What exercises support the development of tongue flexibility in young singers for belting in Contemporary Commercial Music?

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COMPONENT 1: 1576 WORDS
COMPONENT 2: 6111 WORDS

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PORTFOLIO

Introduction

As a vocal coach working with students aged 10-12, I am developing practical ways to cultivate healthy, flexible voices. In response to student needs, my practice is evolving away from Western classical to contemporary commercial music (CCM) teaching (LoVetri & Weekly, 2003). In this context, sustainable belting is a challenge, especially for the tongue, which can interfere with resonance, reduce efficiency and cause strain (Bestebreurtje & Schutte, 2000; Sundberg & Thalen, 2015).

CCM pedagogy differs from classical education and requires distinct skills (Barrett, 2014; Edwards & Hoch, 2018), and translating tongue physiology into clear, age-appropriate teaching is difficult (Perrier et al., 2007). While research has shown the importance of tongue freedom for efficient phonation (Miller & Schutte, 2019; McCoy, 2014), there are few resources for young singers. This study fills that gap by developing pedagogical flashcards that provide concise cues and targeted exercises that encourage tongue flexibility in CCM belting for learners aged 10- 12.

Planned Programme of Study

<u>Theoretical Influence</u>

The study draws on theoretical frameworks linking tongue anatomy and motor learning to the development of belt quality in young singers. Biomechanical studies of tongue control and muscular movement (Perrier, Ma & Payan, 2017) underline the need to target specific tongue components in the flashcards. Research on tongue positioning and its effects on shape and resonance in the vocal tract informs the design of

exercises (Wolfe, Garnier & Smith, 2009; Miller & Schutte, 2019), as does research on belting (Bestebreurtje & Schutte, 2000). Studies of tongue movement and vocal output (Zhang, Jiang & Wang, 2017) enable a rich appreciation of the functional implications. Acoustic analyses of articulatory adjustments (Lindblom & Sundberg, 1971) are recognized but relegated to secondary consideration in order to ensure emphasis on tongue movement.

In this project, voice-focused research is prioritized, and speech studies are also examined to provide a broader picture of tongue function. Motor learning theory focuses on systematic practice in easy-to-measure units (Schmidt & Lee, 2011) and has influenced the design of the flashcard. The three-stage model of motor learning put forth by Fitts & Posner (1967) outlines why stepwise practice is necessary and why instructional material is used to support students' cognitive understanding, associative reinforcement, and eventual autonomous execution (Kim, Ritter & Koubek, 2013).

Best Practice Influences

The artifact is informed by research in vocal pedagogy integrating physiological awareness. Although CCM pedagogy provides various paths to tongue function (Table 1), this study focuses specifically on Andrew Byrne and Estill Voice Training (EVT).

Table 1: CCM Pedagogy Leaders and Tongue Function			
Pedagogue/Method	**Tongue Focus**	**Emphasis**	**Reference**
Andrew Byrne (*The Singing Athlete*, 2020)	Targeted tongue exercises, neurological drills	Brain-based training cues linking tongue control to functional	Byrne, 2020
Jeannette LoVetri (Somatic Voicework)	Sensory awareness, coordination with articulators	Integrates tongue awareness with resonance and stylistic tone	LoVetri, 2017
Matthew Edwards (CCM Vocal Pedagogy Institute)	Flexible tongue positioning is required for singing	Emphasize vowel clarity, registration balance, and expressive articulation	Edwards, 2017
Estill Voice Training (EVT)	Tongue control in 3 positions (low, middle, high)	Isolates tongue position as high, mid or low	Steinhauer, McDonald & Estill, 2017
Complete Vocal Technique (CVT, Cathrine Sadolin)	Tongue placement for specific vocal modes	Adjusts tongue to influence sound colour, articulation, and stylistic effects	Sadolin, 2000

I am currently doing Estill Certification (EMT), and most students in my studio already understand Estill principles; therefore, its structured approach to tongue control is a natural foundation for studio practice. Byrne's neurological approach also includes a number of multisensory cues can use to connect sensation with movement (Byrne, 2020). For young singers, there is a lack of tongue-specific resources available for their education. Somatic Voicework is more about functional outcomes and release-based phonation, but is not specific about tongue positioning (LoVetri, 2009). The specific

belting mechanics for specific techniques were therefore chosen over CVT for anatomical precision and the ability to recognize muscle body parts (tongue and jaw). Edwards also links Estill's high tongue configuration to resonant efficiency and F2 tuning relevant to belting (Edwards, 2014). Together, these frameworks inform the design of flashcards to support healthy belt development in young singers.

Methodological influences

The goal of this artifact is to aim for exercises for tongue freedom in healthy belting in young singers. As framed by Situated Knowledge (Haraway, 2013), the study acknowledges that knowledge is constructed through a dynamic process involving teacher skill, learner experience, and embodied practice, thereby situating the exercises in a context that makes them meaningful and relevant. Based on tongue biomechanics and muscular control (Perrier, Ma & Payan, 2007), as well as studies of tongue positioning, vocal tract shaping and resonance (Wolfe, Garnier & Smith, 2009; Miller & Schutte, 2019; Bestebreurtje & Schutte, 2000), targeted exercises are selected at various aspects of tongue function.

Motor learning theory (Schmidt & Lee, 2011) and Fitts and Posner's three-stage model (1967) are effective approaches to progressive repetition and evidence-based techniques that can be measured in young singers. Pedagogical approaches, including Andrew Byrne's tactile, brain-based prompting and Estill Voice Training's muscular isolation and consistent vocabulary, make the theory effective in practice. By addressing these gaps in current CCM pedagogy, this approach will ensure the artifact is evidence-based, pedagogically relevant, and age-appropriate for young singers comfortable exploring tongue flexibility in belting.

Reflective Framework

Gibb's reflective cycle (1988) will be used to reflect on the learning process of this project. The model was chosen because of its structured approach, which provides a clear framework for systematically examining experiences and evaluating the insights gained.

Aim

To develop accessible, evidence-informed pedagogy exercises for tongue flexibility in young CCM singers.

Objectives

1. Review and synthesize research on tongue function, vocal tract shaping, and belting in young singers.
2. Look at pedagogical approaches, including Estill Voice Training and Andrew Byrne's strategies, to identify effective methods and gaps.
3. Create a research-informed collection of tongue exercises based on vocal anatomy, CCM pedagogy, and motor learning principles that are age-appropriate and applicable for belting in young CCM singers.

Expected Learning Outcomes

1. Demonstrate knowledge of tongue anatomy and important tongue positions for belting. Measured by the ability to design exercises focusing on these positions.

2. Implement the three stages of motor learning in the design of flashcards, measurable by the progressive design of exercises to support skill acquisition and stepwise mastery.
3. Develop age-appropriate exercises to teach tongue flexibility for young singers, measurable by exercises and flashcards that are pedagogically focused and accessible for young singers to comprehend.

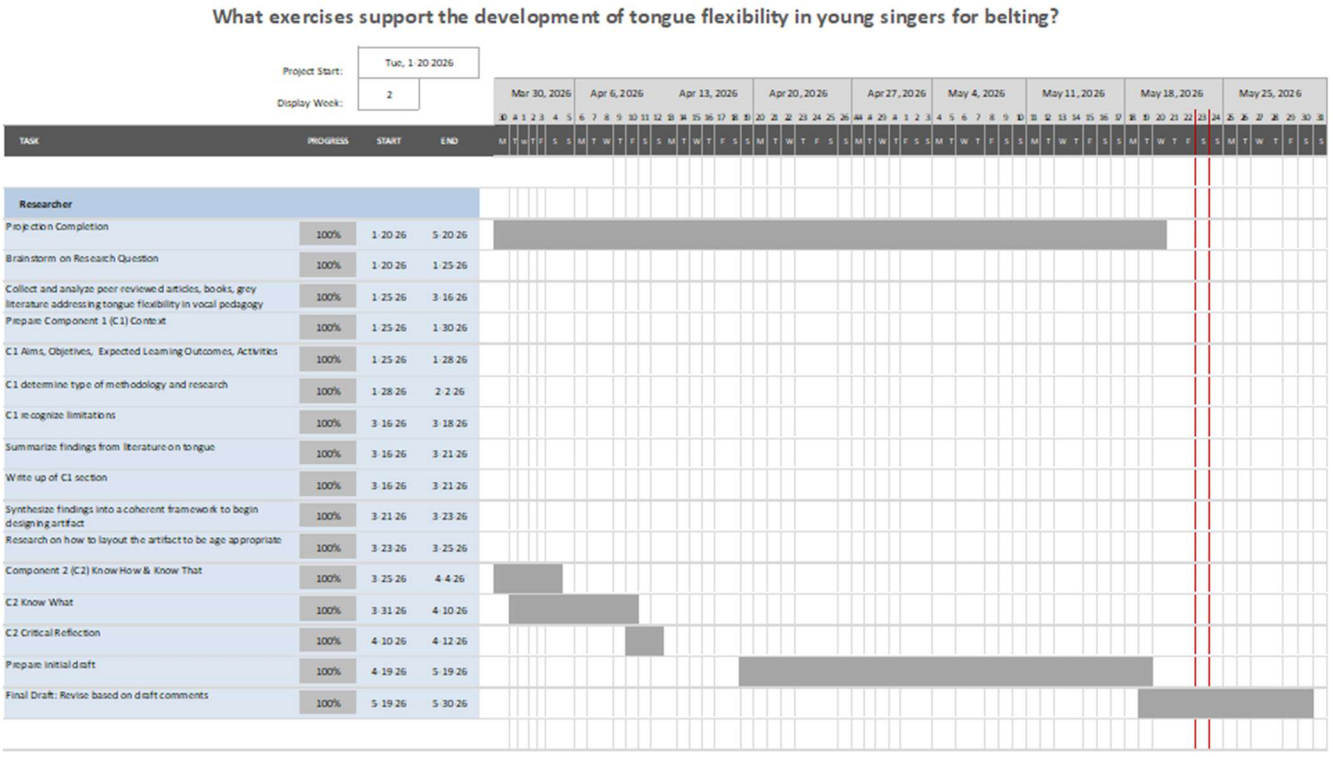
Activities and Assessment Criteria

Table 2: Activities and Assessment Criteria

Research Component	Tasks	Artifact	Assessment Criteria
Aim: To develop accessible, evidence-informed pedagogy exercises for tongue flexibility in young CCM singers.	Work on designing exercises focusing on tongue flexibility and independence	Flashcard exercises focusing on specific tongue muscles for flexibility	Review with tongue anatomy materials; check exercises are doable and possible for the age group
Objective 1: Review and synthesize research on tongue function, vocal tract shaping, and belting in young singers.	Conduct a review of the literature on the tongue	Synthesize findings into a table	Cross-check with information from other peer-reviewed literature
Objective 2: Look at pedagogical approaches, including Estill Voice Training and Andrew Byrne's strategies, to identify effective methods and gaps.	Compare Estill Voice Training and Andrew Byrne strategies; identify gaps	Compare the strategies amongst the different methods for tongue flexibility	Analyze and determine if the exercises are feasible for the targeted age
Objective 3: Create a research-informed collection of tongue exercises based on vocal anatomy, CCM pedagogy, and motor learning principles that are age-appropriate and applicable for belting in young CCM singers.	Design exercises based on the review of the literature	Design stepwise exercises that are multi-level.	Self-check as a teacher to determine if exercises are possible for the age group based on teaching experience.
Learning Outcome 1: Demonstrate knowledge of tongue anatomy and important tongue positions for belting.	Apply anatomical knowledge to exercise design	Exercises targeting key tongue positions for belting	Assessment of exercises against tongue anatomy materials

Measured by the ability to design exercises focusing on these positions.			
Learning Outcome 2: Implement the three stages of motor learning in the design of flashcards, as measured by the progressive design of exercises that support skill acquisition and stepwise mastery.	Structure exercises to support cognitive, associative, and autonomous stages	Flashcards organized progressively for stepwise skill acquisition	Compare exercises with Fitts & Posner stages
Learning Outcome 3: Develop age-appropriate exercises to teach tongue flexibility for young singers, measurable by exercises and flashcards that are pedagogically focused and accessible for young singers to comprehend.	Check exercises are accessible, engaging, and pedagogically effective	Flashcards with visual, tactile, and gamified elements	Review and self-assessment against criteria for age-appropriateness

Timeline



Methodology

This study is based on practice-based research (PaR) methodology, in which the design of a pedagogical flashcard artifact serves as both the key research method and the intended outcome. Robin Nelson (2022) views PaR as a form of inquiry in which creative practice itself is evidence (Nelson, 2022). The study is based on practice-based research epistemology, which considers knowledge made through creative practice, reflection and embodied action, as well as abstract theory and reflection. Through making, reflecting, and evaluating, insights are created that inform the artifact's development (Candy & Edmonds, 2018).

Based on a narrative review, the literature was synthesized to provide an interpretive view of tongue anatomy and its effect on voice, including how muscular control shapes resonance and belting quality (Sukhera, 2022). A snowballing method was used to follow references from the research to identify other relevant research not reported in standard research (Contandriopoulos et al., 2010). These led to the design of the flashcard, which builds the artifact from current evidence and makes it relevant to the studio. The artifact is then a process in which the creation and maintenance of flashcards are considered a series of research and practice (Nelson, 2022).

One key aspect of the idea is that it is a constant process of creation, reflection, and writing, in which reflection serves as critical feedback. According to Frisk and Österjö (Nelson, 2022), every pedagogical intervention prompts critical reflection on the product, the practice, and, hence, the process of its creation. This developmental cycle makes the artifact flexible rather than fixed (Smith, 2009). The design of the flashcards for tongue function in belting was based on voice science and motor learning theory and

was later refined through reflective testing. Each card brings specific physical instruction into visible vocal performance for young singers. This process continued in a reflexive journal throughout the study.

Reflexivity is an embodied, introspective practice (Sanders-Butsle, 2020). In reflection on my experiences as a singer and teacher, I find that this artifact has improved in clarity, accessibility, and effectiveness. Reflexivity, which is not only the process of producing knowledge but also reflective documentation, enables knowledge to emerge through creative practice rather than production (Ross, 2022). McCaffrey and Edwards (2015) also portray reflexivity as a continuous, iterative research process. Such reflection can also assist in questioning pedagogical assumptions about tongue relaxation, positioning, and belting in young singers (Ross, 2022).

Literature Search and Selection Strategy

Search terms are included in Table 3.

Table 3: Search Terminology in Review of Literature

Search Terms	Tongue in singing Tongue in belting Tongue position in singing Tongue in CCM Tongue muscles in singing Voice pedagogy of tongue Tongue anatomy in singing
	Tongue AND Contemporary Commercial Music Tongue position AND CCM “tongue” AND (“belting” OR “CCM”)

	"belting" AND ("tongue" OR "tongue position") "CCM" AND "tongue" "Contemporary Commercial Music" AND "tongue" AND "belt" ("CCM" AND "pedagogy") AND ("tongue") AND "(music education" OR "voice study" OR "vocal pedagogy) "Contemporary Commercial Music" AND ("pedagogy" OR "strategies")
Academic Databases	Google Scholar Jstor Library of UWTSD
Inclusion Criteria	Publications from 2000 to present. English-language publications. Studies focus on tongue, CCM and belting Research examining vocal pedagogy with relevance to tongue and CCM. Peer-reviewed journal articles, scholarly articles and vocal pedagogy text.
Exclusion	Sources mention tongue and CCM in passing without meaningful engagement with the research question. Non-scholarly web articles, opinion blogs, or informal teaching materials. Publications that are older than 1999 unless relevant to my research question and no further updated existing literature on the same topic.

Studies were included if they (a) examined the tongue in singing or speech, (b) included human participants, (c) were published in English and (d) were at least published after 2000. Titles and abstracts were reviewed in line with these criteria. Peer-reviewed studies were selected for their rigour and credibility (Kelly et al., 2014). To broaden the field and fill gaps in the literature, selected grey literature from established voice pedagogues was also used to find practical strategies for tongue work in CCM contexts. This was particularly important in light of limited peer-reviewed guidance on applied teaching methods for young CCM singers. Therefore, practitioner knowledge is

a key component of evidence-based voice pedagogy and offers applied insights grounded in studio experience (Bozeman & Ragan, 2022).

Limitations

The literature regarding vocal physiology and acoustics was quite technical. My role as a vocal teacher without extensive formal training in voice science may have influenced how the findings were understood and presented. However, the information I have concluded is based on studies supporting a similar point, as well as practical applications from vocal pedagogues. In addition, the chosen methodology has limitations, namely the absence of learner testing. Due to the project's timeline and framework, testing with students will be a future consideration.

PROJECT REPORT

Introduction

As a vocal educator of 10- to 12-year-olds moving towards incorporating Contemporary Commercial Music (CCM) (LoVetri & Weekly, 2003) alongside Western Classical training, I am trying to learn more to better cater to these students' current interests and needs. In teaching, my students often report that tension in their tongues impedes a comfortable belting approach, and they complain that when they try to belt, their tongues feel odd or uncomfortable. These findings parallel those in voice science, where the direct influence of tongue position and muscular tension is shown to shape the vocal tract and the overall ease of phonation (Sundberg & Thalen, 2015). Although it is well acknowledged that the tongue plays an important role in efficient singing, the literature largely focuses on complex anatomical and physiological mechanisms, making the translation of theory into actionable strategies for young singers challenging (Hermant et al., 2017; Bryne, 2020). Thus, based on student feedback, there is a need to design pedagogically age-appropriate exercises that target tongue flexibility.

Data from motor learning studies indicate that systematic, focused exercise paired with immediate sensory input facilitates skill learning in children, enabling accurate articulatory precision and control (Schmidt & Lee, 2025). Pedagogical approaches, including Estill Voice Training (EVT), offer techniques for distinct regulation of the tongue and jaw to reduce tension (Steinhauer, McDonald & Estill, 2017), although age-appropriate resources designed for younger CCM singers are in short supply (Edwards, 2014). To bridge this gap, this study aims to create a toolbox of pedagogical flashcards to isolate and reinforce the tongue movements required for belt production

for young learners. The artifact, by drawing on evidence from voice science, motor learning, and CCM pedagogy, provides actionable strategies to improve both teaching effectiveness and students' embodied understanding.

Review

Know How

Literature emphasizes that belting in CCM is not characterized by a single universal position for the tongue (Lim et al., 2019; Rudisch et al., 2025). Rather, it is suggested that a flexible tongue posture fosters sustained resonance tuning and vowel adjustment in pitch and intensity changes (Bestebreurtje & Schutte, 2000; Sundberg, Thalen & Popeil, 2012). The literature has also evidenced that vowel-dependent tongue adjustments are important to both acoustic efficiency and vocal health in belting (Herbst, Story & Meyer, 2023). These findings suggest, taken together, that tongue flexibility is required for belting.

A review of the literature indicates that studies on belting (Miles & Hollien, 1990; Bestebreurtje & Schutte, 2000; Sundberg, Thalen & Popeil, 2012) investigate resonance characteristics and vocal tract shape but make no reference to specific tongue position. Schutte & Miller (1993) comment on the tongue in passing as an element that impacts vocal tract shape, but make no specific comment on the tongue position. The main literature in voice science that includes the tongue on belting is Estill (1988), which includes an analysis of the genioglossus muscle of the tongue. In addition, Estill's recipe for belt quality includes a description of the tongue being in a high position (Steinhauer, McDonald & Estill, 2017). The tongue is taught to be in three positions (high, mid, and low) in the Estill Voice Training (EVT) method (Steinhauer, McDonald, &

Estill, 2017). Thus, the exercises in the artifact are inspired by EVT tongue-position training.

Importance of the Tongue

The tongue structure, without bones or joints (Sanders & Mu, 2013), serves as an anatomical role in swallowing (Stone et al., 2018) and a key articulator in speech or singing (Stone et al., 2018), structurally integrating into the laryngeal system via the hyoid bone and associated suprahyoid and infrahyoid muscles (Perrier et al., 2000). This anatomical connection, coupled with cross-muscular tension, can affect laryngeal posture and, in turn, overall vocal function (Perrier et al., 2000). Thus, this suggests tongue flexibility is not an isolated articulatory concern but a fundamental aspect of vocal production. This relationship is particularly important in CCM belting, where elevated subglottal pressure, heightened acoustic demands and increased muscular engagement require efficient vocal tract adjustments (Perrier et al., 2000).

The literature consistently identifies the tongue as an integral part of vocal efficiency. LeFevre (2011) argues that excessive tongue tension may pull the larynx into a position too high or too low, while Koufman et al. (1996) associate supraglottic hyperfunction with compensatory muscular behaviour that impacts laryngeal configuration. These studies suggest that exercises that promote tongue flexibility may reduce unnecessary extrinsic muscular tension during belting. However, the literature rarely identifies specific tongue exercises. Instead, the literature acknowledges the negative consequences of tongue rigidity and implies the need for tongue-flexibility exercises.

Tongue tension has also been implicated in interference with natural vibrato production (Hsiao et al., 1994) and compensatory jaw and neck tension (Stavness et al., 2013). These findings are particularly relevant to belting, since the style already demands considerable muscular engagement; consequently, unnecessary tongue rigidity intensifies global tension in the vocal tract, leading to vocal inefficiency. This influenced the design of the various difficulty levels in the exercise in Figures 1 and 2.

Figure 1 At the apprentice level, the learner focuses on controlling the genioglossus muscle and stabilizing the tongue tip with the superior longitudinal muscle for "th" vs "t" (Sanders & Mu, 2013).

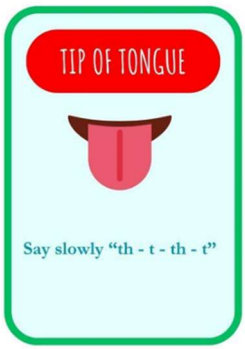
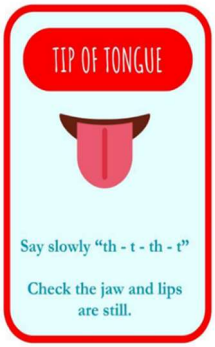


Figure 2 Upon security in this articulatory training exercise, improving tongue positioning (Bressman et al., 2016), the master level of this task invites the learner to check that the jaw and lips are still.

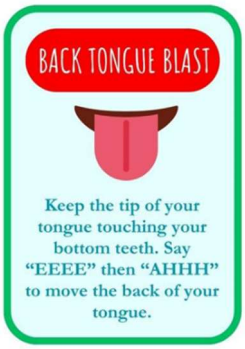


The master level is influenced by Stavness et al. (2013), who suggest that compensatory jaw tension is often associated with tongue tension. The reminder to gently hug the chin brings awareness to the jaw (Namasivayam & et al., 2018) and reminds the learner to be mindful of the independence between the tongue and jaw. Similarly, the exercise "Tongue Zone Mission" (Appendix B) singing on la, ya, ga with a still jaw focuses on this isolation between tongue and jaw.

From an acoustic perspective, the literature supports the need for training in tongue flexibility. Titze, Maxfield, and Walker (2017) explain that tongue positioning changes oral and pharyngeal orientation, thereby affecting resonance within the vocal

tract. Similarly, Lee, Shaiman and Weismer (2016) show that tongue position affects first and second formants, which are critical for vowel modification and resonance tuning. This study supported the development of Figure 3.

Figure 3 Exercise with /i/, engaging the styloglossus muscle, then /a/, using more of the hyoglossus muscle, to move the back of the tongue while the tip stays at the bottom of the lower teeth. Students are changing the vowel with the tongue with the intention to keep the tip at the bottom of the teeth, demanding focused control of the superior longitudinal muscle (Sanders & Mu, 2013)



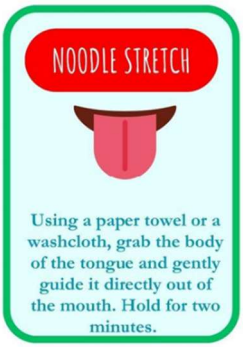
A similar exercise is conducted by Brendan Houdek, a certified speech-language pathologist with experience in singing and voice impression (New York Vocal Coaching, 2019, 2:40). These findings, in combination, provide the answer to the research question, as they suggest that the ability to belt can be achieved through exercises to develop flexible and responsive tongue coordination.

Biomechanical Coupling

The tongue is also connected to the larynx via the hyoid bone and its associated extrinsic musculature (Balata et al., 2012). Over-tension in the tongue root can lead to supraglottic constriction and localization changes in the laryngeal muscles, thus diminishing phonation performance (Roy, Ford & Bless, 1996; Lovetri, Lesh & Woo, 1999; Van Houtte et al., 2011). Greater stress in the tongue root may affect vocal fold

motion and resonance balance during singing (Ribeiro et al., 2025). These findings are therefore of influence for exercises to encourage tongue release (Figure 4).

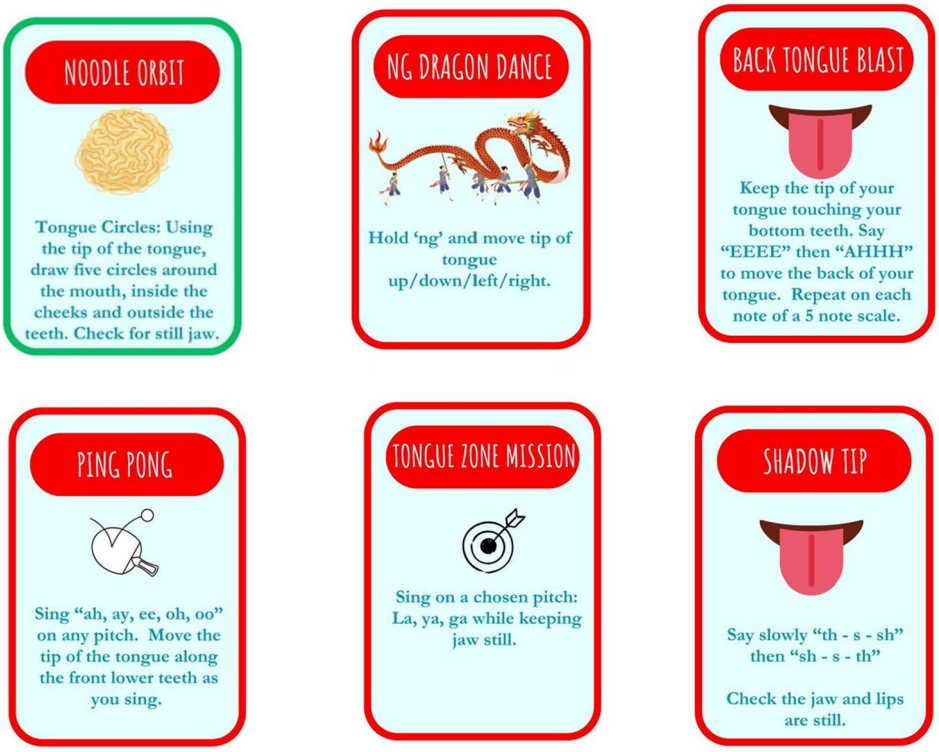
Figure 4 Exercise to target this tongue-root release. This exercise is used by pedagogue Andrew Bryne (Bryne, 2020) and speech pathologist Hwang et al. (2019) to maintain a healthy tongue (Kappert et al., 2021).



Tongue tension is associated with overactivation of the jaw and cervical muscles (Koufman & Blalock, 1991) and is therefore associated with muscle tension dysphonia during dysphonia. This is especially relevant for belting, since singers may compensate for acoustic or technical difficulties by recruiting greater muscular effort and unintentionally increasing tongue rigidity. Taken together, these results suggest that exercises to improve tongue flexibility should consider surrounding muscle coordination, as reflected in the exercises in Figure 5.

Although the literature does not consistently identify a single superior exercise method, it collectively supports the use of tongue stretches, tongue-release drills and

Figure 5 Exercises promoting independence between tongue, jaw and neck to help reduce compensatory tension patterns that interfere with resonance and vocal freedom.



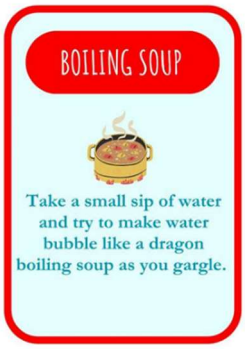
articulation-based coordination tasks as strategies to improve functional flexibility in CCM singers, as illustrated in Figure 5.

Optimal Tongue Position

Optimal tongue position is usually seen as neither rigid nor absolute, but there is no specific terminology or literature to support this. In the context of CCM, positioning of the tongue in belting is often seen as more flexible than fixed but also more vowel-sensitive in tone and vowel (Lim et al., 2019; Rudisch et al., 2025). No specific tongue position is defined for belting (Lim et al., 2019; Rudisch et al., 2025), but acoustic studies show that the best belting techniques are resonance tuning (Echternach et al., 2010) and vowel selection and tuning of the supraglottic position of the underlying vowel

position (Herbst, Story & Meyer, 2023). This implies that the best way to create CCM is not to constrain the tongue to move forward, and that the tongue root and the tongue root rear need to be flexible (Herbst, Story & Meyer, 2023) to avoid tongue root and pharyngeal retraction. This literature led to the development of Figure 6.

Figure 6 Exercise engaging a gargle. The gargle engages the hyoglossus muscle to pull the tongue downward and backward while the styloglossus pulls the tongue upward and backward during the gargle (Sanders & Mu, 2013). This focuses on the back of the tongue rather than the tip. The palatoglossus is engaged to keep the soft palate active and preventing water from entering the nose. The bubbling and vibration of the gargle provide stronger feedback to help learner improve awareness of the back of the tongue (Nip et al., 2023).



Gargling has been less studied in the peer-reviewed literature. However, it is logical to see the benefits of gargling, which adds vibration to the pharynx and oral cavity, increasing awareness of how far back the tongue root extends, as Loucks and Luc (2001) observed in their study of how vibration increases proprioceptive awareness. Through this exercise, students can gain a clearer map of their tongue to assist with tongue flexibility.

Know That

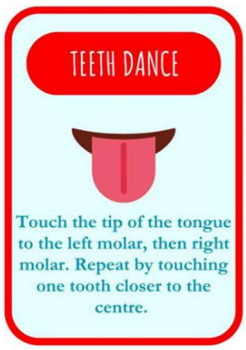
A set of flashcard exercises (Appendix B) was designed to help young learners aged 10-12 develop their relationship with the tongue in singing. Saltzman & Munhall (1989) identified the tongue's anatomy as comprising four intrinsic and four extrinsic muscles and described their roles in generating sounds. These flashcards are designed

to identify and target specific muscles by showing how each works. Appendix A describes each exercise, the targeted muscle, and research from voice science or speech pathology influencing the makeup of each exercise.

Fitts and Posner's (1967) three-stage model of motor learning (i.e., cognitive, associative, and autonomous) is a useful model for exercises involving the tongue. The model suggests that learning these skills begins with conscious movement, continues with practice and feedback, and eventually becomes automatic. In this regard, flashcard training is for the early cognitive stage, as the learner needs to understand tongue mapping more clearly.

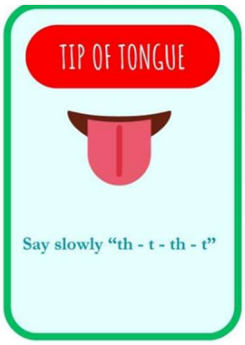
On the cognitive level, learners are oriented to what to do, not to how to do it effectively (Salehi et al., 2021). For young singers, flashcards that describe articulatory parameters, such as tongue positions, serve as external scaffolding that makes the subject less complex (Gibbons, 2002). In addition to strengthening the superior longitudinal muscle, exercise helps the human brain learn the tongue's extreme parameters within the mouth. At this point, the learners primarily rely on visual and verbal instructions to form an initial internal picture of the tongue's position in the mouth and its movements (Salehi et al., 2021). Thus, the exercise in Figure 7 is designed with instructions to guide a learner in understanding how the tongue's parameters are

Figure 7 Exercise focusing on tongue articulatory parameters



mapped by touching the outer limits of the different tooth spaces in the mouth. Motor learning literature suggests that early performance is characterized by marked cognitive load and frequent errors arising from immature sensorimotor mappings (Schmidt and Lee, 2011). Thus, the importance of having a teacher to guide the learner through the exercises. Flashcards, from a cognitive-organizer perspective, can help reduce ambiguity and make complex vocal-tract behaviour easier to navigate. This is in line with Cognitive Load Theory (CLT) (Sweller, van Merriënboer and Paas, 2019), which advocates learning in small units. For instance, Figure 8 isolates anterior tongue placement at the roof of the mouth and narrows the attentional target to the tip of the tongue.

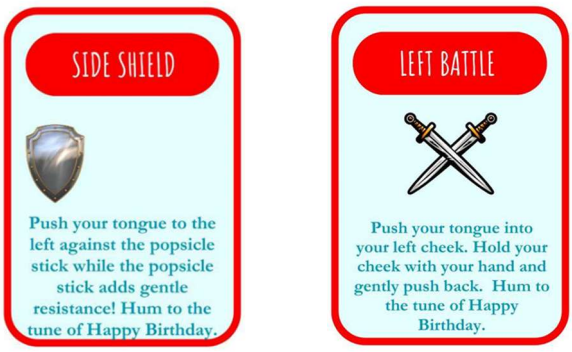
Figure 8 Targeted tongue exercise on the tip of the tongue to lessen cognitive load



As with CLT, this task minimizes the cognitive load of matching multiple tongue regions simultaneously and focuses on the tip of the tongue as the user produces the ‘th’ and ‘t’ sounds. This approach is crucial in voice teaching, where learners often struggle to separate articulation from pitch as they work on their voices, as I have found in my practice. The artifact allows tongue mapping awareness to develop gradually by externalizing articulatory targets as visual representations. Although there is no concrete evidence linking tongue mapping to singing outcomes, the vocal pedagogy literature suggests that articulation awareness is associated with increased singing efficiency (Byrne, 2020).

In the associative phase, motor patterns are learned and gradually refined through repeated practice and error correction (Le Pelley, 2004). It is when auditory and fine motor feedback (i.e., aural, proprioceptive, and tactile) are more in line with one another that the accuracy and effectiveness of tongue movements can improve. Repeating the flashcard drills for specific tongue muscles helps to stabilize these (Lage et al., 2015). Research in motor learning indicates that skilled performance results from repeated, sequential execution of movements and that this process consolidates an underlying motor skill that can be demonstrated (Schmidt and Lee, 2011). This learning

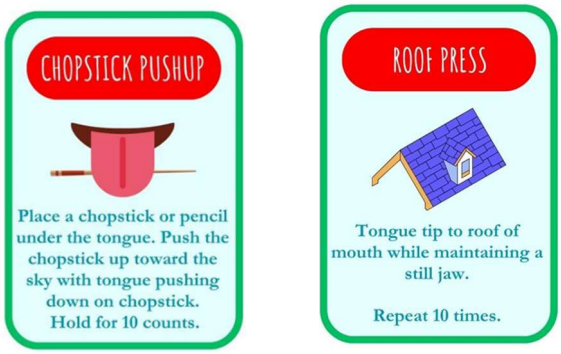
Figure 9 Exercises that both focus on the right side of the genioglossus muscle contraction, demonstrating repetition of drills through different exercises



emphasis influenced the design of the drills and the integration of repetition across them. Figure 9 demonstrates two different drills targeting the same muscle motion.

Beyond repetition, the structured variability that flashcards allow, as demonstrated in Figure 10, requires ongoing reconfiguration of tongue-mapping on the part of the learner (Byrne, 2020). This aligns with studies indicating that repeated reconstruction of movement plans in the brain leads to better retention and transfer through variable practice (Czyż et al., 2024).

Figure 10 Exercises demonstrating structured variability with Chopstick Push-up targeting the inferior longitudinal muscle and Roof Press focusing on the superior longitudinal muscle



Using flashcards across a variety of learning environments may provide more spaced retrieval practice (Roediger et al., 2006) and greater contextual variation, both of which are known to enhance long-term retention and recall (Cepeda et al., 2006). Flashcards are used not only for in-session instruction but also as portable learning signals relevant to our daily learning environment and practice beyond the classroom.

In the associative phase, self-monitoring and instructor correction are more important (Salehi et al., 2021). Repeatedly learning cues in each session and making small adjustments to these cues helps learners recognize differences in tongue

movements (Proteau et al., 1992). This method expands the ability to identify internal errors, which is essential for learning motor skills (Seidler et al., 2013). There is also evidence that self-correction and reduced reliance on external feedback are important for learning and transfer (He et al., 2025). Thus, flashcards help learners move from externally directed performance to internal tongue control.

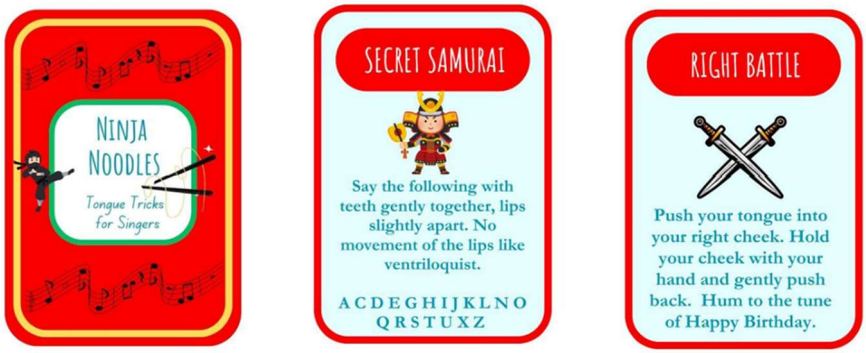
In the autonomous stage, movements are very efficient and require minimal conscious attention (Salehi et al., 2021). Gestures that require conscious cognitive control are already embedded into fluid vocal production and free up time to perform in a musical form. The development of this stage is supported by repeated exposure to structured exercises and the use of flashcards. The tongue-training artifact was developed to support Fitts and Posner's (1967) motor learning model.

For the cognitive stage, flashcards act as scaffolding for articulatory awareness; for the associative stage, where practice, feedback, and variability are built up; and for the autonomous stage, where efficient motor patterns are automatically learned. This evolution of flashcards in vocal teaching suggests that theoretical models of skill learning can be linked to real-world strategies for tongue control.

In addition to motor learning, the flashcards are designed as fun, themed games for young children in the 10-to 12-year-old group (Figure 11). I also included a Ninja Noodles theme to help the learner engage with the game and be more animated. As research has shown, fantasy-based (Habgood et al., 2005; Zuo et al., 2022), game-like

learning environments (Jackson & McNamara, 2013) can enhance participation and motivation in the task (Nand et al., 2019; David & Weinstein, 2023).

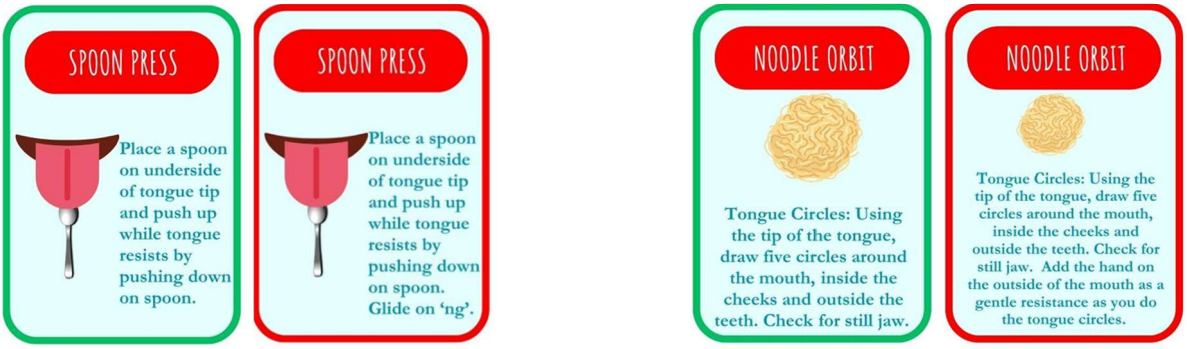
Figure 11 Example of the Ninja Noodles theme used within the activity. Learners progressed through a series of ninja-themed missions and battles against samurai characters, creating an engaging context for repeated practice of the target skill.



Visual elements are designed to minimize cognitive load and maximize engagement by being clear (Norman, 2013), relevant (Schnotz & Kürschner, 2007), and free of distracting details (Mayer, 2014), which help learners focus their cognitive resources on processing the targeted material (Mayer & Moreno, 2003). Within this framework, Ninja-themed flashcards are not only educational scaffolds but also motivational tools (Deci & Ryan, 2012) that promote the enjoyable repetition of tongue movements.

The flashcards are also designed to progress through mastery levels (Apprentice and Master) to help the learner develop skills incrementally and support motivation to learn (Figure 12).

Figure 12 Flashcards showing progression across levels for the same target skill, with an Apprentice level (green) and a Master level (red) to reflect increasing difficulty and skill development.



The design is consistent with gamification research (Hamari et al., 2014; Mekler et al., 2017) that staged progression systems (Ericsson et al., 1993) such as levels and mastery hierarchies can foster and sustain learners in that they achieve short-term targets and clearly defined goals and criteria for them (Imran, 2023; Tahir, Mitrovic, & Sotardi, 2022). There is clear evidence that such a system is more effective when progression is based on perceived skill growth rather than rewards (Imran, 2022). Graded levels are also linked to learners' motivation, as they create realistic achievement milestones that learners can meet and continue with the activities (Imran, 2022). In tongue-training, graded progress will therefore continue to encourage the learner to engage in iterative articulatory practice, and the difficulty of challenges might be aligned with learners' skill levels. In addition, if gamification is overvalued or detached from real skill acquisition (Hanus & Fox, 2015), skill development will be adversely affected. Thus, the artifact includes only two levels, with apprentice tasks designed as single-task challenges on each flashcard to keep the activities manageable and avoid overwhelming the learner.

Although Fitts and Posner's (1967) three-stage model of learning provides a useful framework for understanding skill acquisition in pedagogy, its application to fine articulatory control in CCM belting requires several assumptions. The model was originally developed from research on gross motor tasks and limb-based movement behaviours (Schmidt et al., 2018). Applying the framework to singing, therefore, assumes that vocal behaviours progress through comparable stages despite the substantially different physiological and sensory demands of limb and vocal tract movements.

Know What

What?

The construction of tongue flashcards has several important implications for applying motor learning theory to vocal pedagogy. As supported by CLT, reducing the number of concurrent demands on learners helps the focus on specific articulatory targets, at least in the early stages (Sweller, van Merriënboer and Paas, 2019). Thus, the design of multiple levels in the artifact (Figure 13) is to meet the varied development stages found within the 10-12 age group. Based on my experience, some students are

Figure 13 Flashcards showing two levels of the same targeted skill, with the Apprentice level (green) focusing on correct tongue placement and the Master level (red) extending the task to more advanced application, including phonation.



still consolidating basic pitch matching while others are ready for more refined control of tone with the tongue. Offering layered tasks in the design of the artifact (apprentice- and master-level) allows a broad range of learners to succeed while still being appropriately challenged (Tomlinson, 2014).

Evidence from speech and voice research suggests that non-speech oral-motor exercises have little impact on functional speech outcomes, which contrasts with my initial belief that flashcard-based drills could be useful for singing development (Parra-López et al., 2022). And singing development is a matter of auditory-motor integration, whereby pitch and tone are tuned with continuous listening and feedback rather than through one-off articulatory exercises (Keough & Jones, 2009; Pfordresher & Dalla Bella, 2011). This made me reassess my teaching approach to voice and why flashcards alone were not enough to enhance singing skills. Instead, they had to be repositioned as short prompts within sound-based teaching to ensure that visual cues are translated into sung responses in a very short time (Keough & Jones, 2009).

So What?

Tongue is visible

In vocal teaching, the vocal mechanism is largely hidden from direct view, and learners are unable to draw on external feedback while singing in the way others might (Tremblay, Shiller & Ostry, 2003). In contrast, articulators such as tongue movement can be externally visible through mirror work, providing learners with more sensory feedback to support motor learning (Katz & Mehta, 2015). Studies of speech motor control show that visual feedback for articulatory movement can improve the accuracy of tongue

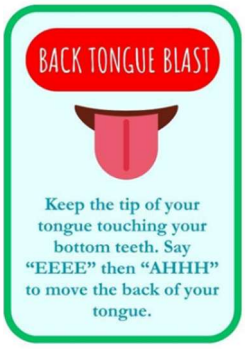
placement and sound acquisition by enhancing sensorimotor integration and error correction (Tremblay, Shiller & Ostry, 2003; Katz & Mehta, 2015). More broadly, multimodal speech learning research has shown that adding visual input to internally guided speech learning can enhance learning by improving motion calibration and formation of more stable articulatory targets (Guenther, 2016; Katz & Mehta, 2015).

In practice, this has important implications for vocal teaching with young learners. Children struggle to internalize abstract proprioceptive signals as sensorimotor mappings are still forming (Tremblay, Shiller & Ostry, 2003; Guenther, 2016). Visual feedback from a mirror on the tongue can help identify errors and improve tongue placement (Katz & Mehta, 2015). This externalization movement through visual feedback is particularly helpful in voice teaching because it allows an otherwise invisible portion of the vocal system to be seen and thus easier to understand (Barbier et al., 2021). Since articulation, resonance and phonation are all part of the same vocal system, even slight changes in tongue position can affect tone and clarity (Sundberg, 2003). Research on oral speech motor control supports the concept that visual access to articulatory movement can enhance motor learning by making internal processes more concrete and easier to improve (Tremblay, Shiller & Ostry, 2003; Guenther, 2016). For students, this transforms an abstract system into something they can see, adjust, internalize in practice, and develop.

In the voice studio, the tongue can be a useful entry point to explain an otherwise internal system at work. With an understanding of vocal anatomy from the literature review above, the teacher can indirectly influence laryngeal position through the tongue. For the belt quality of CCM singing with a brighter belt, it would be more comfortable to

raise the root of the tongue through the exercise in Figure 14 for a /i/ vowel, and therefore a higher larynx position since the vocal tract is coupled (Titze, 2008). This more forward tongue position is preferred and is very prevalent in belt qualities (Bourne & Garnier, 2012; Steinhauer, McDonald & Estill, 2017). The Estill voice method also promotes a high larynx position for the belt quality (Steinhauer, McDonald & Estill, 2017), which a higher tongue position can encourage (Hosbach-Cannon et al., 2020).

Figure 14 Exercise to activate the hyoglossus muscle as the back of the tongue lowers in the 'Ah'. This focuses on increased awareness of the root of the tongue-mapping.



However, the literature warns that overreliance on visual input may lead to dependency on the mirror, and tongue skills may not be learned (Ronsse et al., 2011). That creates a pedagogical tension in the voice studio with the artifact. Visualizing the tongue can be useful for early motor calibration, but it can also disrupt the auditory feedback loop that ultimately affects singing accuracy. Research on speech motor control argues that stable vocal learning is better when sensory feedback is incorporated, rather than relying on a single tool (Guenther, 2016). If visual cues are so strong that learners are more concerned with what they see than with what they hear, the development of internalized auditory targets for voice control can be compromised (Tremblay, Shiller, &

Ostry, 2003). Instead, the teaching method should use visual support as a short-term scaffold rather than a permanent one. That is, mirror-based tongue work should be done once the tongue mapping is recognized, and should gradually move away from visual cues and return to the auditory process. Tasks should be modified so that any visual movement is followed by listening, repetition, and singing, and visual feedback is always related to sound. Thus, visual input is seen as a transitional factor in the sound-led pedagogy rather than as another source of power for vocal development.

Application of Flashcards in Voice Studio

Research has found that young children learn more from experience and auditory learning than from abstract analytical learning (Broadbent et al., 2018). While we are primarily studying those aged 6-10, these multisensory benefits appear to generalize to later childhood, and studies have shown that 12-year-olds also benefit from enriched sensory learning environments (Macedonia, 2025). In this context, flashcards might encourage visual-symbolic recall without the auditory-motor feedback that is critical for the development of singing (Keough & Jones, 2009). Vocal accuracy depends on the continuous comparison between the heard input and internal auditory targets, with auditory feedback being the primary instrument of intonation (Pfordresher & Dalla Bella, 2011; Pfordresher & Beasley, 2014). Childhood vocal learning is largely imitative and aurally mediated, and listening is more important than visual abstraction (Meltzoff & Prinz, 2002).

In voice pedagogy, this suggests that flashcards should be used only as a secondary prompt in sound-based instruction, as there is no evidence of transfer from visually mediated or non-speech-based tasks to singing (Parra-López et al., 2022).

Their value is in eliciting an immediate vocal response rather than in supporting recognition-based learning. Without this auditory integration, symbolic understanding will be reinforced, while the feedback and learning mechanisms needed for vocal control will not be developed.

Now what?

The next step is to translate those principles into consistent, repeatable teaching behaviours within the studio to directly support students' learning of tongue control in vocal training. As a singing teacher, one of the biggest challenges I had with younger singers was not knowing how to use the tongue and replicate it in different musical environments. That's where the interplay of component deconstruction and variability is very real (Ranganathan & Newell, 2010), and it provides a method for moving children from single movements to a stable form (Bortoli et al., 2001). In my practice, that means the tongue-work in lessons should be very short and repeated in a variety of ways, not just one. Instead of simply fixing a sound and ending as I have sometimes done in the past, the same action should be brought back to the student directly in another phonetic setting to see if they remember basic tongue action. This is typical of what I see as a problem: students may produce a desired sound once but not make the same change, so it cannot be applied consistently (Grand & Montilla, 2003). The flashcard system then serves as a platform for repetition and variation beyond lesson time.

In my teaching, more progress is noticeable when students practise in short bursts and not in longer sessions every so often. But this happens only when the task is simple first, or not at least not when the students are resistant. And that's why the design should be cognitively light and visually stable. As for CLT (Sweller, 2011), when

material is easy and not overly challenging for the mind, students return to it more readily. This is reflected in the flashcard design, where the directions are simple and short and feature an engaging Ninja theme. It also changes how progress is measured in the studio. Instead of judging a student on the success of a single sound, progress can be more accurately achieved when multiple tasks are performed in the same area of the tongue. For the future, it may be beneficial to add a third level to the flashcard system. Once the Master level is reached, the same task is performed for different vowels and pitches in different vocal ranges. If a student can still control tongue-tip placement across different phonetic contexts, then it is more likely to demonstrate motor learning rather than isolated proficiency (Graser et al., 2019). As many studies have found, stability under variation is a better indicator of development than isolated correctness (Wulf, Shea & Lewthwaite, 2010). This move shifts the teacher from just correcting isolated sound sequences to creating a series of environments which contribute to motor learning over time. The teacher must determine what is being repeated and how often, and how quickly to change it. So the flashcard system is not a set of exercises and procedures as much as it is an organized way of practice that helps students control their tongue and gradually develop a routine, adaptable-to-singing behaviour.

Conclusion & Future Recommendations

This study found that tongue flexibility for belting in young singers is most effectively developed through a small set of targeted, progressive exercises delivered through a structured flashcard system. The vocal mechanism remains largely hidden from direct view (Tremblay, Shiller, & Ostry, 2003); however, the tongue offers an

externally visible aspect of the vocal mechanism that can be directly addressed through pedagogical interventions, including the tongue exercises developed in this artifact. Given the functional interdependence of articulatory structures within the vocal tract, targeted work on tongue positioning may also influence broader vocal tract behaviour. This supports the use of tongue-focused exercises as an accessible entry point for voice pedagogy.

According to Fitts and Posner (1967), in their model of motor learning the activities first develop knowledge of the position of the tongue (cognitive stage), then routine (consistency through repetition and variation) (associative stage) and finally automatic and efficient coordination required to execute the movements (autonomous stage). By dissecting specific tongue tasks into small, repetitive components, the system minimizes cognitive load and helps learners gain greater insight into the tongue's proprioceptive state during vocalization.

This paper contributes to the field of CCM vocal pedagogy by providing young singers and their teachers with a practical set of tongue-flexibility exercises tailored to the developmental and technical needs of this age group. Through the flashcards, the study translates complex anatomical and pedagogical concepts into accessible learning tools that encourage healthy tongue coordination without overwhelming developing singers with excessive technical language. This project helps bridge the gap between voice science research and practical studio applications, offering CCM educators a structured, age-appropriate resource for developing tongue flexibility in young CCM learners.

Future studies should use testing under real studio conditions and assess learning outcomes more systematically. Observation of the student's response and application of the flashcards to their learning may be helpful in assessing the extent to which learners were able to transfer isolated flashcard exercises to their singing repertoire.

Critical Reflection

This section reflects on my learning and teaching process using Gibbs's Reflective Cycle (1988), selected for its structured framework that enables systematic analysis of experience and evaluation of learning.

Description

The artifact was designed to support young singers' awareness of and control over tongue movement for CCM belting. This required engaging with speech pathology literature on the roles of intrinsic and extrinsic tongue muscles and their influence on vocal efficiency. The aim was to isolate tongue movement in an accessible way to develop learners' awareness during singing. This was informed by voice science and pedagogical literature, resulting in a set of flashcard systems (Appendix B).

Feelings

I was initially intimidated by the complexity of tongue biomechanics, as articulatory control seemed difficult to translate for young learners. As my research progressed, I gained confidence by linking theoretical concepts to practical design decisions, including colour choices. Literature supports using bright colours to enhance attention (Lyu & Liu, 2022), and I also considered inclusivity by avoiding gendered colour associations (Karniol, 2011). My initial preference for red and black, influenced by cultural associations with ninjas, was revised after recognizing that black is less bright and less stimulating for children (Lyu & Liu, 2022). I used green for beginner-level tasks, associated with cognitive ease, while retaining red for more detail-focused activities

(Mehta & Zhu, 2009). Due to time constraints, I did not investigate optimal font type or size, though this could further refine engagement for learners aged 10-12.

Evaluation

A key strength was my ability to simplify complex anatomical information into child-friendly language and visual cues in the flashcards. However, it became challenging to isolate exercises to target individual muscles of the tongue. All eight muscles of the tongue are often linked to each movement (Kier & Smith, 1985; Katz & Mehta, 2015); I had to try the exercise personally and consult tongue anatomy textbooks. I watched several YouTube videos by recognized pedagogues performing the same exercises I designed to determine whether the correct tongue muscles were activated. In addition, I did not have advanced visual imagery to illustrate the three-dimensional positioning of props, such as popsicle sticks, in relation to the tongue. I had to reword the instructions several times to clearly and simply explain where to place the popsicle stick. I reread the instructions many times and consulted pedagogical textbooks for guidance on wording to design age-appropriate, informative instructions that were not overly instructional. My reflexive journal shows several revisions of wording, shaped initially by my intuition as a voice teacher and ideas encountered through online sources such as YouTube. I did not initially recognize how significantly wording can alter the interpretation and application of an exercise. The process highlighted the importance of precise instructional language, as small shifts in phrasing can change how an exercise is understood and performed. In future projects, including video demonstrations would reduce reliance on highly precise verbal descriptions and

help minimize the risk of misinterpretation by students, particularly where multiple interpretations of the same instruction are possible.

Analysis

I realized that I was using Schön's (1983) notion of reflection-in-action, in which 'understanding' developed in the design itself rather than being formed in advance of it. While I was working on the artifact, I constantly questioned my assumptions about tongue movement, particularly when translating abstract anatomical concepts into age-appropriate physical exercises. Consistent with Schön's theory, the design process became a conversation between formulation of the problem and development of the solution (Schön, 1983). Originally, I focused on tongue motion mostly from a voice-anatomy perspective, but as the artifact developed, I recognized that great design required exposure to the speech pathology literature. This change happened as I assessed whether my exercises adequately isolated individual tongue movements. For instance, I was forced to question whether some exercises were actually targeting intrinsic muscles, such as the superior or inferior longitudinal muscles, or were instead just making the tongue move more generally. This repeated reflection on decisions displayed reflection-in-action, with decisions made and updated as gaps in understanding were identified during the design process.

Also, reflection-on-action became important after every exercise, when I would step back and assess what I had created. I re-examined the success of the activities with evidence from speech pathology research after the initial drafts of the artifact, particularly studies emphasizing motor learning principles (Maas et al., 2008). These reviews made me realize that although my tasks were interesting and engaging, they

weren’t always targeting specific muscles accurately. Through this post-evaluation, I was able to hone in on the artifact's potential to mirror the literature and its nuances across multiple revisions.

Reviewing the speech pathology literature made me more aware of the neurophysiological dynamics of tongue movement, particularly of the hypoglossal nerve. But adding that level of neuroanatomical detail to an artifact for young learners would cause cognitive overload and reduce usability. Reflecting on it, I decided to focus on muscular explanations rather than neurological mechanisms. At first, I was concerned that this would diminish the scientific integrity of the resource, but I found the educational design literature to be in favour of removing unnecessary cognitive load for younger learners and still making the artifact accessible and grounded in the principles of speech pathology (Sweller, 1988). Overall, reflection-in-action and reflection-on-action supported the iterative refinement of the design, highlighting that artifact creation can be done with complexity in mind, based on audience needs rather than merely applying anatomical knowledge in a fixed form (Schön, 1983; Maas et al., 2008).

Conclusion

As I reflected on my three expected learning outcomes: a) I’m more aware of tongue anatomy and key tongue positions that are relevant for belting, b) the three stages of motor learning by Fitts & Posner were well-grounded and c) I was able to develop practical and age-appropriate exercises for teaching tongue freedom in young singers. By understanding the anatomy of the tongue muscles, I could identify which exercises to do with students and work on with them to improve their tongue muscles.

The benefits of variation practice are what I take away. Overall, this paper met the outlined learning expectations.

Action Plan

To build on the concepts we have gained in this project, I would develop targeted flashcards that directly relate to the CCM repertoire. Instead of treating tongue awareness as an abstraction, I will present key concepts through short, lyrical excerpts from current songs, thereby situating learning in a musical context. This corresponds with research on contextualized learning, which shows that motor skills are better retained when practiced within functional tasks than when performed in isolation (Maas et al., 2008). For instance, a flashcard could address a challenging belting lyric with a brief cue to support real-time execution. Both during and after teaching, this approach needs to be maintained. Schön's (1983) framework of reflection-in-action and reflection-on-action supports the constant revision of exercises in response to student needs. In other words, teaching must remain adaptive to the physiological and developmental requirements of young CCM singers.

Several studies document game-based learning as a proven instructional approach that can prompt student motivation and engagement in learning (Iten & Petko, 2016). Games can promote active and experiential learning (Plass, Homer & Kinzer, 2015) through repeated gameplay with flashcards. In music education, playful activities appear to be significantly associated with increased confidence and reduced anxiety in music learning (Deterding et al., 2011). I plan to use the designed flashcards during lessons through games. In this regard, Table 4 outlines how the artifact can be taken to the next level in relation to the teaching studio and used more broadly.

Table 4: Interactive Games with Flashcards	
Game	**Task**
Challenge Tower	Every successful flashcard performance can allow the student to add a block to a tower with the purpose of seeing how tall can the tower be stacked.
Speed Race	Setting a timer and seeing how many flashcards can be completed accurately within three minutes.
Spot the Mistake	The teacher intentionally performs the exercises with mistakes and students identify and correct the error.
Mystery Card	Student closes their eyes and randomly picks one flashcard and performs the exercise.
Flashcard Simon Says	Teacher leads each flashcard exercise but the student only performs when the teacher introduces the card with “Simon Says”.
Guess the Card	The teacher performs one of the exercises and the student needs to analyze and guess which flashcard exercise is being performed.

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Although much could be refined in future iterations of this study, I believe the current artifact meets its immediate aim of supporting the development of tongue flexibility in young singers for belting in CCM as informed by voice science, speech pathology, and current voice pedagogues.

APPENDICES

Appendix A: Compilation of Exercises on Flashcards

Compilation of Exercises for Flashcards				
Exercise	**Description**	**Research Based on Sanders & Mu, 2013**	**Best Practice**	**Adaptation**
Chopstick Pushup	Place a chopstick or pencil under the tongue. Push the chopstick up toward the sky with the tongue pushing down on the chopstick. Hold for 10 counts.	This exercise primarily targets the hyoglossus muscle, which pulls the tongue downward. Intrinsically, the vertical muscle is activated since the tongue is flattened. The inferior longitudinal running along the underside of the tongue is also engaged more since this is the muscle pulling the tip of the tongue downward and helps to arch the tongue (Bryne, 2020).	Andrew Bryne uses this exercise to strengthen the inferior longitudinal muscle (Bryne, 2020). Vowels '/u/ in "food" and /i/ in "knee" use the arch form of the inferior longitudinal muscle (Bryne, 2020)	After the exercise, assess using the /u/ vowel on a 1-octave scale and reflect on the changes. An advanced version of this is to phonate while doing the exercise. Gliding from low to high on. Phonating requires maintaining vocal tract shape while generating downward resistance and increasing coordination through the co-contracting of multiple muscles (Pittman & Bailey, 2009). On 'ng,' the back of the tongue stays elevated against the soft palate. The dome shape of the tongue should be maintained, and pushing up with the chopstick helps with this. If the tongue retracts, it can be seen, and the chopstick helps maintain a relaxed jaw position.
Spoon Press	Place a spoon on the underside of the	This focuses on the inferior	This is a type of isometric exercise as outlined in	No adaptations.

	tongue tip and push up while the tongue resists by pushing down on the spoon**.**	longitudinal muscle.	speech pathology and Andrew Bryne (Bryne, 2020).	
Roof Profess	Tongue tip to the roof of the mouth while maintaining a still jaw. Repeat 10 times.	Superior Longitudinal muscle is engaged to raise the tip of the tongue.	Andrew Bryne uses this exercise while opening the mouth (Bryne, 2020).	Combining this exercise with opening the mouth ma be engaging additional neck and jaw muscles. Since the purpose of the flashcard is to work on the tongue, it is decided to remove the element of opening the mouth and focus just on the ability of the superior longitudinal muscles to raise the tip of the tongue.
Noodle Dog	Take two popsicle sticks, one on the top of the tongue and one on the bottom. Press the popsicles together, then use the tongue to push them apart. The tongue will form a narrow hot dog.	Engagement of transverse intrinsic muscles.	Andrew Bryne uses this exercise to strengthen the transverse muscle (Bryne, 2020).	This task proves difficult for me, revealing my own weakness in the targeted muscle. This is important to note as students may have difficulties.
Pancake Smash	Take two popsicle sticks, place them sideways, facing each other, on either side of the tongue. Squish the popsicles towards the middle of	Engagement of vertical intrinsic muscles.	Andrew Bryne uses this exercise to strengthen the vertical muscle (Bryne, 2020).	This task proves difficult for me, revealing my own weakness in the targeted muscle. This is important to note as students may have difficulties.

	the tongue while actively using the tongue to form a flat pancake.			
Front Shield	Popsicle stick facing the tongue. Stick out your tongue against the popsicle stick for gentle resistance! Hold strong.	This engages the genioglossus muscle as shown in the study of Pittmann & Bailey (2008).	Andrew Bryne uses this exercise to strengthen the genioglossus (Bryne, 2020). In addition, speech pathologists use this as a tongue-strengthening exercise (Wang et al., 2019; Lin et al., 2022).	No adaptations.
Side Shield	Press your tongue to the left against the popsicle stick as it offers gentle resistance! Hold strong.	This engages the genioglossus muscle as shown in the study of Pittmann & Bailey (2008).	Speech pathologists also use this as a tongue-strengthening exercise (Wang et al., 2019; Lin et al., 2022).	No adaptations.
Noodle Orbit	Tongue Circles: Using the tip of the tongue, draw five circles around the mouth, inside the cheeks and outside the teeth. Check for still jaw.	Focuses on the coordination of muscles. All intrinsic and extrinsic muscles are engaged to create the circle motion. These exercises on the range of motion (Sanders & Mu, 2013).	Exercise used by Andrew Bryne (Bryne, 2020), in speech pathology (Lin et al., 2022) and suggested to maintain a healthy tongue (Kappert et al., 2021).	This brings awareness to the whole oral cavity and the ability for the tongue to explore all of it helps build tongue-mapping.

Noodle Stretch	Using a paper towel or washcloth, grab the tongue and gently guide it out of the mouth. Hold for two minutes.	A stretch for the genioglossus since this muscle is responsible for protrusion. Styloglossus and hyoglossus are simultaneously stretching for the posterior of the tongue retraction.	Exercise used by Andrew Bryne (Bryne, 2020), in speech pathology Hwang et al., 2019) and suggested to maintain a healthy tongue (Kappert et al., 2021).	This has been a pedagogy practice I have used in my own singing learning with past teachers and found helpful.
NG Dragon Dance	Hold 'ng' and move the tip of the tongue up/down/left/right.	'Ng' places the tongue in a posterior-arched posture. In addition to the genioglossus, the styloglossus is engaged to maintain the posterior retracted dome shape. Palatoglossus is also engaged to link the soft palate for this nasal sound. When the tip moves independently is isolates the intrinsic control of	Similar exercises by speech pathologists for moving tongue in different directions while stabilizing jaw' however, none to specifically engaged in 'ng' to anchor the posterior part of the tongue to work on the front half of the tongue. Brendan Houdek, a certified speech language pathologist with experience in singing and voice impressionist uses this exercise to develop front of tongue freedom (New York Vocal Coaching, 2019, 5:44).	This exercise is an extension of the previous apprentice level exercises; thus this should be emphasized after successful completion of the apprentice level cards.

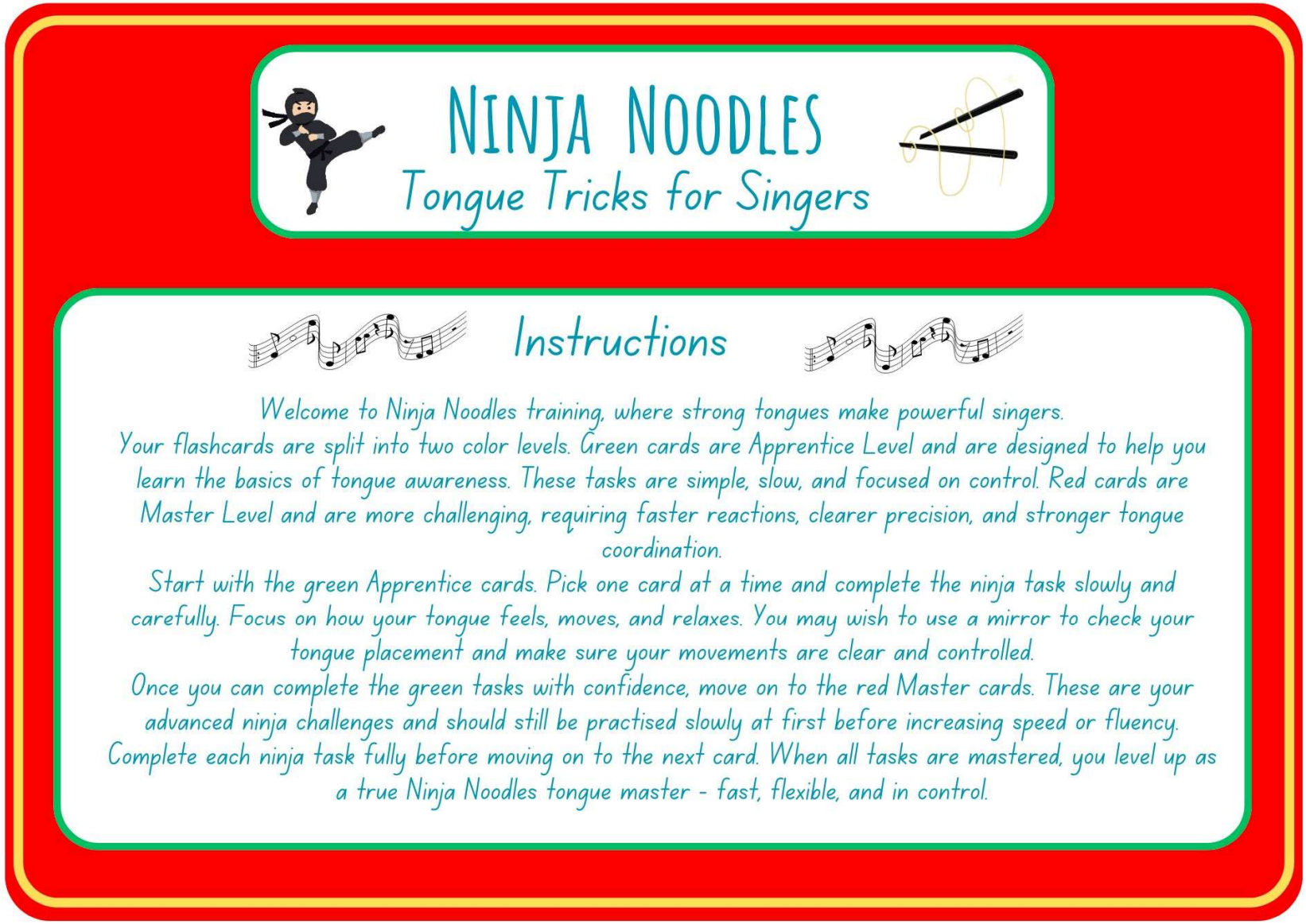
		the superior longitudinal and inferior longitudinal muscles.		
Teeth Dance	Touch the tip of the tongue to the left molar, then right molar. Repeat by touching one tooth closer to the centre.	The superior longitudinal muscle is highly engaged in this exercise.	This exercise trains tongue tip control. Speech pathologists use tongue lateralization drills for articulation training (Takei et al., 2010).	This exercise helps build tongue-mapping for the learner and can be used in initial tongue-mapping for the learner.
Back tongue Blast	Keep the tip of your tongue touching your bottom teeth. Say “EEEE” then “AHHH” to move the back of your tongue.	The genioglossus is heavily exercised to stabilize the tongue. Superior longitudinal is engaged to keep the tip still. Styloglossus is used to transition to ‘EE’ because the tongue dorsum elevates and narrows. Superior longitudinal is also engaged. Tongue is more narrow for ‘EE’ using the transverse muscle.	Brendan Houdek uses this exercise to focus on developing the back of the tongue (New York coaching, 2019, 2:40).	There are less exercises found to work on the back of the tongue to build tongue-mapping of the root of the tongue; thus this exercise should be prioritized in voice pedagogy usage of the flashcards.

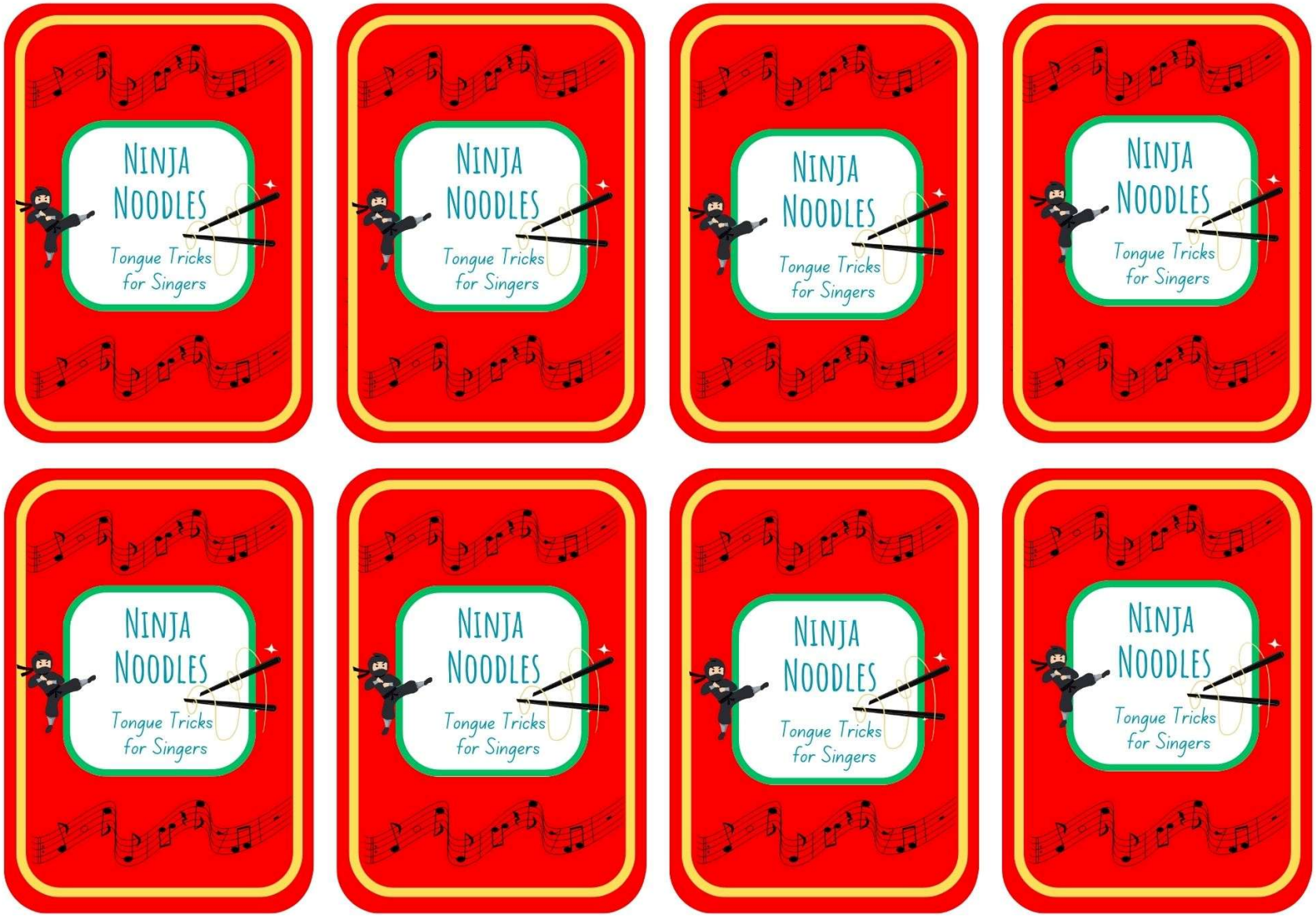
		Hyoglossus is engaged for 'AH' as back of tongue lowers. Inferior longitudinal engaged. Vertical muscle for flattening tongue.		
Shadow Tip	Say slowly "th - s - sh" then "sh - s - th"	These three sounds are vocal fricatives made with the front of the tongue (Shadle & et al., 2008). Genioglossus is highly engaged.	Brendan Houdek uses this exercise to focus on developing the front of the tongue (New York coaching, 2019, 4:30).	Focusing on the slow transition between the sounds allows students to feel and engage additional senses.
Tip of Tongue	Say slowly "th - t - th - t"	The genioglossus is the primary driver of this exercise. The superior longitudinal muscle stabilizes the tip for the 't'. The 'th' is a fricative with loose forward tongue and slightly flatted tongue engaging the vertical. The 't' requires a firm tongue tip sealed	This exercise focuses on quick alteration between relaxed and tightly sealed posture of the tongue. This builds precision control of the tongue. There is no specific research evidence for this exercise. However, articulatory training improves tongue positioning (Bressmann et al., 2016).	Focus on slow transition between the 'th' and 't' allows students to feel and engage additional senses.

		at the roof of the mouth.		
Boiling Soup	Take a small sip of water and try to make a water bubble like a dragon boiling soup as you gargle.	Gargle engages the genioglossus, styloglossus and hyoglossus. Hyoglossus pulls the tongue downward and backward, while styloglossus pulls the tongue upward and backward. The soft palate is engaged to prevent water from going into the nose. Hence, the palatoglossus is likely engaged also.	This focuses on the back of the tongue rather than the tip. The bubbling and vibration give stronger feedback to help improve awareness of where the back of the tongue is. Gargling has been studied less directly in the peer-reviewed literature. However, it is logical to see the benefits of gargling, which adds vibration to the pharynx and oral cavity, increasing resonance feedback and awareness of vocal tract shape.	There were few exercises found for these flashcards that focus on the back of the tongue; thus, this gargle exercise is adapted for voice pedagogy.
Ping Pong	Sing “ah, ay, ee, oh, oo” on any pitch. Move the tip of the tongue along the front lower teeth as you sing.	All muscles engaged.	Develops stability in the vowels as you sing. There is a separation of tongue tip control, as the other parts of the tongue are creating the vowels.	This exercise brings together many of the green-level apprentice skills from the flashcards.
Tongue Zone Mission	Sing on a chosen pitch: La, ya, ga while keeping jaw still.	La engages the front of the tongue tip. Ya engages from the mid front	Research shows that consonants are controlled by regional parts of the tongue. Hence, an	Literature shows the following consonants engage the following parts of the tongue (Browman & Golstein, 1992)

		of the tongue. Ga engages the back of the tongue.	exercise using the front, middle, and back of the tongue will help with transition (Recasens & Rodriguez, 2016).	- Front t, d, n, l, s, z, th - Middle Y, sh, zh - Back: K, g, ng
Secret samurai	Say the following with teeth gently together, lips slightly apart. No movement of the lips like a ventriloquist. A C D E G H I J K L N O Q R S T U X Z	All muscles rely on intrinsic muscle shaping to produce sound.	Ventriloquist Jeff Dunham teaches this as an elementary exercise to develop ventriloquist skills. This can be used to heighten tongue coordination without the lips (Jeff Dunham, 2018).	Originally for ventriloquists and applied now to singing pedagogy because it can help isolate the jaw, lips and tongue.
Nose Tap	Lift your tongue up and try to touch your nose like a sneaky ninja!	The superior longitudinal muscle is highly engaged in this exercise.	Speech pathologists use this to help improve the tongue's agility.	Adapted from speech pathology to help with tongue flexibility, particularly in the movement up of the tip of the tongue, which may be of importance when articulating clarity in belting.

Appendix B: Artifact Flashcard




NINJA
NOODLES
Tongue Tricks
for Singers

CHOPSTICK PUSHUP



Place a chopstick or pencil under the tongue. Push the chopstick up toward the sky with tongue pushing down on chopstick. Hold for 10 counts.

SPOON PRESS



Place a spoon on underside of tongue tip and push up while tongue resists by pushing down on spoon.

NOODLE DOG



Take two popsicle sticks, one of the top and one on the bottom of the tongue. Press the depressors together while using the tongue to push them apart.

PANCAKE SMASH



Take two popsicle sticks sideways, facing each other on the two sides of the tongue. Squish the popsicles towards the middle of the tongue while actively using the tongue to form a flat pancake.

NOODLE ORBIT



Tongue Circles: Using the tip of the tongue, draw five circles around the mouth, inside the cheeks and outside the teeth. Check for still jaw.

NOODLE STRETCH



Using a paper towel or a washcloth, grab the body of the tongue and gently guide it directly out of the mouth. Hold for two minutes.

NOSE TAP



Lift your tongue up and try to touch your nose like a sneaky ninja!

ROOF PRESS



Tongue tip to roof of mouth while maintaining a still jaw.

Repeat 10 times.

CHOPSTICK PUSHUP



Place a chopstick or pencil under the tongue. Push the chopstick up toward the sky with tongue pushing down on chopstick.
Glide on 'ng' while holding the position.

SPOON PRESS



Place a spoon on underside of tongue tip and push up while tongue resists by pushing down on spoon.
Glide on 'ng'.

NOODLE DOG



Take two popsicle sticks, one of the top and one on the bottom of the tongue. Press the depressors together while using the tongue to push them apart. Can you make 5 noodle dogs in 10 counts?

PANCAKE SMASH



Take two popsicle sticks sideways, facing each other on the two sides of the tongue. Squish the popsicles towards the middle of the tongue while actively using the tongue to form a flat pancake. Can you make 5 pancakes in 10 counts?

NOODLE ORBIT



Tongue Circles: Using the tip of the tongue, draw five circles around the mouth, inside the cheeks and outside the teeth. Check for still jaw. Add the hand on the outside of the mouth as a gentle resistance as you do the tongue circles.

NOODLE STRETCH



Using a paper towel or a washcloth, grab the body of the tongue and gently guide it directly out of the mouth. Hum the the tune to Happy Birthday as you hold your tongue out.

NOSE TAP



Lift your tongue up and try to touch your nose like a sneaky ninja!

Glide on 'ng'

ROOF PRESS



Tongue tip to roof of mouth while maintaining a still jaw.

Hum to the tune of Happy Brithday while doing this task.

FRONT SHIELD



Popsicle stick facing the tongue. Stick out your tongue against the popsicle stick while the popsicle stick adds gentle resistance! Hold strong.

SIDE SHIELD



Push your tongue to the left against the popsicle stick while the popsicle stick adds gentle resistance! Hold strong.

SIDE SHIELD



Push your tongue to the right against the popsicle stick while the popsicle stick adds gentle resistance! Hold strong.

LEFT BATTLE



Push your tongue into your left cheek. Hold your cheek with your hand and gently push back.

RIGHT BATTLE



Push your tongue into your right cheek. Hold your cheek with your hand and gently push back.

BACK TONGUE BLAST



Keep the tip of your tongue touching your bottom teeth. Say "EEEE" then "AHHH" to move the back of your tongue.

TIP OF TONGUE



Say slowly "th - t - th - t"

SHADOW TIP



Say slowly "th - s - sh" then "sh - s - th"

FRONT SHIELD



Popsicle stick facing the tongue. Stick out your tongue against the popsicle stick while the popsicle stick adds gentle resistance! Hum to the tune of Happy Birthday.

SIDE SHIELD



Push your tongue to the left against the popsicle stick while the popsicle stick adds gentle resistance! Hum to the tune of Happy Birthday.

SIDE SHIELD



Push your tongue to the right against the popsicle stick while the popsicle stick adds gentle resistance! Hum to the tune of Happy Birthday.

LEFT BATTLE



Push your tongue into your left cheek. Hold your cheek with your hand and gently push back. Hum to the tune of Happy Birthday.

RIGHT BATTLE



Push your tongue into your right cheek. Hold your cheek with your hand and gently push back. Hum to the tune of Happy Birthday.

BACK TONGUE BLAST



Keep the tip of your tongue touching your bottom teeth. Say "EEEE" then "AHHH" to move the back of your tongue. Repeat on each note of a 5 note scale.

TIP OF TONGUE



Say slowly "th - t - th - t"

Check the jaw and lips are still.

SHADOW TIP



Say slowly "th - s - sh" then "sh - s - th"

Check the jaw and lips are still.

NG DRAGON DANCE



Hold 'ng' and move tip of tongue up/down/left/right.

TEETH DANCE



Touch the tip of the tongue to the left molar, then right molar. Repeat by touching one tooth closer to the centre.

BOILING SOUP



Take a small sip of water and try to make water bubble like a dragon boiling soup as you gargle.

PING PONG



Sing "ah, ay, ee, oh, oo" on any pitch. Move the tip of the tongue along the front lower teeth as you sing.

SECRET SAMURAI



Say the following with teeth gently together, lips slightly apart. No movement of the lips like ventriloquist.

A C D E G H I J K L N O Q R S T U X Z

TONGUE ZONE MISSION



Sing on a chosen pitch: La, ya, ga while keeping jaw still.

BACK TWIST

Say these tongue twister quickly:
King Kong kicks Kites in the Kitchen.

Goofy goats gobble golden granola.

Crazy crabs crawl across cracked caves.

MIDDLE TWIST

Say these tongue twister quickly:
Nina's noodles need nice neat numbers.

Teddy twists tiny tablets in the tunnel.

Danny dances in the middle of muddy mountains.

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