surprising if one is used to the CTD/TAD terminology, but the findings were true for all the subjects on all vocal tasks, thus indicating that a change in terminology might be warranted. In a master's thesis from 2013, Hull (2013) goes as far as saying that

[47] Electromyography (EMG) is a way to measure muscle activation by inserting small hooked wires into the muscles (Varadarajan, Blumin & Bock, 2013).

> the delineation of chest and falsetto register with TDP [TAD] and CDP [CTD] terminology is misleading. Muscular dominance does not lead to register transition and … the CDP [CTD] and TDP [TAD] terminology does not seem an accurate description of the physiology underlying register control. (p. 47)

Another important finding that has been reported is how little the CT muscle has to do with registration (Kochis-Jennings et al., 2012; Kochis-Jennings et al., 2014). As has been pointed out already, the CT muscles are essential for frequency regulation, especially in the middle and higher parts of the range, but CT contraction does not reveal much about a singer's register. TA contraction on the other hand, along with LCA activation, seems to be the number one register regulator (Kochis-Jennings et al., 2014, p. 652.e22). In a study I will describe further below, Kochis-Jennings et al. (2012) found that singers substantially increased TA muscle activity when they shifted to heavier registers, and further that "adduction changed as a function of register, it did not change as a function of pitch" (p. 190). This means that the vocal folds did not adduct more because the singers were ascending or descending in pitch, but because they chose to switch to a heavier registration. I find this to be an important division, because pitch and certain voice qualities or registers often co-occur. For instance, high pitches, such as D5 in the female voice, are often sung in what is called head, head mix or falsetto, depending on the author. Because CT contractions obviously are substantial at higher frequencies, we get the co-occurrence of high CT values and perceptually light registers. The same is true for the heavier registers, which often co-occur with lower pitches. I find the whole picture becomes clearer when I separate registers from pitch in the rhetoric, keeping pitch, mainly regulated by CT contractions, on one side, and registers, controlled by TA contractions, on the other. It must be said here, that the CT muscle is not alone in regulating pitch, although it is often spoken of as the main regulator. Likewise, TA is not the only 'register controller' but is assisted by LCA, IA and possibly PCA (Herbst, Ternström & Švek, 2009, pp. 108-109). Contractions of the CT muscle also help TA in the registration task, but not, as often described, by 'being more activated and taking over the work' at the same point where a register break can be heard. The idea to separate pitch and register when describing and teaching these phenomena will be discussed further later.

Picking up where I left the CT and TA contractions above, I will present some more findings from Kochis-Jennings et al. (2014). As mentioned, they studied the ratio between TA and CT contractions to see if, and where, one was dominant over the other. Interestingly, two of their subjects showed CTD phonation strategies on all pitches in all registers. For instance,

when they sang in what was perceptually rated as chest at lower notes, the EMG signals showed greater CT contractions than TA contractions. The five other subjects started their ascending pitch glide in chest or chest-mix but showed a transition into CTD phonation long before they reached the perceptually abrupt register transition point where they audibly changed from chest to head register. This means that they had changed register long before the audible register break occurred. In addition, they found changes "or adjustment in CT and TA muscle activity before or during the register transition … However, the phonation remained CT dominant" (Kochis-Jennings et al., 2014, p. 652.e25). This suggests that a register break may need muscle adjustments even though the actual register has already been changed.

One of their subjects actually showed almost no change in the muscle activation ratio between CT and TA at all throughout her range, and she was also perceived to change very smoothly from chest to head register. These findings reflect what has been stated earlier in this thesis, namely that there must be more than one way of achieving intended registers, a notion also supported by "several EMG studies [which] contribute evidence that strategies of muscle activation differ across individuals for the same vocal target …. [and] interspeaker variation in air pressure and airflow is likely a factor in this variability" (Behrman & Finan, 2018, p. 155). I find this topic to be of great importance in singing pedagogy and look forward to following further investigations researching the nature of various laryngeal patterns and why one type of glottal behavior comes more easily to some singers' voices than others. There are, for instance, women who naturally or habitually tend to find M2 (possibly with a convergent glottis shape) easier than M1 (possibly with a divergent glottis shape), while others experience the opposite, finding M1 easier than M2. Of course, each individual voice has its individual possibilities, but I find reason to believe that there might be some patterns in this regard that voice science has not yet delved into.

In their 2014 study, Kochis-Jennings et al. (p. 652.e26) also looked at the relation between CT and TA dominance (CT:TA ratio) in conjunction with a singer's range. An untrained singer, who produced only 14 semitones, showed subsequently large CT:TA ratios, with values ranging from 0.5 to 7.5. A trained singer, on the other hand, who produced 36 semitones, showed CT:TA ratios from only 0.75 to 1.75. This means that the trained singer, who showed the largest vocal range, displayed the smallest ratio in the relation between CTD and TAD phonation, thus supporting the idea that trained singers access a large part of their range with relative ease compared to non-singers.

3.4.11. TA contraction

In a study done two years earlier, Kochis-Jennings et al. (2012) studied seven female subjects with a variation in degree of singing education. They used EMG measurements and found that TA contraction increased in order from head to head-mix to chest-mix to chest. They also found greater vocal process adduction, closing of the cartilaginous part of the vocal folds, in chest and chest-mix than in head-mix and head (p. 192). None of their seven subjects could produce tones perceptually rated as chest higher than G4, so on frequencies higher than this, only the three other mentioned registers were measured. They also found that the gap between the vocal processes[48] gradually closed in conjunction with heavier registrations. This is in keeping with Herbst's (2011) findings, which I will present further below.

What is also interesting in the work by Kochis-Jennings et al. (2012) is that their subjects with classical training "were less likely to produce registers other than headmix and head, whereas singers with primarily commercial training were more likely to produce chest, chestmix, and head but not headmix" (Kochis-Jennings et al., 2012, p. 192). This means that in their middle voice area, the classically trained singers tended to choose head mix, whereas those with CCM training mostly used chest-mix. Moreover, when CCM trained singers transitioned from chest or chest-mix to a lighter register, they typically changed into the breathier and very light head register rather than the fuller head mix. I will refer to Herbst (2011) further down, explaining why this latter transition is so difficult. From my own experience with students, I agree that mastering this transition requires a trained singer, and if this is true, it is perhaps why many CCM genres that are rooted in more spontaneous singing have this particular register-break transition—heavy and brassy to very light and breathy—as a stylistic feature. In other words, the break from chest or chest-mix into a very light head register might be a part of some singing styles because most voices that use chest or chest-mix phonation for an extended period of time will have this break naturally, except if trained repeatedly not to reveal the transition, as in the European classical singing tradition.

Going back to the concept of classically versus CCM trained singers, I must mention that "the chestmix and headmix registers were found to be perceptually identifiable, different in degree of TA muscle activity and VP adduction and different acoustically" (Kochis-Jennings et al., 2012, p. 192). Singers showed clear audible examples of chest mix and head mix, which

[48] The vocal processes are the frontal facing tip of the arytenoids where the vocal ligament and TA muscle is attached. The vocal processes form the cartilaginous part of the vocal folds, and when the interarytenoids (IA) are not activated, there is a gap in this posterior area of glottis, hence the gap between the vocal processes.

raises the question of whether the type of training a singer gets 'sticks.' This is a very interesting and large topic which I think should be prioritized in further scientific studies. At this point I can only lean on Kochis-Jennings et al. (2014), who state that "it is not yet known whether differences in type of vocal training result in differences in laryngeal muscle activity and hence implied glottal configuration as measured by EGG. More research is needed to investigate laryngeal muscle activity in singers with CCM training and singers with classical training" (p. 652.e29).

3.4.12. Intercartilaginous adduction and membranous medialization

As mentioned above, the gap between the vocal processes can be gradually adjusted. Herbst (2011) has provided new insight into how this parameter can be configured, and how it affects the registers. His work is influenced by Sundberg's (2001) descriptions of four phonation types, which is a categorization of the degree of vocal fold adduction. Sundberg (2001) writes about the phonation types *pressed, neutral, flow* and *breathy*, which occur on a gradient from the firmly closed glottis to a glottis that does not close completely in each cycle. Pressed phonation comes from vocal folds that are pressed together along their whole length, with a high subglottic pressure underneath. Flow phonation is recognized as having the lowest subglottal pressure and is used, for instance, in professional classical singing. This is the last type of phonation on the gradient, with a fully closed glottal configuration, and if the tension in the vocal folds is released just a little more, you get a leaky and thus breathy type of phonation. Neutral phonation is usually used in speech and is found somewhere between pressed and flow phonation. As far as I know, these terms are not interchangeable with register terms such as chest voice or head voice, but are types of phonation that can be used almost regardless of register.

Herbst (2011) thus divides glottal behavior into two groups, where registration is one adjustable parameter, and voice quality or phonation type is the other. He found that both untrained singers (who received only one very short lesson lasting 30 minutes where they learned the targeted phonation types in the two relevant registers) and trained singers were able to produce what he calls *adducted* and *abducted chest*, and *adducted* and *abducted falsetto*. These terms can be explained like this: The adducted phonation types occur when there is intercartilaginous adduction, possibly by contraction of the LCA and IA muscles, ensuring the closing of the vocal processes. When combined with thyrovocalis activation, which is responsible for the membranous medialization, we get the adducted chest register. In the case of less or no contraction in the thyrovocalis, adducted falsetto is the suggested label.

The abducted phonation types occur when there is little or no muscle activity closing the cartilaginous part of the vocal folds, in other words an open vocal process gap. This gap can be seen in both abducted chest, where the thyrovocalis ensures membranous medialization but with no closing of the intercartilaginous gap, and in abducted falsetto where there is neither membranous medialization nor intercartilaginous closing.

Herbst (2011, p. 47) warns against using solely closed quotient as an indicator of registers in singing. As mentioned earlier in this thesis does high CQ values indicate chest voice, whereas lower CQ values may indicate a head voice register. In a study by Herbst, Qiu, Schutte and Švek (2011, p. 2259), the CQ values in adducted falsetto were actually higher or equal than in the abducted chest mode in eight of their subjects. This means that a person is able to produce falsetto tones that have a higher CQ than the tones produced in chest voice with an open vocal process gap. To their knowledge, this was a new finding and had not been reported in the scientific literature before.

To summarize, Herbst (2011) states that "both chest and falsetto register can be produced either with glottal closure, or without, depending on vocal fold cartilaginous adduction" (p. 30). He also points out that "these fine-controlled muscular adjustments allow experienced singers to create a large variety of sound timbres at the glottal level, increasing their expressional freedom within the aesthetical boundary conditions of their chosen singing style" (p. 50). In other words, singers are not constricted to one of these four glottal configurations but can freely choose between the voice qualities along these two major axes: cartilaginous adduction, in the form of phonation types, and membranous medialization, in the form of registers.

Before leaving Herbst (2011) altogether, I would like to share his thoughts on a model case from the singing studio. The example is relevant both because many beginner students have this particular problem, and because Herbst suggests laryngeal explanations for the 'whys and hows' of the problems in the case. He writes about how untrained female singers have a tendency to sing above the primo passaggio either in adducted chest register or in abducted falsetto, meaning either in a pressed and pushed chest register or in a too soft and breathy falsetto register. This is supported in a later study by Herbst, Hess, Müller, Švek and Sundberg (2015, p. 400). He further gives an explanation as to why it is so difficult to switch from adducted chest to adducted falsetto. I adopt Herbst's terminology here, using falsetto, but in English I would usually prefer to use the term 'head' when talking about this female register:

> When changing from chest to falsetto register, the TA muscle relaxes, and thus membranous medialization is reduced. The resulting decrease of overall vocal fold adduction could be counteracted by a slight increase of cartilaginous adduction via the LCA and IA muscles, in order to keep the timbral change at a minimum. Such maneuver (decreasing TA whilst increasing LCA and IA activity, respectively) is, however, both ambivalent and complex: Since the three involved muscles are all innervated by the recurrent laryngeal nerve, the required level of fine control might be hard to reach by some singers. (Herbst, 2011, p. 50)

This description is followed by a pedagogical strategy that takes into account both the adduction/abduction issues and register configurations.

> A valid pedagogical strategy would try to establish the aDducted falsetto at higher pitches (around Bb4 to F5), via calling (but not shouting) at vowel /u/, or using "primal sounds" … This sound quality could then be applied to other vowels and pitches all the way down to the primo passaggio. When attempting to achieve a successful transition from (aDducted) chest to aDducted falsetto on ascending scales, there is the danger that the singer "gets stuck" in the chest register. In order to avoid this, it is advisable that ascending scales are only sung when:
>
> a) the student reliably succeeded to produce aDducted falsetto in the primo passaggio on descending scales; and
> b) s/he managed the falsetto-chest register transition at the primo passaggio without abrupt timbral changes. (Herbst, 2011, p. 50)

This procedure may have resemblances to strategies mentioned in the CCM literature, where calling exercises like "Hey Taxi" (Jared Trudeau, 2016) are commonly used. However, the latter triggers a heavier voice production, and may in some cases be quite distinct from what is sketched above. Herbst (2011) does not indicate how much adduction and how much chest or head register respectively should be used in the adduction, but by recognizing the gradual lines in which singers can sing with great variety both in pitch, loudness and timbre, I believe this method works for classical singers as well as CCM singers as long as genre-appropriate features are accounted for.

3.4.13. Musical Theater

Because of the vast number of musical styles used in musical theater, this is a very demanding genre for singers. Nowadays, one cannot limit musical theater to one or two genres with stylistic variations; rather, it is a mix of several stylistically challenging and differing genres. Singers aspiring to the musical theater stage are expected to master nearly every popular

genre there is, from the older classically influenced styles, often sung in legit,[49] through soft and breathy pop music sounds, to the current high frequency heavy rock songs where another vocal approach is required (Hall, 2014; Kayes, 2004). While these singers sound different than classically trained singers (LeBorgne & Rosenberg, 2014, pp. 221-222), they use the same instrument. What then is different about their technique? As mentioned earlier, I will not go into stylistic or genre-specific musical choices but will describe only technical issues. The main focus will still be on what happens on the laryngeal level, but information about larynx height and vocal tract adjustments is also of relevance. Despite the importance of breath management, I will not cover it at all, although I will mention subglottal pressure. I must also specify that I will highlight only some of the voice qualities or voice type categories relevant for this genre, because it would be too much to cover them all.

3.4.14. Mix

As already mentioned, mix, light mix, heavy mix, chest mix, head mix and so on are all common terms in musical theater describing what happens audibly between M1 and M2. It is imperative to point out that mix in musical theater is not the same thing as middle voice or voix mixte typical of classical voice production (Kochis-Jennings et al., 2012, p. 182). Karen Hall (2014) describes it this way:

> The term "mix" in music theater has a very different meaning than the classical term *voix mixte* …. The music theater mix register is a blend of head and chest register with a predominance of chest register, whereas the *voix mixte* sound used in classical voice is a predominance of head register. (pp. 70-71)

Another way of describing the various ways to mix M1 and M2 is using the terms 'light mechanism' and 'heavy mechanism' instead of head and chest register. These terms, suggested by the esteemed vocal pedagogues Cornelius L. Reid and William Vennard (Hall, 2014, p. 69), refer to the weight of the sound being sung in addition to being grounded on scientific studies on the two extremes of vibration, the two registers. Hall (2014, pp. 69-70) also notes that there is a movement towards using the terms 'mode 1' (for chest) and 'mode 2' (for head).

[49] *Legit* is a musical theater style of singing that is reminiscent of classical singing (Hall, 2014, p. 93-95) (see page 66).

At this point, it is important to recall that the terms mechanism 1 (M1) and mechanism 2 (M2) strictly refer to glottal behavior, as measured by EGG, for example. Mode 1, heavy mechanism, modal voice, chest register, thyroarytenoid-dominant and so on, may be used like M1, with reference to the vibration pattern of the vocal folds, but they can also be and are perhaps more often used to describe the audible results of a mixed register. As mentioned before, there is at least an octave in which a singer can choose between the two register options, but as my review up until this point has shown, we cannot say with certainty whether the CCM or classically trained singer who sings in this overlap area is singing in either M1 or M2 (with vocal tract adjustments making what we recognize as the mixed sound), or if they actually do a kind of mix at vocal fold level. My point here, however, is to show how a reference to the term chest register, for instance, does not send a clear message, unless there is prior agreement on how the term is being used.

3.4.15. Belting and Legit

Until now I have described some of the common musical theater terms, such as TAD, CTD, chest mix, head mix, and mentioned some others. I have not yet described perhaps the most debated and popular voice quality of CCM singing: belting. In this section, I will describe this type of singing, with a mention of its counterpart: the legit voice or legit register.

Legit, which is shorthand for 'legitimate' (Hall, 2014, p. 93), is often associated with sounds more similar to the western classical model, whereas belt, commonly called chest-dominant, is a speech-like type of singing. Both legit and belting can be further divided into traditional and contemporary. This division is suggested by the leading musical theater teacher Robert Edwin (Hall, 2014, p. 94). Contemporary legit is more speech-like and less formal than traditional legit, and can include pop and rock influences. It is important to mention that traditional legit is not the exact same thing as classical voice production, but a voice category that is classically oriented (Hall, 2014, p. 95). In general, the female traditional belt "uses a more chest dominant sound and a speech-like approach to singing …. The male belt requires a narrowing and brightening of the classical sound and a more speech-like approach and phrasing" (Hall, 2014, p. 95). To my understanding, this difference between the male and female belt voice suggests that the voice configuration at vocal fold level is not that dissimilar between classical and belting or mix for male singers (Hall, 2014, p. 65), whereas the dominance of chest voice in the voice production of both belt and the various versions of mix is *the defining difference* (Hall, 2014, p. 69) between classical and musical theater singing for the female voice. The contemporary belt voice "includes many additional vocal

sounds such as slides, slurs, noises, melismatic runs, shrieks, and screams. The vocal quality is also varied and includes breathy, whiney, nasal, and raspy" (Hall, 2014, p. 95). Several authors find the early Broadway word brassy to be most descriptive (Hall, 2014, p. 70; Jeannette LoVetri, 2011). It must be noted that belting in its early days in the 1920s and '30s was not the same as belting in 2018. Voice quality has developed both in terminology and range. When characterizing the belt voice as a register phenomenon, we can describe it as chest-dominant, referring to the use of more chest register as opposed to a dominant use of the head register, or we may call it; mode 1, chest mode, modal voice and thyroarytenoid-dominant. The last term has already been discussed at length and I have suggested that it not be used.

Range requirements have expanded from C5 as the highest note in the early Broadway belt songs to the contemporary expectations of belted notes up to at least E5 (Hall, 2014, pp. 63-65). What happens in the instrument of the female CCM singer when belting this high? This will be the topic in the following section.

3.4.16. Healthy voices and configurations of belting

There has been a lot of prejudice against belting because it is very similar to chest voice production, which has been deprecated as hyperfunctional and damaging to the vocal folds. First of all, very few, if any, musical theater songs require belted notes throughout the whole song. Usually the CCM singer uses some type of chest-mix, adding strong feelings by belting selected tones or passages. This contributes to vocal fold health, as it is considered harmful to belt at all times and on all pitches (Hall, 2014, p. 71). Secondly, many singing teachers recommend what LeBorgne and Rosenberg (2014, p. 117) call *vocal pacing*, which includes an overall awareness of vocal use in all daily tasks and reducing voice use when possible, as well as conditioning the amount of practice to the training level of the singer. Many singing teachers also believe that a balanced healthy mix ensures vocal fold health and longevity (Hall, 2014, p. 72).

Some singing teachers consider belting to be a register of its own, while others consider it an extension of the chest voice (Hall, 2014, p. 70). Instead of trying to place belting in the jungle of confusing terms, I find it easier to categorize the belting sound as a voice production with a divergent glottis shape, clearly done in M1. As will be mentioned later in the thesis, the register terms may limit interpretations of what can be done with the voice, and I will suggest alternatives when presenting my interview findings.

Belting is "produced with high sub-glottal pressure, long closed phase of duration greater than half of the fundamental period, high SPL, and great harmonic richness" (Henrich, 2006, p. 11). Moreover, "a tuning of the first formant with the second harmonic has been observed on open vowels" (p. 11). These characteristics are supported by Schutte and Miller (1993, p. 149). Even though some aspects of belting seem to be understood, "the actual mechanisms by which female commercial singers maintain chest or chestmix as they traverse the upper middle and upper pitches are not currently known" (Kochis-Jennings et al., 2012, p. 184).

Schutte and Miller (1993, p. 149) also present three potential sources of vocal abuse in belting: high larynx position, high closed phases and high breath pressure. None of these factors on its own leads to vocal abuse, but in belting all three factors are often challenged simultaneously.

> That there are robust voices that stand up under the rigors of "belting" without immediately developing acute problems is an undeniable fact. Even with these voices, however, well-coordinated, firmly closing vocal folds and avoidance of such extreme larynx positions that all freedom of movement is lost would seem in order, along with respect for the limits imposed by fatigue. (Schutte & Miller, 1993, p. 149)

That belting should be done with a closed glottis is in line with CVT, where the metallic modes curbing, overdrive and edge are presented as non-breathy modes, as adding breath added to them is seen as harmful. It is perhaps tones on lower pitches in overdrive and mid to higher pitches in edge that best resemble the belting sound.

It is also interesting that Schutte and Miller (1993) mention the high larynx position, because this has become a highly discussed topic. Many studies (Estill, 1988; Popeil, 1999, p. 28; Sundberg, Gramming & LoVetri, 1993) have found high larynx positions during belting, but the renowned CCM singing teacher Jeannette LoVetri (Jeannette LoVetri, 2011; 2017), considered to be an expert on the field, has claimed that a large amount of the earlier research on belting was done using subjects that cannot belt at all, thus calling into question the validity of the research. Fortunately, more recent studies usually cross-check the sound data obtained from singers using a taxonomy developed by Bunch and Chapman (2000), thus ensuring that participants are representative of the standing vocal demands. These studies have also shown a higher larynx position than what is found in classical singing, but not very high per se. A flexible larynx at speech level, or an elevated larynx (LeBorgne & Rosenberg, 2014, p. 103) are commonly taught today. Kayes (2004) who has a background from EVM writes that

> a shorter vocal tract (high larynx) will favour the higher harmonics and give a brighter sound; a longer vocal tract (low larynx) will favour the lower harmonics and give a darker sound. Neither of these positions is wrong unless the larynx is fixed there. (p. 22)

The vertical positioning of the larynx is essential for resonance tuning, which is crucial for the singer who wants to keep singing in a chosen phonation type and register across large parts of the range, for example, maintaining a heavy, brassy sound, the belt voice, in a higher part of the range. To maintain this mode while ascending, a singer must tune the resonance differently than she would do if she mixed into a much lighter register on the way up. Keeping the same mode also involves a different resonance tuning of the higher notes than the lower notes. This is done by manipulating the length of the vocal tract, and, as stated in the citation above, a raised larynx shortens the vocal tract, making it easier to tune the resonance in a way that maintains a belt mode.

Another feature thought to be important for a healthy belting tone is the forward-tilted cricoid. This is promoted in particular by the EVM, which claims that this position secures a further thickening of the vocal folds in the lowest frequencies and in loud productions such as belting and dramatic opera (Steinhauer et al., 2017, pp. 103-113). The EVM further holds that retracted false vocal folds are elementary to opera and belting voice qualities, as described on pages 28-29. As mentioned earlier, the retracted option can be obtained by what they call 'the silent laugh,' which reminds me of the 'smile in the throat' often mentioned in classical singing tuition. Although Jo Estill, who initially was classically trained, may have been influenced by this 'smile,' she has taken it all a step further, as Steinhauer et al. (2017) explain:

> The silent laugh should be as hard as possible. "Smiling" is not good enough. You can smile and still constrict. The effort is not in the smiling mouth, but in the voice box …. When you sing, you have to hold this [retracted] posture all the time you are singing. (p. 68)

The retracted position may be achieved by acting happily surprised, but be aware that it is the feeling in the throat that is the target, not a surprised facial expression. By retracting the vestibular folds and slightly raising the larynx, the singer is adjusting the vocal tract, in other words the filtering of the sound coming from the sound source. Many studies have documented that formant tuning in high-frequency phonation reduces the degree of vocal trauma, and such strategies may be a reason why "many belters are able to maintain a long

career" (LeBorgne & Rosenberg, 2014, p. 103). In addition to the already mentioned formant tuning strategies, LeBorgne and Rosenberg (2014) mention lowering of the jaw into 'belt mouth' at extreme frequencies and the narrowing of the AES as beneficial for belting singers. Lowering the jaw raises the first formant, which contributes to reducing glottal airflow. Belt mouth can be seen, for instance, when a singer belts out the E5 note, and interestingly looks quite similar to the jaw opening used in the production of a classical C6 note (LeBorgne & Rosenberg, 2014, pp. 103-104). The positive outcomes of a narrowed AES have been described earlier in this thesis.

Though belting is often recognized as a sound from Broadway, it has reached into the even wider world of CCM singing. The extreme rock vocal may be seen as an offspring of belting voice production, but whether such vocal modes are combinable with classical singing, for instance, is highly debated, as demonstrated below.

3.4.17. Some thoughts on more extreme vocals

Teachers of complete vocal technique (CVT) are crystal clear in their message: Everyone can learn to sing in every mode and with every effect; they just have to practice, and of course, practice correctly. CVT is one of few teaching models that promotes the idea that anybody can produce effects such as growling, creaking and screaming, and that if done correctly these effects are not damaging to the voice (Sadolin, 2008). It is doubtful, however, that such extreme vocal productions are compatible with operatic training on an advanced level. Melissa Cross (2008), a singing teacher specializing in the more extreme rock vocals, is quite cautious when asked about the combination of extreme metal singing and a career in opera. "Yes, [you will hurt your classical career]. Don't do it … There are certain kinds of wear and tear that are not appropriate for classical performance. You need to maintain traditional vocal practice to preserve the purity of your range" (Cross, 2008). As I understand her, Cross is talking about the combination of a professional career as both an opera singer and a hard metal vocalist with demanding tours. There are many reasons this kind of combination may be hard to carry out for an adult, but I feel it imperative to point out that Cross' warning is not necessarily applicable to the teenager searching for his or her identity as a singer (this will be discussed in the final chapter). Regardless of whether this is the case, I sometimes have students that sing whatever they want despite warnings from me. This has led me to search for ways to help them in their singing, even when I cannot help them gain better technique in their chosen genre. In these cases, the vocal pacing mentioned in LeBorgne and Rosenberg

(2014, p. 117) has proven to be helpful. The overall principle that what feels wrong or hurts probably *is* wrong is also a simple and easy-to-teach guideline.

3.4.18. Other limiting features

Both female and male vocal instruments vary in size because of individual differences such as larynx size and vocal fold length. In the classical European tradition, these differences are preserved in the Fach[50] system, and this thinking has also influenced the musical theater scene. It is important for singers to choose roles and songs that best match their stamina, meaning that songs and parts where "the amount of time you can maintain a particular singing sound and remain vocally healthy and fresh without fatigue" (Hall, 2014, p. 72) should be prioritized. A rule of the thumb that fits well with the studies already presented is that lighter-weighted voices tend to use head voice often and with ease, favoring mixed register over the seldom-, if ever, used belt voice. Heavier-weighted voices favor belt and mix registers and often display a good deal of 'noise' in their head voice. I understand the word noise in this context to refer to a hissing sound. These singers usually have more stamina when belting at higher frequencies than those with lighter-weighted voices (Hall, 2014, p. 72). I find all this to correspond well with similar categorizations mentioned earlier in this chapter, and as will be seen in chapter 4, my interviewees' statements also support the descriptions mentioned above.

In the next chapter, I present the findings from my interviews and combine them with information reported in the current chapter.

[50] The Fach system is a method for categorizing classical singers based on the range, timbre and weight of their voices, making the casting of opera productions easier because singers are not asked to take on roles that are not appropriate for their voices. Examples of two such categories are the lyric coloratura soprano and lyric mezzo soprano.

4 INTERVIEW FINDINGS: SINGING TEACHERS' EXPERIENCES OF TEACHING CCM GENRES TO ADOLESCENTS

4.1. SINGING TEACHERS: TERMS, TECHNIQUE, AND TEACHING YOUNGSTERS

The previous chapter dealt with data regarding this thesis' topics largely seen from a scientific angle. This chapter addresses many of the same topics, but here they discussed in light of my conversations with four interviewees, who all shared interesting and useful information as well as describing some hands-on ideas on how to work with the target age group. Because a large amount of data was transcribed from the interviews, the excerpts presented here are carefully selected to match the topics of the previous main chapter. I wish to remind the reader that instead of presenting exercises and specific approaches to teaching mix or belting, for instance, I have chosen to concentrate on how my interviewees *think* and *talk* about the relevant topics.

As explained and discussed in the methods chapter, I did not find it relevant to arrange the topics of this chapter in the same order as the previous chapter. Therefore, this chapter has another disposition. Because both my interviewees and I are singing teachers, I have chosen a setup that reminds of how a singing teacher may approach the relevant issues in relation to her or his practice. This has resulted in a structure where meta-level questions such as those pertaining to terminology and musicality come first, followed by thoughts on basic technique and vocal health; the target age group is then described before ending with insights on mixed voice and belting.

The reader may also notice that the language and terms used in this chapter both resemble and are distinct from those used in the previous chapter, reflecting statements that are clearly influenced by science and/or traditional singing pedagogy as well as language used in their respective practices tailored to their students. All four teachers have their own ways of expressing themselves, and this necessarily creates a gap between the language used in scientific literature, which was the main interest in the previous chapter, and the language used when singing teachers talk about teaching 15- to 20-year-old singing students, used in this chapter.

4.2. TERMINOLOGY

In the section called 'Registers,' I wrote about the rather confusing area of voice quality and register terminology. The impression that there exists a myriad of labels for different

phenomena, and that all the words used in singing tuition have various meanings, was confirmed to be the perceived reality for the singing teachers I interviewed as well, and I got the impression that all my interviewees were well acquainted with many different labels. How, and to what degree, they used various terms differed, however, as did the conceptual meanings of some of the words. This will be further examined below.

4.2.1. Strategies for how to talk about registers and functions with students

All four teachers spoke of various strategies for how to handle the question of terminology in their teaching. Some of them also emphasized the importance of being flexible and adopting the student's semantics to start with, introducing the teacher's preferred labels only when it seemed advantageous for the student's learning process. In the statement below, Morten (male interviewee who teaches mostly CCM genres, see page 17 for a presentation of the four interviewees) describes how he is open to the student's vocabulary at first, perhaps later adopting more subject-specific terms:

> I: What labels do you prefer to use for sound qualities such as belting, metallic modes (CVT), chest voice and so on?
> M: I actually use many, because my students come from many different places. So I have learned to, instead of going into a confrontation stating that "This is called this, this is called that," I say, "What do you usually call it?" (…) There are perhaps fourteen types of belting, or more, perhaps as many as there are people, so I say, "Let's see how many different ways we can do it so that your belt gets flexible." I use the belt label, but I make it clear that people attribute various meanings to the word, and some don't use it at all.

Hilde (female interviewee who also mostly teaches CCM genres) also described this kind of strategy, taking the students' already internalized vocabulary seriously and introducing CVT labels only when she found that they were ready for new or more advanced terminology:

> I use many different labels. Sometimes I thoroughly go through the CVT terms and use those labels, and this is usually done after a while. If [the students] are genuinely beginners, I don't always present those terms right away, and sometimes not at all. It depends on the student. But I would like to get to the CVT terms, because it is kind of a meta-language, a way of explaining and describing things that reveals to the student "OK, this is what we are talking about."

The use of subject-specific terminology seemed to be a key element in Morten's and Solveig's (female interviewee who mostly teaches classical) practices as well, and I presume that their use of traditional or specially developed terminology (like the terminology from the classical singing tradition, CVT, or EVT) was in line with an underlying pedagogical strategy that their students should learn not just to become good singers, but also to become familiar with the various discourses within the field of singing. Interestingly, this strategy contrasts with what Eva (female interviewee who only teaches CCM genres) shared about her teaching practice:

> Well, there's the language again, and this is very challenging. I have a policy for myself, never using terms that describe a sound or a specific function. I never use the word belting, instead I talk about using the voice in a heavy way. Or I talk about associations. (…) My approach is more figurative, and physical, I always link the sound production to the feeling in the body. (…) I am very explorative, and if I say something, I also ask, "Does it make sense to you, is it, how?" Because I am interested in how the student understands it, this is what it all constantly boils down to.

In other words, Eva's approach is to try *not* to use any of the common labels; instead she lets the student describe with his or her own words the felt experience of the sound production. Nevertheless, at some point in the interview, Eva mentioned three adjectives that she often uses to describe vocal production:

> Regarding these main concepts, I use the words *weight, length,* and *expansion* because I feel that those words give helpful instructions to most people. These are the three main principles I often use, and they are maybe not so much based on the voice but are based on the body and have to do with the airstream.

I understand through Eva's description that she finds the use of these adjectives very helpful, but she still refrains from using *nouns*, and thereby avoids putting delimiting or concretizing names on this or that type of voice production. The thought of not giving, for instance, a heavier voice any kind of name is somewhat new to me, and this may of course influence my opinion regarding this topic. This being said, it is my understanding at present that the use of subject-specific terms that allow the student and teacher to discuss and relate to register issues and voice qualities on common ground is beneficial both from a practical point of view and in terms of introducing the student to a relevant discourse. However, as mentioned on page 57, I

believe it is necessary for teachers and students to share a common felt experience of vocal sounds, expressed in careful descriptions, if they are to invest the chosen terms with at least approximately the same meaning.

4.2.2. The concepts of registers and functions

In keeping with my own understanding regarding the *concept* of registers, Morten, Hilde, and Solveig all talked about registers as something changeable. In their opinion, a trained singer should be able to choose what register to use at one and the same pitch, exactly like the singing pedagogue Richard Miller did in the study by Roubeau et al. (2009) (see page 57). He sang C4 notes in various registers, and the EGG signal clearly picked up on the changes. Nevertheless, quite another understanding of the term registers materialized in the interview with Eva:

> I think of the registers as a row of tones, meaning that the vocal folds follow the row of tones, while the function will give the *type* of tone. (…) In my way of thinking, as a former violin player and instrumentalist, the register starts at the lowest string and ends on the highest. You can strum or stroke or whatever you want, but it is still the same register if you are on a particular pitch.

In other words, Eva is of the opinion that a register equals a row of pitches, such that if you sing one specific tone, you cannot change the register. She referred to a change in the timbre of a tone as a change of function instead of calling it a register change. In my opinion, though, she is describing a similar reality to what the other three described, only using different terms.

At this point it is interesting to take into account the way Herbst (2011) talks about vocal fold adduction (see page 62). He does not use the word function but talks about phonation types or voice quality, and in this context, I propose that function can be put in the same category as phonation type/voice quality. Herbst (2011) further differentiates 'phonation type/voice quality' and 'register' by stating that registers are controlled by contractions of the thyrovocalis, called membranous medialization, while phonation types/voice qualities are controlled by the lateral cricoarytenoid muscles (LCA) and interarytenoid muscles (IA), called intercartilaginous adduction. He also demonstrates how these parameters could be controlled separately and in various combinations, even by untrained singers. When Eva talked about function, I understood her to be combining both membranous medialization and intercartilaginous adduction, thus perhaps ignoring some of the inherent options of variation. However, this might not necessarily be the case. She may differentiate between them, for

instance by *hearing* the difference, or based on a kind of 'feel' in her own instrument, understanding what is going on and knowing almost by instinct how to proceed. This type of 'vocal empathy' (Arder, 1996, pp. 68-69) was not a topic in the interviews. However, I believe it to be of importance and will discuss it further in the last chapter.

If I look at how Morten, Solveig, and Hilde talked about registers and functions and relate it to Herbst's (2011) suggestions for how to differentiate between the terms, I find that they were not always consequent in discerning between the various terms, as they so often they are closely related. Solveig talked about this in the conversation below:

> I: So, you think that registers equal function?
> S: Yes. And I realize, I have noticed that I use them interchangeably, I say 'full function' (*fullfunksjon*, in Norwegian, equals chest function) and 'full register' (*fullregister*, in Norwegian, equals chest register) because I talk about what function my vocal folds have in for instance full voice (*fullstemme*, in Norwegian, equals chest voice), or full register if you like. Same in head voice, what function do the vocal folds have in "randregisteret" (the head-register) and so on.

Here Solveig gave a good example of how terms are easily interchanged when talking about these issues, and I found similar ways of talking about registers and functions in the interviews with Hilde and Morten as well. I find reason to believe that this use of the concepts in question also may be applied in their teachings, and one may ask if such a combination of terms is beneficial or not.

Before describing what my interviewees said about basic technique, I would like to address another overarching topic, namely the issue of the student's musicality and how music can be made with whatever technique one possesses.

4.3. TECHNIQUE AND MUSIC-MAKING

In her interview, Eva mentioned that she had the impression that a lot of CCM singers mainly show their musicality by instinct, thus nurturing spontaneous musicality rather than cultivating planned and consciously trained phrases. Some may argue that the kind of musicality seen in such performances are 'freed from technical issues,' focusing on the *music* rather than on *technique*. However, in my understanding, there will always be some sort of vocal technique in use, even though a singer may or may not focus on technical issues while performing and may or may not have developed a broad pallet of various techniques to choose from beforehand. This ability to choose, or at least have a wide range of sound

qualities to draw on, is what, in my opinion, links musicality with technical issues such as the mechanics of mix, belting, head voice, and so on, all of which relate to the main topics of this thesis. In this section I will share some of my interviewees' thoughts regarding the importance of appreciating students' musicality, and how this relates to technical issues.

Eva acknowledged the singer's own musical and technical instinct to be a necessary component of teaching:

> I think the most important thing to do if one is to (…) teach [the student] to be a good singer, is to help the student get in contact with herself. They [the students] know what I do not know. (…) This is also what is most exciting. It is kind of the x-factor or something that one should not underestimate, that is actually, I think perhaps it is the core of a person's musicality. And if one starts to form the student and gives too much guidance, and especially during that age, your actions may possibly hinder rather than enable them.

The importance of making music, and of encouraging the musicality coming from within each student, was emphasized by all interviewees on one or more occasions:

> M: You sing through many different [vocal] setups when you follow the soul, and your soul is not static, and your voice should not be static either.

> S: Well, now we have only talked about technique, and of course, all of this is very tightly bound to expression. It is expression that gives you an idea of what you need [in vocal training], and it is important that the student get involved in this way of thinking. It will become art, and we are to give people goosebumps.

Both Solveig and Morten brought up musicality in relation to the training of the laryngeal musculature, thus connecting the superior purpose of 'making music and art' to more practical scientific questions regarding 'what happens in the larynx' in this or that type of vocal production.

Furthermore, I had the impression that all the interviewees appreciated the link between musicality and singing technique, but did not necessarily think that good singing technique equaled a high degree of musicality or that great music only could be made by someone with excellent technique. Rather, they seemed to agree that whatever vocal setup is used has a huge impact on how musicality comes to life through singing. In order to master more types of vocal setups, thus broadening the range of possible expression, many singers may be

interested in working on their technique. Most singers, though, will have to start with the basics, and the elements of basic singing technique will thus be described in the next section.

4.4. BASIC TECHNIQUE

All my interviewees had a huge focus on vocal health and considered breathing habits to play a key role in students' basic technique. I had the impression that all four interviewees spoke of good basic technique as something that enables students to be vocally flexible and perform long, hard, or complex vocal tasks without being in danger of having any kind of vocal trauma, thus ensuring vocal longevity and a healthy voice. Even though it seemed like respiration in singing was of great importance to the teachers when they talked about vocal health and basic technique, I have chosen to leave this topic out, as I made it clear earlier (see page 4) that I would not focus on this large area.

In addition to emphasizing breath support training, the interviewees regularly mentioned two other parameters regarding basic technique. One was that the body should have a suitable posture, free of unnecessary muscular tension, and the other was the necessity of possessing well-honed fine motor skills. Because I have chosen to concentrate on laryngeal physiology, I present data related to latter parameter.

Embedded in the expression 'fine motor skills' in this context lies the ability to use the voice in many different ways in addition to being able to revisit the 'safe area' of an energy-efficient and basic kind of phonation. As we saw in the section called *Intercartilaginous adduction and membranous medialization* (see page 62), an energy-efficient tone is free of unnecessary tension, both throughout the body and in the larynx. It is driven by an airflow that fits both the pitch and the weight of the tone, and it is advantageously filtered in the pharynx, mouth, and nose. The ideal version of this type of phonation is what Sundberg (2001) calls *flow* phonation. To achieve this type of phonation, the TA, CT, IA, and LCA muscles all need to be trained in a manner that develops a balanced coordination of the muscles. Solveig, Hilde, and Morten frequently spoke of the importance of such work in the interviews:

> S: You should not start working on the effects before the basic balance in the intrinsic musculature is in place. (…) I believe that all singers in all vocal styles need that solidity in their voice, the matter of maintaining two actions at once, where there is good closure because the TA is at work simultaneously with 'having access to' the lengthening CT muscles of the vocal folds. I mean, that is a goal for all voices.

> H: If you sing a lot with effects and don't train a clean vocal sound as well, you may come to a point where you are no longer able to find your clear and clean vocal sound. In CVT we always advise singers who use effects to train the voice in a way that enables them to turn the effects on and off. And underneath the effects, which are mostly done above vocal fold level, there should always be a healthy voice function.
>
> M: When talking about the vocal folds, I think both suppleness and flexibility are very important. You need to train your ability to sing through your range, to smooth out the register transitions, and you must work with different weight in your voice. (…) You need to find sort of a muscular balance.

Eva did not talk about what the laryngeal muscle balance should be, but she mentioned issues that she felt should be thought of as secondary goals in vocal practice, thereby seconding many of the above statements regarding effects:

> These things that have to do with effects, how you manipulate your voice, if you put on vibrato, if you put on an effect, how you manage your timbre, right, in the making of your tone. These are, I think, sort of secondary things.

Eva also stated clearly that students need to know their basics before heading on to more advanced repertoire, but she was still not talking specifically about the function of the vocal folds:

> Often people come to me saying, "I want to sing with more volume" and "I want to reach higher pitches in my range," and there is a large amount of foundational work that underlies the ability to do that. We never start the first lesson by singing out loud to Adele;[51] we usually have to work with some other stuff before we go there.

All my interviewees focused on how to *build* an instrument, thus acknowledging that there exists an overarching idea concerning the order in which things should happen in technical vocal work. This is typical for classical pedagogy, in my opinion, so I find it interesting that these thoughts also are shared by all the CCM-oriented singing teachers in my research.

[51] Adele Adkins is a famous singer and songwriter from England, known for her three studio albums ("19," "21" and "25"), the theme song "Skyfall" made for the 2012 James Bond movie, concert tours and several appearances on TV, to mention some of her achievements (Adele, 2018).

Further, three of them commented on how basic technique is beneficial for any singer, regardless of genre. In line with Solveig's answer above, Eva shared these thoughts:

> Of course, everyone benefits from training basic vocal technique, and this is independent of genre. To a certain extent. I mean, the physicality, how to use the body; there are commonalities across genres.

Hilde addressed the universal importance of basic technique, regardless of genre, in the following way:

> I: In your opinion, what is important to train in a young voice, a 15- to 20-year-old [a student] who wants to sing other genres than classical?
> H: Actually, I don't think there are large differences. (…) A lot of them come to me with pressed voices, having a rather hard sound quality, and then we have to work towards getting the balance right between the support and the openness of the throat so that the vocal folds can vibrate freely. An adequately supported tone can remove tension in the neck, and so we work with the support combined with 'opening up.'

At this point, the conversation turned more specifically towards similarities and differences between CCM and classical styles of singing, as well as addressing parameters included in basic technique. I asked Hilde if she could be more specific about the phrase 'opening up.' What should be opened?

> H: Yes, well, open up, lifting the soft palate, the combination of lifting the palate and lowering the larynx.
> I: In CCM genres as well? [referring to the lowering of the larynx]
> H: In CCM genres as well, oh yes. And when you sing with a really heavy chest voice (…) the tone sounds squeezed and compressed if you don't open up sufficiently. (…) I think some of my classical colleagues have been a bit surprised sometimes at how much I work to 'open up' because this is something associated with the classical singing style. Here we are moving into the topic of different stylistic ideals, and of course the classically sung tone demands an even bigger opening to achieve the darker sound, but it has to be opened up almost as much to sound nice in the CCM styles as well. I really work a lot with this.

Hilde mentioned that an open throat is important for the vocal folds to vibrate freely, but she did not say much more about the differences between CCM and classical singing on the vocal fold level. She touched upon the topic again, but like Eva, she talked about breathing and

support when mentioning the link between CCM and classical singing, thus implying that the teachers saw similarities mostly in the activator, in addition to the opening I have already described, rather than in the vocal production, the vibrator. Solveig, on the other hand, often commented on issues regarding the function of the vocal folds, as in the conversation below:

> I: Do you think the smoothing of register transitions is something else in belting, metallic modes (CVT) than in classical?
> S: Not in the basic training. But after a while, the comprehension of the stylistic features calls for different approaches. This is when you are on an advanced level, though, and not at basic level. (…) In the *training* of the muscular balance in the throat, I don't experience big differences. I know many don't agree with me on this, but it is what I experience; I see it, I see that it works.

Here, I understand Solveig to be talking about how basic technique is, or at least should be, applicable for both CCM and classical singers on all levels. Further, she also shared some thoughts on differences and similarities at vocal fold level between CCM and classical singing styles:

> I believe that, if you think of a very, very advanced classical voice, the difference is minimal, but if you think of a semi-trained voice, kind of a student's voice, I think the difference is bigger. If you use more twang it might be easier to master the compression, and well, this has often been done in a bit slipshod kind of way in the classical pedagogy, the way of keeping the intercartilaginous gap closed at the same time as the vocal folds are lengthened. But when this is really in place, I don't think there are large differences. But if it is sloppy, there might be a difference.

Her mention of the intercartilaginous gap, and how it may be neglected in some of the classical training traditions, touches upon the same issues described by Herbst (2011) (see page 63). As we may remember, Herbst (2011) wrote about adducted and abducted chest and adducted and abducted falsetto, suggesting that the latter should be trained and successfully bridged with the former on descending scales before trying to change from adducted chest to adducted falsetto on ascending scales. I must remind the reader that genre-specific stylistic features were *not* an issue in the conversation with Solveig, and she was specifically instructed to concentrate exclusively on the various sound qualities or functions on vocal fold level. Knowing this, I find it interesting that Solveig proposed that a singer who has mastered

transitions like those described by Herbst (2011) on a highly advanced level also would also be able to perform vocal tasks in the CCM genre.

In the next section, I turn to vocal health, and many of the interviewees' responses on this topic are closely related to the issue of basic technique. When I asked about what to do in cases where students come to lessons with tired voices, a cold, or hoarse voices due to misuse over time, all of them highlighted one or more elements that are usually regarded as 'basic technique.' This supports the notion that exercises that activate the building blocks of basic technique often get singers 'back on track' again when they have been overusing or misusing their instrument.

4.5. VOCAL HEALTH

To stay in the game, whether that 'game' is singing in clubs every night of the week or holding presentations at work every now and then, requires a vocal technique that fits the demands to which a person's voice is exposed. Previously, I mentioned that vocal pacing may be recommended (LeBorgne & Rosenberg, 2014, p. 117), and that many singing teachers uphold the benefits of a balanced mix. The idea that training a balanced mix leads to vocal health and longevity is precisely what my interviewees talked about when discussing basic technique and muscular balance, as described above. Further, LeBorgne and Rosenberg (2014) also recommend that the amount of practice should be conditioned to the training level of the singer, and this issue was touched upon in the interview with Morten:

> M: I usually to say that I prefer frequent and short practice sessions, and especially if they are practicing new things.
> I: How long is a short practice session?
> M: Five to ten minutes. (…) And if we work on belt, for instance, and they are new to it, I say, "This exercise should be done two minutes daily, nothing more. That's enough until next time." It is not beneficial for them to work too hard on their belting for too long when it is new to them.

In other words, Morten was quite clear when it comes both to the length of each practice session and the amount of time he considers to be 'safe' for a student to work on new things. In cases where students had worked too hard on the belt voice, were just very tired, or had worked on very vocally demanding repertoire, both Hilde and Morten had several recommendations:

> H: When a student comes to me with a hoarse voice because of overuse or wrong use over time, I only work on basic technique with them. Get the support on track, the airflow, lowering the shoulders, work to get all the tension to leave the body. When they are tired, and the support doesn't work as it usually does, I never demand any extreme singing at a loud volume.
>
> M: Sometimes rest is best. To stay properly hydrated is also a good thing, and if your voice is very tired, at least try to make sure that all the surrounding musculature is loosened by making soft sounds in comfortable pitches and massaging your neck, chewing musculature and so on. You can also massage your voice and nearby structures by doing what are called 'blocking exercises' (*blokkeøvelser* in Norwegian).

Blocking exercises, which are done on consonants such as B, D, and G, consist of stopping the airstream, making the pressure build up inside the throat before letting go. According to Solveig, who also mentioned this type of exercise, such exercises block the swallowing sphincters, the muscles used when swallowing. As we may recall from the anatomy chapter, most of the muscles in the throat are sphincters, thus closing the throat by constriction (Kayes, 2015, p. 25), and a tired voice is often a product of too much pressure and constriction. Blocking exercises work by counteracting the constricting activity of the sphincters. A voice may also be tired due to sickness, and according to Solveig, soft SOVT exercises[52] may be helpful in these cases:

> Fatigue in the voice may develop into sickness, because a sore throat makes you more disposed to throat infections and colds. This means that if you are hoarse because the vocal folds are swollen, rest is advisable. If you are through the worst period and only cough some loose mucus and so on, it is OK to sing, and voiced and unvoiced lip-trills are good, as well as singing on 'vvv,' or through a tube in a bottle with lukewarm water.

I find the comments and suggestions presented above to be equally important in both classical and CCM pedagogy, and perhaps even to apply to voice use in general.

[52] SOVT is an abbreviation for *semi-occluded vocal tract* and refers to the semi-occlusion of one or more places in the vocal tract or outside the mouth (using, for instance, a straw or a tube) during phonation. Examples of typical SOVT exercises for singers include lip trills, tongue trills and humming, all of which offer "the potential for heightened interaction between the glottis and the supraglottal tract" (Titze, 2006, p. 449). The benefits of such exercises are less mechanical trauma to the vocal fold tissue and a more economical and efficient voice (Titze, 2006; de Vasconcelos, Gomes, & de Araújo, 2017; Vlot et al., 2017).

Another issue that came up when talking about healthy voice use and different genres was whether or not taking singing lessons would harm a singer's individual CCM sound. To my surprise, all my interviewees responded negatively to this question and said they felt this this apprehension was outdated and wrong. However, it was mentioned that this may only be true as long as the singer works with a teacher who actually teaches CCM genres, or in the case of having a classical singing teacher, if the teacher teaches basic technical principles and does not insist too much on typical classical voice qualities such as a remarkably darkened sound achieved using a very low larynx and lowered jaw.

To conclude this section, I would like to share one of Eva's answers on these issues, thereby bridging the gap to the next topic, namely how to teach the specific age group of 15- to 20-year-old singing students:

> Of course, if you want to be on a professional level, your technique is alpha and omega so that you know how to stay vocally fit for the whole tour, and you need to know how to sing when you get a cold; but still, I think it is, you should not be too preoccupied with the ego in the presentation. The need to show that you can do this or that. (…) But this is not easy to teach in that age group [15- to 20-year-olds]. They are in another mindset, and rightfully so, because they are searching for identity.

4.6. 15- TO 20-YEAR-OLDS: WHAT IS SPECIAL ABOUT THEM?

For most teenagers, who are no longer children but not yet adults, the constant search for identity is a demanding process. The majority of boys are finished with the most challenging part of their voice transition at 15–17, but they are still learning how to 'be' with their new, deeper voice. Some girls also experience voice changes at this age, but these are usually less apparent and audible (Arder, 1996, p. 149; LeBorgne & Rosenberg, 2014, p. 154-205). In the interviews, I usually rounded up each topic by asking the interviewees to combine the issue in question with insight about the selected age group. They emphasized four matters concerning the teaching of 15- to 20-year-olds: youngsters' need to do things correctly; the ability to play and have fun with the voice; the intensity of 'teenage emotions'; and the muscular flexibility and elasticity that come with a young body.

First, I would like to share Eva's and Morten's experiences with teenagers' 'inner need' to do things correctly.

> E: Most girls are concerned with doing everything so exceedingly correctly, or feel that they must know their song extremely well. They are willing to put in a very large amount of

> training hours to get it right, and some even want it to be perfect. I find it to be typifying of that age group, and they don't have enough life experience to appreciate how beautiful it is with what is not *just* like that.
>
> M: First of all, I don't want my teenage students to devote so much attention to what is correct. For instance, if we are talking about the belt voice, I never say "that was a wrong way to belt, and that was a correct way," but rather ask questions getting them to reflect: "How did it feel?," "Did you get tired of it?" (…) And I never say such things as "You should move your tongue slightly this or that way, because we are going to train belting." I *never* say it, because some of them get so fixated and don't really listen to what we do for the rest of the lesson. Then they go home and practice for a whole hour explicitly on one small detail from the half an hour–long lesson, and all we did is ruined and we have to start anew the week after.

I recognize this type of singer from my own experience as a teacher, and I find that such students are often prone to excessive tension, either as a result of overuse or because of psychologically restraining ideas. They want to do it right so intensely that it tenses the whole body. This puts a special demand on the teacher, and I believe that dealing with it the way Morten described is very beneficial, especially the part where he emphasizes the importance of minding one's words, because these singers may very well remember and practice it all.

Second, most of my interviewees also mentioned that they encourage their students in this age group to have fun with their voices. Morten shared his good experience with having students mimick other dialects or personalities, thus equipping them with a broader palette, allowing them to achieve an even more flexible voice. It is my understanding that through mimicking, students also often come closer to healthy types of phonation. Such playfulness calls for a spontaneous teacher who does not take him or herself too seriously, and I believe that if you are going to succeed in guiding students out of their comfort zone, you must provide a good example by taking some risks yourself.

The third aspect of this age group mentioned by the interviewees was the search for an identity and emotions that often grew out of proportion. These topics are perhaps somewhat beside the point of this thesis, but I will include one comment:

> M: I find it special for this age group how life affects them. Their emotions are enormous, and their reactions are so big. It is a lot of drama, and I don't know exactly why, but it is my impression that we get more and more fragile students. This is sometimes very challenging. In addition, many of them show such strong will. They want to achieve this or that so much that

> it overruns the steady pace needed for development to happen. They want so much and they want it so fast that they don't have time for the process.

This excerpt is rich with scenarios I recognize from my own practice, and I deem them all to be of great importance. Nevertheless, to stay on track regarding my research questions, I refrain from commenting on all of them. Instead, I want to point out that the student's inner drive to accomplish something too fast often presents a great challenge in the teaching process, perhaps especially when working on fine motor skills that need careful, repetitious, and conscious training, such as when trying to develop the balanced musculature needed for blending registers. As seen in the previous section, this fine muscular work is also regarded as a cornerstone of a healthy voice, but in spite of this, youngsters do not always take the time to train and implement such change. I find reason to believe that this is not only a result of impatience, but may also very well be due to the student's own impression that there is no 'pressing need' for such development. Their young voices are flexible and recover quickly if misused, thus they might be unable to recognize a need that may become more obvious when they get older. Below, I will write more about youngsters' responsive musculature and bodies.

I find that the findings from the interviews support the common understanding that younger bodies have more energy and are more flexible than older bodies. Youngsters need a shorter amount of time to recover when they are tired, and the time needed to get ready for a vocal lesson is sometimes very short. I will come back to the issue of warming up below, but first I will share some views on the pros and cons of young voices' flexibility and plasticity:

> S: The thing about 15- to 20-year-olds that is both great and quite worrisome is that the musculature responds much quicker than in the adult body, and this is a huge responsibility. Everything you assist them in learning will stay in their system, perhaps for the rest of their lives, so when you have the cleverest students who practice a lot, it is a great responsibility to ensure that it is the good habits that are practiced.

> H: Their musculature learns very fast, so I teach them this three times rule to train the 'muscular memory.' If you repeat the same thing three times, your brain works in a way that makes the muscles 'remember' the new movement 'by itself.' And this is the same with all the bad habits.

Both Hilde and Solveig thus emphasized the importance of guiding students so that *good* habits were repeated and trained and bad habits were avoided.

On the topic of young voices and flexibility, I would also like to present some views on the need to warm up before singing. The interviewees did not all use the expression 'warm - up,' but they did use phrases such as 'get started' or 'let's train the voice.' All of them described the benefits of having a warm-up session at the start of each lesson, but not to achieve 'a warm voice': as Morten quipped, "Hopefully it is 37 degrees Celsius in there." Instead they focused on the idea that a warm-up helps teenagers to prepare mentally for new learning processes and to drill the exercises tailored to develop their voice. Hopefully, this weekly repetition together with their teacher is enough to trigger the good habits when they are practicing on their own.

> S: Yes, they are flexible, but they need to train their awareness, to feel what happens, and then they have to push the 'save button' so that they are able to do the same movement again and again on their own. The warm-up is also important to make sure all the registers work as they should, and this should be done every day.
>
> H: In addition to the part of getting mentally ready, I think the warm-up can be used to check that your voice is where you want it to be. If it is, you can go on, but if not, you have to do some exercises to ascertain what your voice needs.
>
> E: I warm up with my students, but we don't always do a lot of scales. Usually we do some physical exercises, and I am very consistent in conveying that the warm-up should awake your concentration, your awareness and make you ready to sing.

As mentioned, the muscular balance in the intrinsic laryngeal musculature was regarded as one of the main things to be trained in a warm-up session. The next section will look at this more specifically, through a discussion of the development of a mix.

4.7. MIX: WHAT IS IT? WHERE TO START?

For my four interviewees, a mixed voice in the usual singing range seemed to be a mix of what may be called chest register and head register. Solveig described and showed examples of how these registers often exist in their purest form in untrained voices, and how a singer must train to mix them together:

> You can talk about two 'pure' types of registers, which the trained singer continually works to equalize. As a singing teacher, you need to listen extremely carefully in this process, and you are to listen for the *function*, not the filtered timbre.

I find the last sentence to be especially important because a singer can change resonances to make one voice function sound almost like another, as I explained in the section on *Singers and registers*. There I described how some singers are able to mask the transition area, for instance singing in M1 while it sounds like they are in M2, or vice versa. In my experience, not all aspiring singers have developed sufficient kinesthetic awareness, meaning that they need help determining what register or vocal function they actually are using. This is what Solveig seems to point to when she emphasizes that the teacher must 'listen for the function' rather than the total output.

On page 50 I wrote about bi-stable vocal fold adduction and Titze's (2014) hypothesis about rectangular, convergent, and divergent glottal shapes. In Titze's (2014) work, the 'flipping' between a convergent and divergent glottis happens due to instabilities such as pressure changes or variations in the muscular tension below the glottis, in between the vocal folds, and/or in the supraglottic cavity. When the vocal folds are trained to close to a rectangular setup, they are more susceptible to these changes and 'flip' more easily, but the change in the sound output is not necessarily very obvious. The convergent and divergent vocal fold shapes, on the other hand, are less likely to 'flip' because a higher pressure or greater muscle instability is necessary to induce change. When the change happens, then, it happens to a larger degree than when the singer has more rectangular-shaped vocal folds, and the change in the sound output is also much more audibly distinct. This angle may be used when talking about working with register transitions and mixing the voice, and Morten described aspects of the mixed voice that resembled Titze's descriptions. Consequently, the voices described below may be categorized as having a natural ease with voice production based on a divergent glottal configuration:

> M: One should find and train different degrees of weight of the tone when working with mixed voice, and it should not only be one setup, but several. (…) Often, the student's heavy voice production in the lower frequencies is too firmly closed, and consequently the lighter top tones are not closed completely. This makes it hard to do anything else but flip between the two modes, and makes it hard to achieve differently weighted tones, in regard to vocal fold mass. (…) You have to adjust both top and bottom to gain full flexibility in your mixed voice.

I also find it interesting that Morten's way of talking about the flipping between the registers somewhat matches Titze's description (2014) (see section 3.4.5.), though Morten puts it in quite another way.

Hilde also talked about issues that can be related to Titze's (2014) theory when she mentioned the importance of working both bottom to top and top to bottom in the student's range. As a singing teacher, it is easy to assume that exercises from bottom to top are based on divergent glottal shapes whereas top to bottom exercises trigger convergent glottal shapes, but this is of course not given, as both higher and lower tones may be either convergent or divergent. However, based on my overall impression in the interview, I believe this assumption may apply here:

> It is important to train the function behind the chosen timbre of the voice, and I always work from bottom to top. And this is in contrast to what I do if I am working on higher tones with them. Then I work from top to bottom, using mostly gliding exercises.

As I understand it, Hilde focused on singing with a divergent shaped glottis, but in the cases where students needed to train their higher ranges, I believe her exercises stimulated convergent vocal fold positions. Hilde's descriptions can be seen as traditional ways of training a mixed voice, and the importance of this work also came up in the interview with Solveig. Here the topic of mixing came up when talking about tired voices, and she described how many choristers suffer from tired voices due to mixing problems:

> The tired voice most of all needs to access the mentioned balanced intrinsic musculature. (…) I see it, for instance, in choirs where singers are wrongly thought of as altos, and they start cheating in the middle of their range because they don't master the transition. This is really tiring, and decidedly a place for vocal trauma to arise, from around C4 to C5 in female singers. A large amount of rehabilitation cases have to do with mixing problems. Either you take the lower register up too far, or the other way around.

Solveig's statement can be taken to further support the descriptions above, explaining how altos, for instance, who probably often are singers with a divergent shaped glottis, need to train their lighter register in order to master the transition in a vocally healthy way.

According to my interviewees, they always start where the student feels at home in his or her voice when working with mix. They all spoke of 'the comfort zone,' the place in the voice where the student usually speaks or sings. They mentioned taking small steps from there, letting the musculature stretch and get used to new habitual patterns without hurrying too much. This approach is linked to the challenges mentioned in the last section, namely that

such muscular training requires patience that not all 15- to 20-year-old students possess. Here is how Eva and Solveig talked about it:

> E: I usually talk about the comfort zone. Where is it OK, where do you speak, where is your preferred pitch when talking? I also try to keep a relaxed approach when working with registers, and I find this to be important because they [students] often get so pretentious, showing more interest in reaching four octaves than making music in the range they already possess.
>
> S: I often think about the comfort zone because this is often very important, to stay there, then move into the learning zone gradually and carefully. Then you should establish a feeling of comfort in that new zone before continuing to expand.

All my interviewees expressed that they only felt comfortable working on heavier vocal tasks such as belting when the mix, or 'the mastering of the balanced muscles,' was incorporated in the student's motor pattern.

4.8. BELTING, BELT-LIKE, OR IS IT BELT AT ALL?

As we saw on page 73, Morten talked about how belted sounds may exhibit a variety of different features. In accordance with this assessment, and with what I presented in the previous chapter, I think it is safe to say that belting is not *one* thing, but a term incorporating sounds from the heavier chest mix to the pure belted or perhaps 'chesty' sounds known from speech-like voice production (Hall, 2014, p. 70). The observant reader may have noticed how vague my characterization of belting is, and this is not without reason. After all my research into this matter, I am still not quite sure what meaning or meanings to ascribe to this particular word; I know only that it spans *a lot.* In this section, the reader will be acquainted with how my interviewees talked about belting, as well as important features contributing to making the belt voice both stylistically correct and healthy.

Solveig first talked about what she perceived belting *not* to be before sharing some ideas on how to work on the belted sound:

> Very often there is a misunderstanding where this [metallic sound/belting] is perceived to have something to do with pushing the pure chest voice very high. This is one reason I always work very thoroughly with the basic technique to begin with. I explain that the groundwork must be laid. Then I start with a broad 'aa' to get the twangy feeling, (…) and [repertoire that] requests a close-to-speech-voice feeling. It should be a bit direct in the timbre, and the tone sits a bit

> broader in the mask, using a broad tongue, a broad feeling in the cheeks. I must tell you that I have found that the divide between CCM and classical is not as wide as I first believed, presumably because of these features. The tongue and the broad feeling in the whole mask. Further, when the student is ready, I slowly encourage him or her to heighten the energy, letting the student feel that he or she can hold everything together even though the energy increases. Trying and feeling where the limits are.

Here Solveig describes her perception of what belting sounds like, how it should be 'placed' in the instrument, and how to work on it. Morten, who perhaps has the longest experience with teaching belting of the four interviewees, talked about the same problem that Solveig mentioned, namely singers pushing too hard on their way up, believing that exclusively training pure chest voice is the answer:

> The typical mistake people do when trying to belt is that they press their chest voice up too high, and I believe CVT agrees with this, if you think about the skulls they use to show the limits of the overdrive mode. What happens is that the vocal folds are in a heavy weighted function, combined with a high subglottal pressure. This constitutes a solid pressure against the vocal folds as they strain to stay closed, and they get tired. At this point, I often experience that either the vocal folds blow apart, and you cannot close them properly, or the vestibular folds move inwards trying to protect the area.

As discussed in the section on *Healthy voices and configurations of belting*, the positioning of the vestibular folds may be of importance in a belted tone. It is not surprising that Morten refers to this parameter, as he is a trained Estill teacher, but he also expresses some doubts regarding the importance, or positioning, of the vestibular folds in belting. Morten further described how he, too, found the 'broad face' to be a feature of healthy belting and gave examples of how to counteract the stiffness that often comes with loud singing:

> The student often develops tension in the neck or jaw. Even though I usually teach a broadness in the face, almost like the old singing teachers who talked about a smile in the throat or something, I always check that the neck is free, and that the jaw has not been locked in a 'biting' position. I have good experience, for instance, with doing arm movements because it limits how tense everything else gets. Chewing is also nice, as is walking around, perhaps in another pulse than that of the song. This often releases muscle tension.

As may be recalled from the section about the hyoid bone (see page 32), tension in the infrahyoid muscles can result in an unrelaxed larynx with adverse constriction. Further, the *height* of the larynx is of interest when talking about belting. In the section called *Healthy voices and configurations of belting*, I wrote that it is generally believed that the larynx should be free to move upwards on belted tones, and Hilde, Morten, and Solveig all seconded this opinion. They insisted that the larynx should *not* be pressed or pushed up, but rather merely be allowed to go *higher* without going to its highest possible position. Then they talked about how one could try to lower the larynx very carefully, just a little bit, once the belting function is mastered, thus giving the otherwise brassy, twangy, and direct tone a hint of a warmer character. Eva also talked about the larynx, explaining that "the issue of larynx height resolves itself if the rest of the muscle coordination is good." I am of the opinion that all these statements concerning larynx height in belting point in the same direction. The larynx should be higher in belting than in classical singing, but the flexibility must be preserved, both to avoid unnecessary tension and to make it possible to change into other vocal setups when desired. Before ending my presentation of the interview findings, I will describe some issues related to the male voice and belting.

Both Hilde and Morten experienced that men often have easy access to the heavier types of voice production. The chest voice is often men's natural speaking register, and the most problematic transition point does not occur before around C4 or D4. Since most group singing happens below these notes, the average male singer gets to exercise this specific range, thus strengthening the function. For women, the picture is a bit different. Before going on, I must mention that both men and women seem to have a tendency towards either a convergent or divergent glottis shape in phonation, to use Titze's (2014) terms, but as I understand it, more men than women naturally have the divergent shaped glottis, while the reverse is also true. For example, women often speak in a voice resembling head voice, perhaps switching between head voice and chest voice, and this usually ensures them easier access to the higher parts of their voice. Below, Hilde talks about the tendency for boys to have an easier access to chest voice-sounding functions:

> The boys have often been there [in metallic modes] more. They have used much more metallic tones in their daily voice use. There are girls who have metallic sounds in their voice as well, but this is not the tendency as I see it. Boys sound one octave lower, thus making the road upwards easier, without losing the chesty feeling. In addition, it is possible that there are perhaps more silent girls than silent boys; the boys have training in talking loud and

> energetically. Whatever the reason, I experience that it is easier for the boys to sing higher up in their range with a lot of power, than it is for the girls. The girls usually don't have the same range in their voice where the sound is powerful and still sounds good, so the girls must be technically very advanced to sound good high up in their range with the kind of power expected in many CCM genres.

Morten talked about this in fairly the same way as Hilde, but in addition, he mentioned a related topic that I found very interesting, namely 'How much do boys really belt?'

> There's this discussion, that I actually agree with, to some extent. How much do boys actually belt? It has something to do with where we are in our range compared to what pitch is sung. We are one octave lower than girls, so when we sing a high f (F4) in our voice, which is not very high at all in a female voice, we are in kind of a prolonged speech-type kind of voice, which is a bit stretched or whatever we want to call it.
> I: Is it better to talk about a mix?
> M: Yes, I think so. Many boys have a lot more mix in their voice, rather than belt. So, it is almost as if you take a mix, and twist it *just* a little to get the belt feeling.

I understand it as a question of whether or not men are able to belt throughout their whole range. In line with what I believe Morten implies here, I agree that the male belt voice perhaps only happens during loud singing and in speech-like tones *above* the passaggio. Below the passaggio, which is the normal speaking range for men, I think the heavy and speech-like tones are more like a heavy mix, or perhaps even chest voice in some cases. Of course, because belting may be defined in many ways, my categorization here is a case of 'thinking out loud' rather than a deliberate claim. Anyway, I believe it is very important for singing teachers to reflect upon this issue, especially, as Morten pointed out during his interview, when being male teaching female students.

In this chapter, I have presented some of the data from the four interviews I conducted. I find that the perspectives my interviewees have shared are basically in harmony with the results from the document analysis, and I see their contributions as 'real-life' scenarios describing how to work with basic technique, registers, and belting in young voices belonging to 15- to 20-year-olds, with a focus on features of CCM singing and healthy voice habits. In the next chapter, I will discuss these issues further, drawing on the findings from both this chapter and the document analysis.

5 DISCUSSION

As is evident from the research questions, the goal of all my work on this thesis was to learn and understand more about the underlying laryngeal physiology of CCM singing techniques and the teaching of such genres to 15- to 20-year-olds. These matters have been thoroughly explored and described in chapters 3 and 4, however, to understand the physiology behind these techniques was not the *overarching* goal. The aim of the thesis as a whole was to establish a basis for understanding *what* and *how* to teach students who wish to sing CCM, a basis which I, and hopefully other singing teachers and singers, may draw on as we strive to hone our skills as teachers and singers.

When I look in the rear-view-mirror back on the process of triangulation method used in this work (see page 9), I find that it has given me both answers that were easy to unify, as well as answers of such dissimilar nature that it was hard–and sometimes nearly impossible–to merge them into appropriate entities. Some would probably say that such a combination of scientific approaches and humanist interpretation is basically flawed, but regardless of the obstacles I met in the process due to the incompatibility of the 'two worlds,' I have found the possibilities in the 'hermeneutical arc' to produce both interesting and useful answers. Some of these are highlighted in this chapter, and I combine them with my reflections and considerations as a singing teacher. The latter means that the conclusions of this thesis will be characterized by having a somewhat 'practical' bent to them, in line with my overarching wish to know *what* and *how* to teach my singing students. In the end of this chapter, the reader will see how these last notions specifically contain requirements for further investigation.

Working on CCM material with 15- to 20-year-olds calls for teaching methods and singing techniques that both resemble and differ from the classical singing traditions (Romme, 2009; Augdal, 2012). For many in the field of singing, an obvious place to start is to ask, "What are the differences?"; this was also the case for me when I started researching this topic. However, through the work on this thesis, I grew more and more interested in the actual *similarities*, and I became convinced that there had to exist some kind of common denominator, or at least some common ground. This became especially apparent when I tried to combine what I had learned from CVT (Sadolin, 2008), Sundberg's phonation types (Sundberg, 2001), and the EVM (Steinhauer et al., 2017) with the more traditional classical (Brown, 1996; Arder, 1996) ways of describing and talking about matters such as registers, voice quality, modes, and so on. I was curious about what happens in the vibrator on the vocal

fold level, and I believed that there had to be some way of merging these models of conceptualization, since we all have a larynx that is built and has the ability to function in more or less the same way. So what is the reason for these conflicting descriptions of what we can (and cannot) do with our laryngeal muscles? The history of the development of various terms has not been a topic in this work; rather, I have examined the nature these concepts from different angles, thus giving an idea of what unites these conceptual models on a basic level. Because I come from the field of classical singing myself, I chose to focus on CCM singing techniques in this thesis, and the articles I have read and the interviews I have conducted have helped me to better understand both the commonalities of the various approaches to singing and the defining differences.

This final chapter has a different structure than the previous chapters. I start by presenting my findings on the topic of terminology, both in general and in the singing studio, and continue with a description of what I consider the most pressing matters, namely those of vocal functions, registers, phonation types, and so on. Then, I present some ideas on how my research may provide practical knowledge relevant for singing lessons, and finally I share some thoughts on how this work, and how it with its focus on technical issues related to CCM singing, might convey a deeper meaning related to the art of making music.

5.1. TERMINOLOGY

When talking about the terminology used in the singing studios of my four interviewees, a variety of terms related to registers, voice quality, functions, and so on were used, though in one case, such terminology was completely avoided. The existence of many names for the different laryngeal choices a singer has was apparent in the articles of my document analysis as well. There are many names for registers, types of phonation, functions, voice qualities, and so on, including head and chest registers, light and heavy mechanisms, modes 1 and 2, M1–M4, pressed, neutral (Sundberg, 2001), neutral (CVT), metallic voice—the list goes on and on.

5.1.1. Register terminology

As far as I know, no terminology has gained the popularity of the terms chest and head voice/register since the movement to exclude such terms (because they originate in felt vibrations rather than depicting the actual activity in the throat) began (Hoch & Sandage, 2017, p. 648). This is also the case in Norway, even though we have two words that, in my opinion, actually work quite well. Both *randregisteret/randstemme* (falsetto or head

register/voice, depending on which author one wishes to identify with), and *fullregisteret/fullstemme* (chest register/voice) refer to the appearance of the glottis[53]; moreover, both terms are easy to remember and not easily confused. However, it is not clear how these terms should be used in relation to describing a mix. Sometimes I encounter singing teachers who talk about *randregisteret* as something resembling the head register in the way that it is used by female classical singers to make a fuller, ringing sound. Based on the work of this thesis, I would consider such a voice production to be a mix based in an M2 laryngeal mechanism. At other times, singing teachers talk about *randregisteret* as the *pure* 'randregister' (pure head voice/M2, very little or no TA contraction), without clarifying this specifically. In my opinion, using terminology that preserves the variants of mix while accentuating that mix is not a separate register would be beneficial in terms of clarity. Perhaps *randmiks* ('rim mix,' directly translated) and *fullmiks* ('full mix') might be an option for Norwegian speakers? I believe that these terms should be able to fill the gap left now that terms such as *blandingsstemme* (mixing voice) or *mellomregister* (middle register) have both become somewhat outdated. By proposing the terms *randmiks* and *fullmiks*, I also preserve CCM interests, as I perceive *rand, miks,* and *full* all to be fairly neutral terms, being derived from how the vocal folds look when one sings in the respective registers. Furthermore, *rand, full,* and the English term *mix* are already present in the Norwegian singing discourse, and therefore a combination of these terms is not very controversial but merely provides Norwegians with a terminology for differentiating between various ways of mixing, which, in my opinion, has been missing. These terms relate to the first passaggio transition, which can be seen as the most relevant transition in CCM singing. The transitions from M0 to M1 and from M2 to M3 are also present in CCM genres, but most songs have a range where these transitions are not frequently used. Nevertheless, similar terms should be developed for the second passaggio (M2 to M3). Since I have not made a thorough investigation of this particular area in this thesis, I refrain from proposing relevant terms.

Further, I do not see it as my responsibility to decide specifically which terms should be used in English-speaking countries, but I believe that terms used in the singing studio to talk about register should be both easy for the singer to remember and have useful connotations. Chest voice and head voice would be two such terms, were it not for the fact that registers are produced neither in the chest nor in the head. The sensations in chest and head are only

[53] *Rand* means 'rim,' and relates to the rim of the vocal folds meeting in M2/head voice. *Full* means 'full,' and relates to the vertically fuller closure of the vocal folds associated with M1/chest voice.

secondary vibrations and should, in my opinion, not be used to designate registers, which are obviously, as presented in chapter 3, mostly controlled at vocal fold level. Register terms should be linked to laryngeal activity rather than to perceived vibrations elsewhere in the body. Finally, I think that if terms consisting of numbers are to be used, they should range from 0–3, with M1 being number one and M2 number two. This would acknowledge the fact that number 1 (for instance M1) is the dominant or main register in speech and most singing. However, I do believe that the use of single letters may result in confusion. I am thinking, for instance, of the use of M1: it is not clear if *M* in this case denotes *mode* or *mechanism*. Both terms are used, which is utterly confusing in my opinion.

As mentioned in section 3.4.10., there are two terms that I propose should be avoided until further research is done, and these are *cricothyroid dominant (CTD)* and *thyroarytenoid dominant (TAD)*. They relate to the amount of thyroid and cricothyroid contraction in a mixed register. As may be recalled from previous chapters, it does seem that a mixed voice often is either based in M1 or M2, or, put in another way, the mixed voice is either chest voice–dominant, or head voice–dominant. Because these terms relate to vibrations felt in parts of the body other than the vibrator, this differentiation (using head and chest voice–dominant) might be fine, but to say that a *register* is TAD or CTD strikes me as wrong (Kochis-Jennings et al., 2014).

Before leaving this issue altogether, I must say that I have had success using the terms *metal* and *neutral* (CVT) when teaching my students, as they easily categorize their own vocal sounds as one or the other. However, because these labels connote the sound as it is perceived audibly, as well as being part of a specifically structured system (CVT) that is not largely apparent in the research literature, I find other terms to be a better fit. In other words, I do not think that register terms should address perceived audible sound, which is highly subjective. In my opinion, register terms should be easy enough for singers and non-singers alike to remember and use, and they should also be accurate with respect to physiology so that they appear logical to singers as they learn more about the anatomy and physiology of their instrument.

To sum up the main issue: for Norwegian speakers, I would recommend the use of *fullstemme/-register* (M1), *fullmiks* (mix based in M1), *randmiks* (M2 mix), and *randregister/randstemme* (mix based in M2) (see above for further descriptions). For a *miks* (mix) that is difficult to specify either as *fullmiks* (based in M1) or *randmiks* (based in M2), I propose that only *miks* (mix) be used.

5.1.2. Intercartilaginous adduction and membranous medialization in the singing studio

By calling membranous medialization a register issue and intercartilaginous adduction a determiner of phonation type,[54] Herbst (2011) provides us with a distinction that I find both helpful and clarifying. The next question is, however, how these terms and this knowledge should be implemented in the practice of teaching singing. Many singing teachers are afraid of drawing too much attention to the laryngeal muscles, and rightfully so, I would say. This was also pointed out by my interviewees. Focusing too much on issues in the larynx may very well result in the opposite of what one is aiming for because students can easily become overconscious about what happens in this area, which again may result in unwanted tension. As seen from my interviews, this might be especially risky when teaching adolescents. This is possibly due to their self-consciousness and lack of ability to see things in perspective sometimes (to be a bit blunt). Moreover, the development of laryngeal technical skills calls for teaching strategies that do not encourage students to willfully control muscles that are almost impossible to control directly on the first try. Of course, it is will that initiates any activity, but learning to contract a given of intrinsic muscles is usually done by mimicking and/or exploring. After all, these muscles are not easy to contract at will when one has not already established 'solid' firing patterns, as mentioned on page 37. This means that I believe the distinction made by Herbst (2011) is extremely important for the teacher to have in his or her mind while teaching, and it may be used actively in the singing studio as part of the teacher's repertoire of models for understanding, enabling him or her to listen for what the student is doing.

However, as soon as teachers start guiding their students, whether it is towards closing the intercartilaginous gap or singing in a heavier *fullmiks* (full mix, which requires more of the membranous medialization), I believe that a distinctly different language should be used. At this juncture, students in the mentioned age group would benefit from a more 'down-to-earth' way of speaking, in my opinion, and teachers should use metaphors and more common concepts in their descriptions. This being said, I also think that teachers should tailor how they speak about laryngeal occurrences to each student, as some students need to be guided without the teacher concretizing certain notions, while others benefit greatly from

[54] Register changes due to TA contraction are called 'membranous medialization,' while 'intercartilaginous adduction' refers to phonation types/voice qualities that are controlled by the lateral cricoarytenoid muscles (LCA) and interarytenoid muscles (IA) (see page 62).

understanding underlying structures and react positively to the pinpointing of physical mechanisms. I find that a combination of the two kinds of communication is usually most fruitful.

5.2. PHYSIOLOGICAL CONSIDERATIONS

I believe that registers and phonation types usually are confused because certain registers often co-occur with pitch or with certain phonation types. Findings presented in chapter 3 have showed that it is possible to change the three parameters of register, pitch, and phonation type, in addition to a fourth one, namely volume, both *gradually* and *independently* at vocal fold level (Herbst, 2011). This means that the fine muscular interaction used in phonation enables us to change pitch by contracting CT while keeping all other parameters constant, to change the volume by increasing or decreasing subglottic pressure (Sundberg, 2001) while keeping other parameters constant, to change register mainly by contracting or relaxing the TA muscles while keeping all other parameters constant, and to alter the type of phonation or sound produced by changing from a breathy voice to a closed glottis using the IA muscles (Herbst, 2011). All the above-mentioned parameters are often activated simultaneously in an untrained voice, for instance if a test subject is asked to sing a specific note and then is asked to increase the volume. What will usually occur is that the untrained singer will both raise the pitch and make the sound more pressed, which suggests a change towards a heavier register and/or closing the glottis along the whole length horizontally. A trained singer, on the other hand, will be able to do what she or he was told, namely to increase the volume while keeping pitch, register, and phonation type constant. To give another example, it is not difficult for a trained singer to maintain a breathy voice (with an open intercartilaginous gap) in an M2 register keeping a specific volume while changing pitch quickly and over a larger range.

I have chosen to use the word *function* in some places in this thesis, which may convey one meaning in one situation—like when Solveig talked about function as another way of saying register—and a different meaning in another—like when merging the CVT modes and register terms the way Solveig, Hilde, and Morten used them, into one larger category. In this regard, *function* and *voice quality* would take on the same meaning, as long as one understands voice quality to be the product both of phonation type and of register parameters. Voice quality in the EVM, on the other hand, is a set of specific vocal setups, categorized and structured following fixed rules (Steinhauer et al., 2017).

An additional confusing aspect is that the sound coming from the vibrator can be manipulated by changing various parameters in the resonator. This might also be a part of

what may be perceived as the total voice quality. When singers and singing teachers are talking about these issues, across genres with their different levels of education and knowledge, it is hardly surprising that confusion sets in. For the purpose of clarity, a short summary of how to communicate precisely when talking about these issues follows.

As the four parameters of register, pitch, phonation type, and volume can be changed independently and gradually at vocal fold level, differentiation between them should be preserved in the language, keeping register issues separated from phonation issues. Moreover, how the sound from the vibrator then is modulated in the vocal tract should be addressed specifically and not in conjunction with discussion of issues originating in the vibrator, as far as this is possible. If one sticks to these ideas, the combination of concepts from typical CCM 'schools' and the classical singing tradition should not present any obstacles.

Lastly, I would like to address the matter of TA versus CT contraction and clarify how I understand this distinction based on what I have presented in this thesis. On page 59, I wrote that, "contractions of the CT also help TA in the registration task, but not in the way it is often described, as 'being more activated and taking over the work' at the same point where a register break can be heard." This relates to the ideas mentioned above. If one separates pitch from register when describing these phenomena, one finds, according to Titze (2014), that a register break can occur due to sub-, intra- and/or supraglottal instabilities and is more or less prone to happen when reaching specific pitches. When singing, a singer may use register breaks for stylistic variation or may want to 'smooth them out.' No matter how the transition area is approached, it is not necessarily the case, according to Kochis-Jennings et al. (2014), that CT gradually increases *more than* the TA on an ascending scale. I understand that if one sings in belting, for instance—a heavy type of *fullmiks/*chest mix, bordering on *ren fullstemme/*pure chest register but still with some CT contraction at work—both CT and TA contract more as the singer ascends in pitch. As I understand it, the CT muscles 'take over' the work of TA if the singer then switches from a belted type of voice use to a lighter *randmiks/*head mix—for instance on D5—but only because they (the CT muscles) have already been activated; moreover, these muscles *have* to be activated for the singer to reach that specific pitch. The fact that the singer then would be in M2 does not mean *more* CT contraction, but rather the opposite. Without significant activation of the TA muscles, the CT muscles do not have to work as hard to keep the pitch. In other words, they do not have as much tension to 'work against.' This means the CT muscles may even relax somewhat when going from the belted tone to the light *randmiks/*head mix tone, because when the TA muscles let go, the CT muscles work only 'by themselves' (of course also with IA and LCA at work). I

find it helpful to think of the CT muscles mainly as pitch regulators, and only passively as register regulators.

The discussion above is characterized by how I understand the issues of TA and CT contraction. The inclusion of such a subjective approach, not only conveys my thoughts, but also discloses an obvious vacant spot in the field of singing research. If I had been able to find more studies supporting or disapproving the findings of Kochis-Jennings et al. (2014), for instance, reflections and conceptualizations of how it all *might* function and be related, would not have been interesting. I hope future EMG-studies and other relevant research may give more answers, so that singing teachers and singers can build well informed frame-works for understanding.

More details regarding the practical consequences of physiology issues for singing practice follows in the section below.

5.3. IMPLICATIONS FOR SINGING PRACTICE

I hope that the results from this work may contribute to further conceptualizations regarding *what works* when teaching 15- to 20-year-old students in CCM genres. Some questions have arisen in this thesis that directly relate to such practical issues.

5.3.1. The teacher's 'vocal empathy'

Above, I made it quite clear as to what elements I think a singing teacher should be able to discern between when listening to her or his students. It may seem impossible to hear such refined and intricate differences, but I believe that the teacher's ability to both *hear,* as well as *feel* in her own instrument, what the student is doing is one of the most important tools in guiding students through laryngeal issues. This ability is called 'vocal empathy' (Arder, 2001, pp. 68-69), and it equips the teacher with a refined measuring tool well-suited for assessing nuanced differences in a voice. I must make it clear that I do not consider this to be the same as *knowing* what happens in the larynx, more generally, and I maintain that the teacher's 'vocal empathy,' and hence the kinesthetic experience of the perceived sound, is a fantastic tool as long as it is combined with a thorough knowledge of anatomy and physiology. Of course, a singing teacher cannot necessarily know *all* there is to know about the larynx and its functions, but I think that a practice solely based on individually felt experiences seldom produces satisfactory development in all the students encountered in the school system or in any other teaching arena. To teach students whose anatomy, singing technique, and vocal

experiences differ from their own, I believe teachers need knowledge about *what happens* in addition to tailored ideas about *what to do*.

5.3.2. Basic balance in the intrinsic musculature

"You should not start working on the effects before the basic balance in the intrinsic musculature is in place," Solveig stated (see page 78); she also spoke of simultaneously maintaining the lengthening created by the CT muscles with the fuller glottal closure due to TA contractions. This idea of a being to maintain a basic balance was mentioned several times during the interviews, and was considered to be a necessary trait for all singers, CCM and classical alike. I perceive this to be the same as ensuring a balanced healthy mix (Hall, 2014), and all my interviewees expressed that they only felt comfortable working on heavier vocal tasks such as belting when the mix, or "the mastering of the balanced muscles," had been incorporated into the student's motor pattern. According to my interviewees, this basic knowledge is an important part of learning to know the limits of one's voice, and it may be used as the 'prototype' to check against when something in the voice is amiss.

All my interviewees found the development of such consciousness, the ability to be vocally attentive, to be important when teaching adolescents, and vocal attentiveness is in fact also emphasized in the curriculum for main instruments in the first year of the Music, Dance and Drama (MDD) upper secondary program (Utdanningsdirektoratet, 2006, Musikk, hovedinstrument VP1). This curriculum also holds what was stated by Schutte and Miller (2003), that the students must learn to "respect … the limits imposed by fatigue" (p. 149) (see page 68).

5.3.3. Register transitions

Regarding register transitions, changes in pressure underneath, between, and above the vocal folds probably have a large effect on both the stability of the registers and the controlled transition from one register to another (Titze, 2014). Focusing on the supraglottal cavity above the vocal folds, it seems that a narrow supraglottal tract, in other words a twanged epiglottic funnel (CVT), contributes to stabilization, while a retraction of the vestibular folds seems to make the conditions for a healthy and free vocal sound even better. In addition to being used by the EVM, this mechanism was mentioned by Morten, who talked about "the old singing teachers," and how they talked about a 'smile in the throat.' He also shared that he had had good experiences with practicing the EVM's more active 'laugh' in the back of the

throat with students, as this presumably helps the singer to stay in the intended register. Further investigations of this topic would be of interest.

5.3.4. Opera, rock, and adolescents

On page 70, I presented some considerations regarding having a career as a classical singer while engaging in more rock-oriented singing. The possibility of such a combination has been strongly rejected by the leading hard metal and rock singing teacher Melissa Cross (2008), but I would like to discuss its applications when it comes to young students who have not yet decided what they want for the future. Of course, I agree with Cross that a career on an advanced level combining classical music with, for instance, death metal has little chance of success, but this does not mean that adolescents searching for their identity as a singer, as well as a way of expressing themselves with their voice, should be discouraged from trying out whatever genre they want to pursue. This being said, I also agree with CVT (Sadolin, 2008) that some main principles of singing must be in place before effects and voice patterns associated with genres demanding extremely heavy use of the voice, so-called extreme vocals (Cross, 2008), can be sung safely. Furthermore, I think that in this case, adolescents' flexible and quick-to-heal tissue is to their advantage, making experimentation and exploration less 'dangerous' when seen from a voice health perspective. When teaching students who wish to learn the techniques of genres where extreme vocals are required, it is important that the student first establish a good balance in the intrinsic musculature and develop an attentive attitude towards his or her own instrument and what it 'feels' like when all is well. Most cases of vocal pathology due to singing occur because the singer overburdens the voice for some time, and students who have developed the ability to recognize early signs of fatigue, cold, or hoarseness should be able to 'safely' experiment with 'heavier' genres.

I would also like to propose that such experimentation be limited to certain periods, leaving other periods free to hone other vocal expressions. I see it as the teacher's duty to mention to the 'searching' student that pursuing a professional singing career that combines vastly different genres might be a difficult path to follow. This is in stark contrast to Cross' (2008) recommendation that teachers prohibit any singing student to 'try out' different vocal expressions.

5.3.5. Girls and breathy voices

In my experience, it is common for classically trained women to have too large of an intercartilaginous gap (see page 62), in other words to sing in some kind of abducted chest

voice or, perhaps more frequently**,** abducted falsetto voice (Herbst, 2011). I am not sure what the reason for this is, but I speculate that it might be linked to the notion that girls' voices are naturally breathy, or have a leaky glottis, before maturing fully in their twenties. Singing teachers are often warned against trying to 'train away' this breathiness in young singers' voices because it is believed that it will go away naturally as they get older (Austin, 2012, p. 579). Additionally, to focus on the closing of the intercartilaginous gap, increases the risk of learning to sing in an exceedingly heavy or constrained manner. To my knowledge, aspiring singing teachers are not trained to distinguish between the sound of a naturally leaky voice and the sound of an open intercartilaginous gap, and thus it might be possible that there is a trend among singing teachers towards letting breathy voices due to intercartilaginous gaps pass as 'naturally' breathy voices. I understand it to be a case of 'better safe than sorry' and call for the development of helpful methods to distinguish these differences. I believe both classical and CCM teachers will make good use of such knowledge.

5.3.6. Nose breathing and possible benefits

As was seen in an earlier chapter, contractions of the CT muscles contribute during sniffing and inhalation when they are already in the abducted position (Behrman & Finan, 2018, p. 121). This may entail positive outcomes for the singer, as it is common for singing teachers to ask their students to 'breathe in through your nose as if you are smelling something good,' and perhaps there are more benefits to this sniffing than just the activation of the breathing system allowing a deep and expanding breath. The act of sniffing might help lower the larynx position[55] (Sundberg, 2001, p. 152), and I also wonder if voices in the need of CT strengthening might benefit from nose inhalation maneuvers in order to better sing in tune, as the CT muscle may be regarded as the number one pitch regulator. Perhaps the CT muscles are more readily activated in phonation tasks if they are contracted in a sniffing motion just before phonation starts? I did not come across this idea in the articles I read, but it may be that the matter is investigated in speech language studies. Nevertheless, I find it to be an interesting idea for further examination.

5.4. TECHNIQUE AS A TOOL, NOT A GOAL

Because the work on this thesis has focused on technical issues related to singing, I must make it clear beyond any doubt that in my opinion, singing technique is not the be-all and

[55] A low or lowered larynx position is upheld as a primary parameter for the classical or operatic sound (LeBorgne & Rosenberg, 2014, p. 104).

end-all for a singer. Rather, musicality and expression are. A student may have the worst technique ever heard (seen from a voice health perspective) and still touch me with the words conveyed by the voice. Sometimes the softest, most fragile voice may express the purest of feelings, moving me to tears. This does not mean, though, that I find technical work to be unimportant, but when it comes to moving people, a singer (be it a non-singer or a 'real' singer, if there is a difference) is at the mercy of his or her technique. One's acquired technique—or techniques—constitutes the pallet of colors one has to choose from, and the more colors there are available, the more variations may come to life in the performance. This means that any singer may be able to move the audience and 'make music,' but only the trained singer with a good mastery of singing technique may perform emotionally moving pieces of music day after day, even when not feeling up for it. Regardless of the level, technical work is a great tool for developing and expanding a singer's expressional palette, but when making music, singers should forget all about tongue position, larynx height, and registers (Hasund, 2012, p. 97; Svela, 2013, p. 25). As my interviewee Solveig said, "It will become art, and we are going to give people goosebumps."

The issues I have suggested in this thesis for further research (see for instance sections 5.1.1., 5.2., 5.3.5., & 5.3.6.) have characteristics of being smaller parts in a larger whole, namely the overarching topic of terminology and techniques in CCM singing, and the implementation of these in the singing studio. However, it is this, the last part about *what to teach our students*, that most of all sparks my curiosity, and here I find a large gap in the available literature. As a singing teacher, I call for more research on how scientifically based knowledge may be best implemented in the teachings of CCM singers, and especially request such knowledge regarding adolescents. This would truly be a large and important topic for further investigation, and would be of great relevance and interest for singing teachers and their students.

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APPENDIX

APPENDIX 1: APPROVAL FROM NSD

Sidsel Karlsen

2418 ELVERUM

Vår dato: 03.10.2017	Vår ref: 55657 / 3 / EPA	Deres dato:	Deres ref:

Tilbakemelding på melding om behandling av personopplysninger

Vi viser til melding om behandling av personopplysninger, mottatt 03.09.2017.
Meldingen gjelder prosjektet:

55657	*Ulike stemmefunksjoners anatomi og fysiologi - og anvendelsen av disse i sangundervisning*
Behandlingsansvarlig	*Høgskolen i Innlandet, ved institusjonens øverste leder*
Daglig ansvarlig	*Sidsel Karlsen*
Student	*Ingvild Vestfall*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database.

Personvernombudet vil ved prosjektets avslutning, 15.05.2018, rette en henvendelse angående status for behandlingen av personopplysninger.

Dersom noe er uklart ta gjerne kontakt over telefon.

Vennlig hilsen

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

NSD – Norsk senter for forskningsdata AS Harald Hårfagres gate 29 Tel: +47-55 58 21 17 nsd@nsd.no Org.nr. 985 321 884
NSD – Norwegian Centre for Research Data NO-5007 Bergen, NORWAY Faks: +47-55 58 96 50 www.nsd.no

Katrine Utaaker Segadal

Eva J

Kontaktperson: Eva J. B. .no
Vedlegg: Prosjektvurdering
Kopi:

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 55657

INFORMASJON OG SAMTYKKE
Utvalget (lærere/ansatte) informeres skriftlig og muntlig om prosjektet og samtykker til deltakelse. Informasjonsskrivet er godt utformet.

INFORMASJONSSIKKERHET
Personvernombudet legger til grunn at student/forsker etterfølger Høgskolen i Innlandet sine interne rutiner for datasikkerhet. Dersom personopplysninger skal lagres på mobile enheter, bør opplysningene krypteres tilstrekkelig.

PUBLISERING
Det oppgis at personopplysninger skal publiseres. Personvernombudet legger til grunn at det foreligger eksplisitt samtykke fra den enkelte til dette. Vi anbefaler at deltakerne gis anledning til å lese igjennom egne opplysninger og godkjenne disse før publisering.

DATABEHANDLER
I informasjonsskrivet står det at intervju via Skype/FaceTime er også mulig. Personvernombudet anbefaler at Skype (eller annen videokonferanseverktøy) ikke brukes, siden Skype vil da fungere som databehandler i prosjektet og det ikke er optimalt med tanke på konfidensialitet og informasjonssikkerhet. Data bør innhentes og lagres i systemer innenfor virksomhetens kontroll. Bruk av eventuell databehandler må avklares med Høgskolen i Innlandet. Institusjonen er ansvarlig for at personopplysningene behandles på en sikker måte gjennom hele prosessen.

PROSJEKTSLUTT OG ANONYMISERING
Forventet prosjektslutt er 15.05.2018. Ifølge prosjektmeldingen skal innsamlede opplysninger da anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres ved å:
- slette direkte personopplysninger (som navn/koblingsnøkkel)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted/arbeidssted, alder og kjønn)
- slette digitale lyd-/bilde- og videoopptak

APPENDIX 2: INFORMATION AND CONSENT LETTER

Forespørsel om deltakelse i forskningsprosjektet

"Ulike stemmefunksjoners anatomi og fysiologi – og anvendelsen av disse i sangundervisning"

Bakgrunn og formål
Formålet med studien er å undersøke hva stemmeforskningen kan fortelle oss om de fysiske forutsetningene i strupen for ulike typer fonasjon, og hvordan denne kunnskapen kan bidra til å fremme sunn stemmebruk. Jeg vil også undersøke hva sangpedagogers erfaringsbaserte kunnskap kan fortelle oss om undervisning av 15-20-åringer, der målet er at både sunn stemmebruk og fonasjon i tråd med aktuelle sjangerkrav ivaretas. Jeg vil ha fokus på fonasjonstyper som tradisjonelt sett ikke er mye brukt i klassisk sang, altså fonasjonstyper som vi kjenner igjen fra pop, rock, musikal etc.

Prosjektet er del av en mastergradsstudie ved Høgskolen i Innlandet, campus Hamar, avdeling for lærerutdanning og naturvitenskap.

På grunn av din arbeidserfaring, både med ulike sjangere, og med ungdom fra ca. 15-20 år forespørres du om å delta i denne undersøkelsen.

Hva innebærer deltakelse i studien?
Masterarbeidet vil i hovedsak dreie seg om en dokumentanalyse av artikler og annen litteratur som kan belyse første del av problemstillingen. For å belyse problemstillingens andre spørsmål vil jeg intervjue fire sangpedagoger som jobber med ungdom fra 15-20 år, fortrinnsvis på musikklinjer ved ulike videregående skoler fra forskjellige steder i landet. Intervjuene vil vare fra 1-2 timer, og gjennomføres der deltakerne ønsker, f.eks. på intervjudeltakerens arbeidsplass. Intervju via Skype/FaceTime er også mulig. Det vil gjøres lydopptak og eventuelt videoopptak av intervjuene, samt notater på papir eller bærbar datamaskin. Spørsmålene vil dreie seg om sangteknikk i sjangere som jazz, pop, rock og musikal, og intervjudeltakernes erfaringer med undervisning i dette. Det vil være et fokus på nevnte aldersgruppe og sunn stemmebruk.

Hva skjer med informasjonen om deg?
Alle personopplysninger vil bli behandlet konfidensielt.
Mens prosjektet pågår vil jeg og min veileder (Sidsel Karlsen) ha tilgang til personopplysningene og svarene som oppgis i forbindelse med intervjuene. For å ivareta konfidensialitet vil opptakene fra intervjuene lagres på studentens bærbare datamaskin, som er brukernavn- og passordbeskyttet, og koblingsnøkkelen (koblingen mellom personnavn og de fiktive navnene som benyttes) vil bli oppbevart separat fra selve datamaterialet. Koblingsnøkkelen blir beskyttet med passord, og det er kun studenten som vil ha tilgang til koblingsnøkkelen.

Så langt det er mulig vil deltakerne anonymiseres. Det vil brukes fiktive navn, og ingen geografisk tilknytning nevnes. Det vil imidlertid oppgis at informantene jobber i videregående skole, og deler av deres erfaringsgrunnlag kan være relevant å ha med i den endelige teksten.

Prosjektet skal etter planen avsluttes 15. mai 2018. Når prosjektet er avsluttet slettes alle lagrede opptak fra intervjuene, og datamateriale i form av transkripsjoner anonymiseres.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med Ingvild Vestfall på telefonnummer +47 [redacted]. Kontaktopplysninger til veileder Sidsel Karlsen: telefonnummer +47 [redacted].

Studien er meldt til Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS.

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta

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(Signert av prosjektdeltaker, dato)

APPENDIX 3: INTERVIEW GUIDE

To be mentioned in the beginning:

- I am not asking for conclusive answers, rather, I am interested in how you think about the topics. It is OK to answer "I don't know"☺
- It will continually be a focus on 15- to 20-year-old students.
- I am going to ask you about different phonation types/different types of vocalization. Before we start, would you like me to clarify what I mean by these terms?

---

1. Introduction

A. What is your professional background and education?
   a. Optional: Could you tell more about … part of your background/education? (if something in particular sparks my interest)

B. What is your current work situation?

C. What genres are you teaching?

D. **We are closing in on the topics of this interview:**
   a. Are you familiar with the following terms?

      Activator: The flow of breath

      Vibrator: The vibrating part of the instrument, the vocal folds

      Resonator: The space above the vocal folds and to the lips, where the sound is manipulated by vocal tract, tongue and so on.

   b. Focusing on the vibrator (and possibly the resonator), in your opinion, what is important to train in a young voice (15- to 20-year olds) singing other genres than classical?

2. Belting/metallic voice/overdrive/edge/chest-voice and so on.

Definition so far: The type of sound coming from a voice with long closing time (long closed quotient-time) and with a high sub-glottic pressure. Such phonation is often called belting, metallic voice, thick vocal folds, shouty voice, pressed and so on, and comes from other traditions than the classical tradition.

A. What terms do you prefer regarding this type of voice use?
B. What meaning do you embed in xxxx (the term they used)?
C. In your understanding, what happens in the larynx when one is singing like this?
D. How do you think this may be done, while still taking care of the voice?
E. What are the 'typical mistakes' people do when singing like this?

F. Would you like to tell me about how you work with the students so that they may *find* this way of using their voice?
G. How do you work to develop correct and healthy belting/metallic voice/overdrive/edge function/chest voice?
    a. CASE: You are teaching a 17-year-old female who wants to learn to sing stronger higher up in her range. Let us say that she masters most basic technique (posture, breath/support et cetera). Would you like to tell me how you proceed to further develop this type of voice use?
H. What do you think regarding possible differences in working with these issues in female versus male students?
I. When one sings this way, what issues should be especially considered when working with 15- to 20-year-olds?

3. Legit and neutral, possibly head-voice (*randregister*, in Norwegian)

Definition so far: In line with Hall (2014) is "the soprano or legit singing voice … most similar to classical singing except the color is brighter."

A. What terms do you prefer regarding this type of voice use?
B. What meaning do you embed in xxxx (the term they used)?
C. In your understanding, what happens in the larynx when one is singing like this? (legit, soprano, neutral, *randregister*, head-voice, CTD et cetera)
D. There are various types of 'schools' in Contemporary Commercial Music/*rhythmic singing*, such as CVT, EVT et cetera.
    a. To what extent would you say that legit/neutral (other term?) works just like *randregisteret*/head-voice the way this register is described in the classical voice literature?
    b. And what about legit versus neutral, to what extent are these equal?
E. Do you experience legit/neutral/*randregister*/head-voice as just one way of using the voice, or are there any variations within the term? Would you like to elaborate?
F. Would you like to tell me about how you work with the students so that they may *find* this way of using their voice?
G. And how do you work to further develop this type of voice use?
H. What do you think regarding possible differences in working with these issues in female versus male students?

I. When one sings this way, what issues should be especially considered when working with 15- to 20-year-olds?

4. Mixed voice, middle register, smoothing of the registers

A. What terms do you use on the various registers?

B. What is–in your understanding–a register transition?

   a. Do you use specific names on the different register transitions?

   b. To what degree do you work to bridge the register transitions, (and if yes) how do you do this?

   c. What phonation types (vocal functions) do you usually use when working on the smoothing of the registers?

C. And now, *mixed voice*, what is that?

   a. How would you characterize *mixed voice* in relation to the middle register?

   b. Would you like to tell me about possible differences and similarities between *mixed voice* and heavier belting/heavy belt?

   c. And mix compared to legit?

D. How do you work with your students to develop various types of mixed voice?

   a. Based on a mix that is TAD (thyro-arytenoid-dominant), how may this possibly be trained different than a CTD-mix (cricothyroid-dominant)?

   b. One may also talk about the terms chest-mix and head-mix, would you like to mention what you embed in these variants of mixed voice?

E. What do you think regarding possible differences in working with mixed voice or the middle register (for those that are not familiar with the term mixed voice) in female versus male students? (assuming that both are finished with the most challenging pubertal voice changes)

F. Thinking about mixed voice (or bridging of the registers if that works better in the context), what issues should be especially considered when working with 15- to 20-year-olds?

5. The relation between registers and phonation types

A. CASE: If a female sings C4–or H3 for that matter–soft and relaxed, what register would you say that she sings in? If she sings in belting/metallic voice (or the like) on the same note, would you say that she is in the same register with heightened volume, or in another register? Would you please explain/elaborate?

a. If she, still in the same area around middle C, sings with a timbre with ‘more space’ in flow phonation (like a good classical tone), but still quite strong, what register would you then say she sings in?
b. We get a similar issue like the one mentioned above when a female sings D5 in:
    i. Belting
    ii. Classical
    iii. ‘Neutral’ (meaning a light head-voice without typical classical adjustments)

    Would you then say that she is in one and the same register? Using different phonation types? Would you like to explain/elaborate?

B. To what degree is bridging/smoothing of the registers something else in belting/metallic voice than in classical?
C. According to your experience, are there special conditions that usually convey a positive or negative influence on how easy it is for the students to sing in various phonation types? (Keywords: generally good physical shape, how far they have developed their singing technique in other genres, the shape of their body (thin/muscular and so on), if they are typically altos or sopranos et cetera).

6. Warming up/cooling down

A. To what degree is a warm-up and cool-down a natural part of you teaching?
    a. A lot of things may be important in a warm-up, but focusing on the vibrating part of the instrument, would you like to share what you are emphasizing?
    b. How do you recommend a cool-down to be done?
B. In your experience, are there specific singing functions that need warming-up and cooling-down more than others, and if yes, why? (Keywords: a lot of belting versus singing in legit)
C. If we concentrate on well-trained voices, to what degree would you say that the requirements for warm-ups and cool-downs are similar or dissimilar for 15- to 20-year-olds compared to adults?

7. Vocal health

A. When the voice is not working as it usually does–either because of a cold, the voice has gotten tired because of excessive shouting for instance on a soccer game, a body

lacking energy after some hectic days for instance on a job in a shop–to what extent do you think that such conditions poses a risk for the singer's vocal health?

   a. What is the differences in the 'amount of risk' when one sings in one register compared to another?
   b. And when singing in another phonation type compared to another?

B. If one with a tired voice is not able to take a break, but have to use the voice in singing (for instance because of a concert, audition or the like), what advice do you give in relation to volume, choice of register and phonation types? (Keywords: transpose higher parts down an octave, sing with less volume et cetera)
   a. Do the same things have an effect either if one has a cold or has a tired voice, or should one do different things?

C. In your experience, are there certain student types or voice types that get tired more easily when singing in belting/metallic voice and the like, even when you are certain that they do it the right way? If yes, what types?
   a. Do you have any idea of why this is so?

D. Is it your impression that there are some student types or voice types that apparently 'never' get tired, even when they sing heavy metal/heavy belt and so on for a longer time? If yes, what types?
   a. What do you think may be the reason for this?

8. Final questions

   A. In your day-to-day-work with 15- to 20-year-olds, do you experience any challenges regarding various voice functions and the training of these, that we have not already talked about?
   B. Thinking of various types of phonation and the training of these, do you have any questions? (not to me, but more in general) If yes, what are they?
      a. Do you have any idea where you could find the answers to these questions?
   C. Thinking of various registers and smoothing of the register-breaks, do you have any questions on these topics? If yes, what are they?
      a. Do you have any idea where you could find the answers to these questions?
   D. Would you like to add anything else?

APPENDIX 4: INTERVJUGUIDE (IN NORWEGIAN)

Presiseres før intervjuet starter:

- Jeg er ikke ute etter en fasit, men interessert i hvordan deltakerne tenker og arbeider med de ulike temaene. Det er lov til å svare: 'Vet ikke'☺
- Det vil være et gjennomgående fokus på 15-20-åringer, altså elever i videregående skolealder
- Jeg kommer til å spørre en del om ulike fonasjonstyper/ulike typer 'vocalization'. Trengs det en avklaring rundt dette før vi starter?

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1. **Innledning**
   A. Hva er din faglige bakgrunn og utdannelse?
      a. Evt. Kan du utdype mer om ... delen (den delen jeg gjerne vil vite mer om) av utdannelsen/faglige bakgrunnen din?
   B. Hva er din arbeidssituasjon i dag?
   C. Hvilke sjangere underviser du i?
   D. **Vi nærmer oss temaet for intervjuet:**
      a) Du er kjent med: (?)

         Aktivator: den delen som fysisk setter i gang prosessen, altså pusteapparatet

         Vibrator: den delen av stemmeinstrumentet som skaper vibrasjonene, altså stemmeleppene

         Resonator: den delen som vibrasjonene 'reiser gjennom' på vei ut, altså resonansrommet

      b) Med fokus på **vibratoren** (og eventuelt resonatoren) hva tenker du det er viktig å trene i en ung stemme (15-20 år) som vil synge andre sjangere enn klassisk?

2. **Belting/metall/overdrive/edge, evt. Brystklang/bryststemme etc.**

Definisjon så langt: Stemmelyd som kommer av et tett stemmelukke med lang lukningstid (long closed quotient-time) og med et høyt subglottalt trykk. Slik fonasjon betegnes gjerne som belting, metall, tjukke stemmelepper, skriking, presset etc. og kommer fra andre tradisjoner enn den klassiske sangtradisjonen.

A. Hvilke begreper bruker du om denne typen stemmebruk?
B. Hva legger du i begrepet xxxxx (begrepet som nettopp ble nevnt)? (Kan være belting, metall, overdrive/edge, bryststemme osv.)

C. Slik du har forstått det, hva skjer i strupehodet når man synger som dette (belting, overdrive, TAD etc.)?
D. Hvordan tenker du at det går an å gjøre dette på en sunn måte?
E. Hva er de "typiske feilene" folk gjør når de synger slik?
F. Kan du fortelle litt om hvordan du jobber med elever for at de skal **finne** denne måten å bruke stemmen på?
G. Hvordan jobber dere for å **videreutvikle** riktig og sunn beltingfunksjon/metall-overdrive- edgefunksjon etc.?
    a. CASE: Du skal undervise ei jente på 17 år som gjerne vil lære å synge sterkere oppover i høyden. La oss si at det meste annet fungerer godt (holdning, pust/støtte etc.). Kan du si litt om hvordan du går fram for å trene eller videreutvikle denne typen stemmebruk?
H. Hva tenker du om eventuelle forskjeller når det gjelder å jobbe med dette hos gutter versus jenter?
I. Når man synger på denne måten, hvilke forhold mener du en bør huske spesielt på når en jobber med 15-20-åring?

3. Legit og nøytral, evt. Randregister/hodeklang

Ifølge Karen S. Hall (So you want to sing music theatre) er "the soprano or legit singing voice ... most similar to classical singing except the color is brighter" (Balog, 2005).

A. Hvilke begreper bruker du om denne typen stemmebruk?
B. Hva legger du i begrepet xxxxx (begrepet som nettopp ble nevnt)? (Kan være legit, sopran, nøytral, randregister, hodeklang etc.)
C. Slik du har forstått det, hva skjer i strupehodet når man synger som dette? (legit, sopran, nøytral, randregister, hodeklang, CTD etc.)
D. Det finnes ulike typer 'skoler' innenfor Contemporary Commersial Music/rytmisk sang, f.eks. CVT, Estill, musikalsjangeren generelt ('Broadwaybegreper/definisjoner').
    a. I hvilken grad vil du si at legit/nøytral (annet?) fungerer likt som 'randregisteret' (slik det beskrives i den klassiske sanglitteraturen)?
    b. Og hva med legit kontra nøytral, i hvilken grad kan man sette likhetstegn mellom disse?

E. Opplever du ‘legit’ sang/nøytral/randregisterfunksjonen som kun én konkret måte å bruke stemmen på, eller finnes det variasjoner innenfor begrepet? Kan du utdype?
F. Kan du si litt om hvordan du jobber med elever for at de skal **finne** denne funksjonen?
G. Og hvordan jobber dere for å **videreutvikle** denne typen stemmebruk?
H. Hva tenker du om eventuelle forskjeller når det gjelder å jobbe med dette hos gutter versus jenter?
I. Når man synger på denne måten, hvilke forhold mener du en bør huske spesielt på når en jobber med 15-20-åringer?

4. Mixed Voice, blandingsstemme, mellomregisteret etc. + registre og registerutjevning

A. Hvilke begreper bruker du om de ulike registrene?
B. Hva er – slik du har forstått det – egentlig en registerovergang?
    a. Bruker du spesifikke navn på de ulike registerovergangene?
    b. I hvilken grad jobber du med registerutjevning, og **hvordan** jobber du eventuelt med dette?
    c. Hvilke fonasjonstyper (stemmefunksjoner) brukes vanligvis i arbeidet med registerutjevning?
C. Og så kommer vi til ‘mixed voice’, hva er det?
    a. Hvordan vil du karakterisere ‘mixed voice’ i forhold til blandingsstemmen/ mellomregistret?
    b. Kan du si litt om forskjeller og likheter mellom ‘mixed voice’ og tyngre belting, såkalt ‘heavy belt’?
    c. Og ‘mixed voice’ i forhold til ‘legit’?
D. Hvordan jobber du med elever for å trene ulike typer ‘mixed voice’?
    a. Hvis vi tar utgangspunkt i en mix som er TAD (Thyro-Arytenoid-Dominant), eventuelt hvordan trenes denne annerledes enn en mix som er CTD (Cricothyroid-Dominant)?
    b. Det går også an å snakke om begrepene chest-mix og head-mix, kan du si litt om hva du legger i disse variantene av mix?
E. Hva tenker du om eventuelle forskjeller når det gjelder å jobbe med ‘mixed voice’ (eller mellomregisteret (for de som ikke kjenner så godt til ‘mixed voice’)) hos gutter versus jenter (forutsatt at begge kjønn er ferdig med stemmeskiftet)?

F. Med tanke på 'mixed voice' (eller reigsterblanding/-utjevning der det passer bedre), hvilke forhold mener du en bør huske spesielt på når en jobber med 15-20-åringer?

5. Koblingen mellom registre og fonasjonstyper

A. CASE: Dersom en jente synger c1 - eller lille h for den saks skyld - svakt og avspent, hvilket register mener du at hun da synger i? Dersom hun på den samme tonen synger sterkt i belting/metall el.l., tenker du da at hun er i samme register med økt styrke, eller et annet register? Kan du forklare?
    a. Dersom hun, fortsatt i området rundt c^1, synger med 'romsligere klang' i 'flow phonation' (god klassisk tone), men fortsatt relativt sterkt, hvilket register tenker du da at hun er i?
    b. Lignende problemstilling som nevnt ovenfor får vi også når en jente f.eks. synger d^2 i:
        i. belting
        ii. klassisk
        iii. 'nøytral' (lett randregisterfunksjon uten typiske 'klassiske' justeringer)

        Synger hun da i ett og samme register? I ulike fonasjonstyper? Kan du forklare?

B. I hvilken grad er registerutjevning noe annet innenfor belting/metall enn innenfor klassisk?

C. Er det forhold som etter din erfaring gjerne har en positiv eller negativ innvirkning på hvor lett elever har for å synge i eller med ulike fonasjonstyper? (Stikkord: generelt god fysisk form, hvor langt hun har kommet i den tekniske utviklingen innenfor andre sjangere, om hun er av spe/kraftig bygning, om hun har en typisk alt/sopranstemme, etc.)

6. Oppvarming/nedvarming

A. I hvilken grad er oppvarming og nedvarming en naturlig del av undervisningen din?
    a) Det er mye som kan være viktig i en oppvarming, men med fokus på vibratordelen av instrumentet, kan du si litt om hva du vektlegger?
    b) Hvordan anbefaler du at en nedvarming gjøres?

B. Er det etter din erfaring noen sangfunksjoner som krever oppvarming og nedvarming mer enn andre, og eventuelt hvorfor? (Stikkord: mye belting kontra legit sang)

C. Hvis vi snakker om trente stemmer, i hvilken grad vil du si at behovene for oppvarming og eventuelt nedvarming er like eller ulike for 15-20-åringer kontra voksne?

7. Stemmehelse

A. Når stemmen ikke fungerer som den vanligvis gjør, enten på grunn av forkjølelse, en sliten stemme etter roping på fotballkamp (overforbruk), sliten og "energifattig kropp" etter noen hektiske dager f.eks. i en butikkjobb - i hvilken grad tenker du at slike forhold utgjør en endret risiko for sangerens stemmehelse?
    a. Hvordan er eventuelt forskjellene i 'risikoen' ved å synge i et register kontra et annet?
    b. Og ved sang i en fonasjonstype kontra en annen?

B. Dersom en sliten stemme ikke kan ta helt pause, men må produsere stemmelyd (f.eks. konsert el.l.), hva slags råd gir du i forhold til volum, registervalg og fonasjonstyper? (Stikkord: oktavére lyse partier ned, synge med mindre volum, etc.)
    a. Er det de samme tingene som gjelder for en med forkjølelse, som for en med sliten stemme, eller er det ulike ting man bør gjøre?

C. Er det noen elevtyper eller stemmetyper som etter din erfaring lettere blir slitne av å synge i belting/metall el.l., selv om du er trygg på at de gjør det riktig? I så fall, hvilke?
    a. Har du noen idé om hvorfor det er slik?

D. Har du inntrykk av at det er noen elevtyper eller stemmetyper som tilsynelatende 'aldri' blir slitne av å synge selv tung metall/heavy belt el.l. over tid?
    a. Hva tror du dette kommer av?

8. Avslutning

A. I din arbeidshverdag med 15-20-åringer, opplever du noen utfordringer knyttet til ulike stemmefunksjoner og treningen av disse, som vi ikke har snakket om og som du vil trekke frem?

B. Med tanke på ulike typer fonasjon og treningen av disse, er det noe du lurer på? Hvis ja, hva?
    a. Har du noen tanker om hvor det kan finnes/hvem som kan ha informasjon om dette?

C. Med tanke på ulike registre og eventuelt registerutjevning, er det noe du lurer på? Hvis ja, hva?
    a. Har du noen tanker om hvor det kan finnes/hvem som kan ha informasjon om dette?
D. Annet du vil legge til?

APPENDIX 5: LIST OF ARTICLES AND BOOKS FOR THE DOCUMENT ANALYSIS

BOOKS

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