The Meaning of Exercises.

Our blooming hero awoke, one day,
to find he had nothing whatever to say:
which I might interpret, just for fun
as meaning the es of a be was dun
The Ballad of an Intellectual e e cummings

Speech articulation is often described as the most complex motor behaviour, because over 100 muscles are involved, and the movements occur on an extremely rapid timescale. Despite this complexity, nearly all of us learn to master this skill to speak fluently and effortlessly.
(Conant, Bouchard, & Chang, 2014)

Technique is Meaningless by Nicholas Chagouris.
Homage to Jackson Pollock's saying that: Technique is just a means of arriving at a statement.

Summary.

- Non-speech oral motor exercises (NSOMEs) have been widely used in speech therapy.
- They are exercises for the physical articulators of speech, that are performed whilst not speaking.
- They attempt to restore the clarity and articulation of speech.
- NSOMEs bear close resemblance to some exercises found in a techno-physical approach singing.
- Research suggests NSOMEs have limited or no effectiveness in speech therapy.
- Research suggests only exercises that have speech as their *task* can improve speech
- We can ask whether the same condition might apply to exercises for singing.
- If so, this would have implications for techno-physical approaches to singing.
- In considering *why* NSOMEs are not efficacious, further questions are raised for techno-physical approaches to singing, and further clues provided as to alternative approaches.

Non-speech oral motor exercises.

Exercises that are a close equivalent to those found in a techno-physical approach to singing are found in speech therapy. "Non-speech oral motor exercises" (NSOMEs) have been widely used in an attempt to help patients struggling with verbal clarity and articulation.

Here, from the horse's, or at least the American Speech-Language-Hearing Association's, mouth, is a working definition of *all* oral motor exercises:

Oral-motor exercises are activities that involve sensory stimulation to or actions of the lips, jaw, tongue, soft palate, larynx, and respiratory muscles which are intended to influence the physiologic underpinnings of the oropharyngeal mechanism and thus improve its functions; oral-motor exercises may include active muscle exercise, muscle stretching, passive exercise, and sensory stimulation. {Lof 2008}

The *non-speech* version of these exercises can be defined as a…

technique that does not require the child to produce a speech sound but is used to influence the development of speaking abilities. {Lof 2008}

Examples of non-speech oral motor exercises include those for tongue strengthening and flexibility, jaw release, lip rounding, cheek energising, overall posture and velopharyngeal closure:

Oral motor programs approach articulation as a full body process that includes gross motor activities, oral massage and oral motor exercises. Gross motor activities (for example, a correct aligned seating position) are said to promote postural tone and stability for speech production (Strode and Chamberlain, 1997; Bahr, 2001). Oral massage (for example, stroking of the facial muscles) is purported to improve a child's response to oral sensation, muscle tone and the ability to perform more precise oral movements (Bahr, 2001). Oral motor exercises are repetitive drills that rely on conditioning the muscles of the mouth and face (Marshalla, 1999). {GuistiBraislin 2005}

The approach aims to strengthen awareness and ability with those muscles used in the articulation of speech. The patient undertakes exercises that engage the muscles and articulators of speech, whilst, however, *not* engaged in the act of speaking. The hope is that the awareness and dexterity learnt in the exercises then informs and improves the spoken word.

Non-singing oral motor exercises?
We can see the correlation between NSOMEs and some techno-physical exercises that might be used in a singing lesson.

Tongue thrusts, jaw opening, jaw release, closure of the velo-pharyngeal arch and so on, are exercises well-known to singing teachers. Exercises that clarify the production of consonants and vowels, that explore laryngeal tilt, palate lift, air flow are also oral motor exercises. Their aim is to explore and improve the physicality of the muscles used in singing whilst, however, not singing. We could call these: "non-singing oral motor exercises".

These kind of singing exercises are *techno-physical* because they are explicit, internally focussed and ask for direct manipulation of individual parts of the body.

Non-singing oral motor exercises might also include some where you are, technically, "singing", in that you are making musical sounds, but your focus lies completely on technique and physicality. If no communicative intent lies behind these sung exercises, they also could be considered "non-singing oral motor exercises".

Non-speech oral motor exercises share with the techno-physical approach an internal, explicit, directly physical approach of manipulation.

Do non speech oral motor exercises work in speech therapy?
A considerable amount of research has investigated whether NSOMEs are efficacious in speech therapy.

NSOMEs are *supposed* to work like this:

- We need to improve the function of this muscle when you are speaking.
- Let's isolate this action.
- Here is the exact movement required.
- Practise, strengthen and habituate that movement.
- Integrate that movement into your speaking.

On the face of it, this seems a very clear-headed approach.

But:

Most researchers agree that speech is a special skill and that nonspeech oral motor exercises to improve speech production are contraindicated in clinical treatment.
{Maas 2015}

The role and benefit of nonspeech oral movements are controversial in many oral motor disorders…The preponderance of the evidence does not support the use of NSOM tasks in treating developmental speech sound disorders.
(Kent 2015)

…simple repetitive movements or strength training may not enhance skilled movements and therefore, have less potential for inducing changes in neural function underlying speech production. Training on lip strength, for example, may only benefit the

neural control for lip movement and force but may not spontaneously transfer to speech production because the relevance of the movement is not apparent.
(Bunton 2008)

*Despite their use for many years and their popularity among some SLPs for the treatment of a wide variety of speech problems in children and adults, NSOMTs are controversial because sufficient evidence does not exist to support their effectiveness in improving speech. Moreover, limited evidence exists for the use of NSOMTs to facilitate nonspeech activities. Therefore, the available evidence does not support the continued use of NSOMTs as a standard treatment and they should be excluded from use as a mainstream treatment until there are further data. (*Lass & Pannbacker 2008)

The conclusion that must be drawn from this review is that the existing research literature provides insufficient evidence to support or refute the use of nonspeech OMEs. (McCauley 2009)

At best, there is no evidence to support or refute the use of non-speech oral motor exercises in improving speech. At worst, NSOMEs are "contraindicated" and "should be excluded from use".

Surprisingly, exercising those parts of the body required in speech, in exactly the way they are required to move when speaking, has not been found to have a positive impact on speaking.

NSOMEs in trouble.
Let's consider some specific examples of the apparent limitations of NSOMEs in action. First the phoneme /m/, or bilabial closure:

Bose and van Lieshout (2012) reported that speechlike and non-speech movements had similar kinematic and coordination characteristics for a common task goal of bilabial closure. But when rate of performance was increased, functional adaptations in the form of decreased amplitude and duration were observed only for the speechlike task, indicating that speechlike behaviors are subject to a different form of motor control strategy than similar nonspeech tasks.
(Kent 2015)

Exercising the lips to improve rate of bilabial closure, how quickly one can open and close the lips, was only efficacious if the exercise was "speech-like". Muscular exercises alone did not improve the rate of lip closure in speech. Quickly and repeatedly forming an /m/ was cumbersome, unless motivated by communication.

Next, /k/ and /t/ were found to be produced differently, depending on whether they were uttered as speech, or just nonsense sounds. The acronym DDK in the next quote refers to diadochokinesis: the alternation of opposing movements. A classic example of diadochokinesis is alternating flexion and extension of the arm. In the NSOME research below, articulating pairs of /k/ and /t/ requires an alternating tongue position:

Further evidence for task-specific influences came from the finding of a significant interaction between task and syllable type. More specifically, /k/-onset syllables were articulated more slowly than /t/-onset syllables in DDK, whereas the two syllable types were not different in sentence production. When done as an exercise, k and t consonants were differentiated. Yet there was no difference when the person was speaking.
(Ziegler 2002)

If the person was *intending to speak*, they produced the /k/ phoneme differently, more effectively, from when it was just an exercise.

A final example, perhaps even more notable for singers, velopharyngeal closure, the raising of the soft palate, has been investigated:

The velopharyngeal closure mechanism is the articulator that separates the oral and nasal cavities during speech and swallowing. Articulation and resonance may be adversely affected if velopharyngeal inadequacy (VPI) is present. VPI is generally corrected through surgery or speech prosthetics. There is, however, a small subset of clients who may improve with treatment using muscle rehabilitation procedures that are task specific to speech. Nonspeech oral motor exercise treatment has been used but found ineffective.
(Ruscello 2008)

In certain cases, velopharyngeal closure may be improved through exercise, but only if that exercise is *speech based*. Non-speech exercises have been found to be ineffective

The same muscles, same sounds, could only be improved for speech if the exercises used were speech-based. Non-speech, or perhaps techno-physical, versions of the same movements were not useful.

Why?
Surely a muscle is a muscle is a muscle. We control them, whether in speech or movement. We practice, and they develop a (disputed) "muscle memory"? How can the same muscle, being asked to perform the same action, behave differently because of a different imaginative intention?

Three related explanations have been proposed, which are all interlinked, and which may all have relevance to the teaching of singing.

- Task complexity.
- Successful methods of learning.
- Task-dependent learning.

Nonillions of coordinations.
Let's take complexity first. Speech is the result of the coordination of over one hundred muscles, in the service of communicative intention. It is suggested that this coordinative complexity negates the benefits of isolating a few of those muscles and working them separately from the whole:

As commonly noted in introductory texts in speech science, speech production involves more than 100 muscles located in the trunk, neck, and head. To illustrate the control problem of speech production, suppose that each muscle can have the binary states of either contracted or relaxed (of course, muscle activation is much more complex than that, as it involves gradations in degree and duration of contraction within individual muscles). Even with the severe simplification of two activation states for each muscle, the number of possible patterns of motor activation is 2100, or more than 1 nonillion.
(Kent 2015)

One nonillion. Perhaps attempting to lift out 2, or 4 of those coordinations is too reductive to inform the overall pattern of coordination.

Methods of improving complex actions.
NSOMEs attempt to reduce the complexity of an action (the action of speech), in order that elements of that action may be improved. Three methods of breaking down complex actions have been identified:

- Simplification
- Fractionation
- Segmentation

What is meant by these three terms?

Imagine you were attempting to help someone articulate the /l/ phoneme more clearly, (or perhaps make a sung English /l/ more Italianate), how might you proceed?

You could simplify it, reduce the complexity of the coordination by looking at only one element of it. The focus could be brought, say, to the point of contact between tip of tongue and upper teeth. We could clarify that the contact is lighter, and further forward, than an English /l/. The student would exaggerate the difference between the two, and then repeat, habituate and integrate. The production of an /l/ is *simplified* to focus solely on the action of the tip of the tongue. The assumption is that this is the differentiating factor between English and Italian /l/'s, and that the remainder of the coordination for an /l/ will be preserved, and reinstated after the new tongue position has been learnt.

Alternatively, we could *fractionate* the process. This means to identify and *separate strands of activity that occur simultaneously* when you say an /l/. The preparatory breath, the tongue (movement, placement and engagement), sub-glottal pressure, the energisation of the oropharyngeal cavity and so on. Each of these represents a separate *strand* of activity occurring during the production of an /l/. The complete coordination can be broken down into these separate strands for practice. You track each separately, identifying problems, and later twine the strands back together.

Finally, you could *segment* the /l/. This means to break it into coordinated, complex elements that occur *one after the other*: the complete physical preparation for the /l/, the vocalisation of it and then its release. In this way, each segment is a complete coordination, separated from its "before and after": the activity is broken into sequential pieces of time. Segmentation preserves complete coordinations at each moment in time: breath, pharynx, larynx, intention.

Which is the most effective of the three methods of learning?
All three methods have been investigated for efficacy. NSOMEs rely on fractionation. Here is what has been found:

"The segmentation procedure…proved to be the most effective. […] The fractionation methods were generally less effective than whole-task training and were never shown to be more effective […] Simplification techniques resulted in positive transfer but were generally not superior to whole task training"
(Wightman & Lintern, 1985)

A traditional articulation approach has long advocated practicing individual physical movements associated with speech production (Bauman-Waengler, 2004). More recently, it has been suggested it is more effective to learn the complex whole of articulation instead of the discrete parts (Geirut, 2001; Forrest, 2002)
(Guisti Braislin 2005)

Simplification is no better than "whole-task" learning. Fractionation, on which NSOMEs are based, might actually make learning worse. Segmentation, which preserves complete coordinations but separates them in time, is the only one of these three methods that seems to aid learning.

Segmentation preserves the coordinations, incredibly complex simultaneous activations of muscles, that serve a task. The coordinations remain complete, but are segmented into sequential time chunks. Non-speech exercises, by contrast, rely on *simplification* or *fractionation*, where one strand is untwined and examined separately from simultaneous strands of activity.

This brings us to perhaps the most crucial reason why exercises that don't have speech at their heart seem not to work: fractionation untwines crucial coordinations and removes intention. These coordinations are designed to serve the task of communication. No task, no coordination.

Meaning is crucial.
The concept of *task dependence*, or task specificity is the third reason why NSOMEs might be limited in efficacy:

Task specificity is a key concept in motor learning… The specificity of learning hypothesis states that learning is accomplished most effectively when practice sessions incorporate context and movement conditions similar to those required during performance of the intended task.
(Kent 2015)

The principle of task-specific learning holds that in order to for an exercise to help you improve at something, it must share the aim of the task you wish to improve. If you wish to improve your speech, whose task is to communicate meaning, the exercises must share that same motivation. If the task is lost, the exercise seems ineffective.

Nonspeech oral motor tasks, it can be argued, have goals that are related to an external visual-spatial or proprioceptive target and therefore, are very different from speech production. As an example, contrast the goal of tongue elevation during speech production versus a lingual 'push-up'. During speech production, the goal of a tongue elevation movement is not to reach a certain point at the roof of the speaker's mouth, but rather to produce a sound that can be interpreted by a listener. In contrast, the goal of a lingual 'push-up' is simply to produce the required amount of force to complete the 'push-up.'(Bunton 2008)

"Lingual push-ups", even as *they themselves* improve, seem to make little improvement to someone's speech. They aren't speech. They are lingual push-ups. One could imagine that tongue positioning exercises for the singer might perhaps be vulnerable to the same issue. The brain doesn't link the task of a "tongue push-up" with the task of communication, so the neural networks performing the tasks are not strengthened.

The same effect has been reported for exercises to aid faster lip and tongue movements:

It has been reported that lip and tongue movements in speech are faster (i.e., have a higher natural frequency) not only in comparison with limb movements but also in comparison with lip movements in a task of voluntary contraction (Ito, Murano, & Gomi, 2004).(Kent 2015)

Intending to speak enables lip and tongue movements of a faster maximum speed than an equivalent exercise that lacks the intention to communicate.

All these findings undermine what has been known as the "common effector perspective". This principle has held that the same muscles are always controlled by the same "effectors", parts of the brain.

The view, often called the "common effector perspective", suggests that when the same effectors (structures) are used for different activities they are necessarily controlled by a common set of control principles. General control principles, such as force and timing, are thought to subserve motor activities for any purpose involving the same effectors. On the surface this appears logical, but contemporary motor theory and empirical data are strongly in opposition to such a view. The control of effectors appears to be task-specific with distinct neuromotor control systems responsible for specific motor activities. This task-specific view of motor control suggests that functions specialized for the act of speaking are different from those that control nonspeech oral motor tasks. (Bunton 2008)

Even though the physical actions taught are identical, the teaching is not helpful, because the intended task of the learner is not speaking. For our Italianate /l/, unless the singer intends to communicate as he practises it, exercises to improve that /l/ will be reduced in efficacy.

How can this be? How can training identical physical structures in the body to work in an identical fashion to speech NOT be helpful for speech? Same flesh, same movement, little learnt. How can the same muscles move faster when speech is the aim, rather than the aim is to move those muscles faster?

Neural organisation.
I'll dig into this more fully in the next article, "How does the brain organise movement?". Briefly here, current neuroscience holds that the brain organises movement in a specific way. Rather than an additive method of "I'll have this muscle, plus this muscle, plus this one please: there, I'm walking.", movement is organised as emergent, synergetic networks of activity. A complete network of activity that needs to be considered:

Recent research suggests that the nervous system controls muscles by activating combinations of muscle synergies to produce a wide repertoire of movements
(Ting & McKay, 2007)

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Different functions may draw on the same muscles, but this does not mean that the muscles are recruited and controlled in the same way.
(Kent 2015)

Coordination of jaw muscle activity for speech production sometimes has been modeled using nonspeech behaviors. This orientation has been especially true in representations of mandibular movement in which the synergy of jaw muscles for speech production has been suggested to be derived from the central pattern generator (CPG) for chewing. […] Contrary to some of the models discussed, continuous speech production yielded activation patterns that were clearly not related to coordinative patterns generated by the chewing CPG.
{Moore 1988}

recent investigations have provided strong support for the existence of separate and distinct mechanisms for speech and nonspeech coordination in adults (Moore et al., 1988) {Moore 1996}

Same muscle, different process of engagement. This could go some way to explaining why NSOMEs are proving to have limited efficacy in helping patients with their speech: they aren't speech.

Why are NSOMEs still so widely used?
If they are ineffective, how come they are still used in speech therapy?

Some of these reasons may be that the procedures can be followed in a step-by-step "cookbook" fashion; the exercises are tangible with the appearance that something therapeutic is being done at a physical level […]there is a lack of understanding of the theoretical literature addressing the dissimilarities of speech-nonspeech movements; the techniques can be written out on handouts for caregivers to use outside of the therapy setting; a wide variety of techniques and tools are available that are attractively presented for purchase; many practicing clinicians do not read peer-reviewed articles but instead rely on unscientific writings (e.g., websites, the popular press, marketed therapy tools, etc.); they attend non-peer-re-viewed activities (e.g., continuing education events) that encourage the use of these activities; parents and occupational/physical therapists on multidisciplinary teams encourage using NSOMEs; and frequently other clinicians persuade their colleagues to use these techniques, which is reminiscent of a what Kamhi said: "[N]o human being is immune to hearing a not-so-good idea and passing it on to someone else"
(Lof 2008)

This is a slightly harsh passage, but we could take a caution from it: it is easy to assign exercises to a singer without thoroughly examining their efficacy. They seem to adhere to the dictates of common sense and logic, so we cease our questioning there. And if other people are doing it, it must be fine...

Does singing have anything to do with speech?
Of course, our final question in this essay should be: is any of this relevant? Do NSOMEs, which are used in speech therapy, bear relevance to similar exercises when used by singing teachers?

Your answer would in part depend on what you think singing is, or should be. If it is heightened communication through sung text, then the relevance is easy to see. If you think singing is primarily specialised sound making, your answer may be different. And of course, your answer may lie somewhere between these poles.

Perhaps, just asking the question is important.

Whatever belief you hold, I think the uncertainty regarding the use of NSOMEs might at least give us pause for thought. We can consider what the *task* of singing is, and how exercises that are not engaged in that task may or may not improve our action in that task. Even if singing is specialised sound making, might the same

"task-dependence" condition hold for singing exercises? Could techno-physical exercises be reduced in efficacy unless they share the intention to produce that sound?

To avoid the semantic satiation of e e cummings' babbling intellectual, sounds must keep their meaning. Technique only offers a means to an end, not meaning itself.

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