A Consideration of the Role of Intention in Vocal Instruction.

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Abstract.

How is a singer's intention *as* they learn relevant to *how well* they learn? How might the implied intention of vocal exercises and instructions be relevant to their success? After a brief consideration of what intentions might motivate a singer, vocal exercises and instruction are categorised on the basis of the intent they seem to imply. Research into the role of intent in the neural organisation of movement is discussed. Practical research that sheds light on the role of intention in learning is then surveyed: specifically, research that investigates the relative effectiveness of internal and external foci, the role of intention in movement rehabilitation after stroke, and the efficacy of non-speech oral motor exercises in speech rehabilitation is presented and discussed. This research directly or indirectly suggests that a learner's intention as they learn has relevance to the success of that learning. Some of the research comes from fields related to vocal pedagogy- speech therapy in particular. If intention were important for learning in singing, what would be the implications for the categories of vocal exercise and instruction outlined? The article hopes to offer all those working with singers a perspective from which to consider the instructions and exercises of vocal pedagogy.

What intention motivates classical singing?

An intention is an aim or a plan to do something: intention motivates action. The intention to pick up a cup motivates and coordinates the movement of arm, hand and fingers to achieve that. The intention to stop another's dangerous action motivates a cry of alarm. What intention might motivate a classical singer? One possibility is the intent to communicate (effect change in another) using word-sounds (words extended in resonance, pitch and time in comparison with spoken words, but nevertheless bearing some relation to them). Another is the intent to produce beautiful, resonant tone (across all pitches, vowels and dynamics). Other possibilities can be imagined. Whichever intention is felt to motivate classical singing, how might that intention be relevant to its teaching?

The effect of instructions and exercises on intention.

A wealth of exercises and instructions are found in vocal pedagogy. An extensive literature, public masterclasses, anecdote, discussion and conference papers attest to this. The purpose or presentation of some of these exercises can affect the intention of the singer. Some of them suggest, or demand, that the "intent to sing" (assuming that is felt to have something to do with sound or communication) is replaced by the intent to do something else. Sometimes, this change of intention is *necessary* in order to perform the exercise or follow the instruction. Sometimes, the intent to sing might be preserved, dependent on the language and approach used. We could categorise exercises in vocal

pedagogy on the basis of the intention they suggest or require. Three such categories are identified here: those of anatomic intent, borrowed intent and acoustic intent.

Instructions and exercises of anatomic intent ask singers to intend to manipulate part or parts of their body. The exercises can be performed in silence or during some form of sound-making. In both cases, the intent of the singer whilst fulfilling them is some form of self-directed physical manipulation. The hope is that the manipulation improves vocal performance on some measure. Anatomic intent is importantly different from bodily awareness, as discussed later.

Instructions and exercises of borrowed intent are those which attempt to use the physical co-ordinations of one act, say yawning, swallowing or sobbing, to train or elucidate the physical co-ordinations of singing. They substitute the intent to sing with the intent to do something else, something perceived as requiring a physicality similar to that required for the act of singing. The hope is for a transfer of relevant physical awareness, knowledge or skill.

Instructions and exercises of acoustic intent require an intent to produce a particular kind of sound. If singing is communicating through word-sounds, acoustic intent concerns those sounds, independently of their communicative aim. Scales, arpeggios, fricatives, glides, semi-nasals, vowel rows and meaningless phonemes are included in this category. The purposes of such exercises include finding chiaroscuro resonance across vowels, dynamics and pitches, and solving registration issues. The relationship between sound and

meaning is subtle, to say the least. Whatever the relationship is felt to be, acoustic intent remains importantly different from anatomic or borrowed intent.

Absent intent might also be mentioned: it is entirely possible to sing without any purpose at all. A singer might sing a song in their first language, reach the end, and have no idea of what or why they just sang.

Examples of exercises of anatomic intent.

Silent

Tongue protrusion or "push-ups" for, say, "tongue root tension" or tongue positioning.

Jaw manipulation, for example, to train the "lower mandible maneuver" (Nair, Nair, & Reishofer, 2016).

Cheek lifting, to engage the zygomatic arch, to aid in the "placement" of the sound.

Laryngeal/pharyngeal manoeuvres (maybe "raising the soft palate" "tilting the larynx" etc)

Lip pouting.

Whilst singing

All of the above.

Holding the tongue between teeth or holding the tongue with fingers.

Holding a pencil between teeth.

Opening the mouth wide.

Keeping the mouth near closed.

Any attempt at direct control of the abdominal musculature.

Examples of exercises of borrowed intent

The “beginning of a yawn” breath for pharyngeal space.

The “after-swallow” release, again for space.

The “sob-feel” for pharyngeal/laryngeal set-up.

The “happy surprise” breath.

Examples of exercises of acoustic intent

Vowel rows aiming for acoustic balance across all vowels.

Slides and glides to ensure smooth transitions between vocal registers.

The pursuit of descriptions of sound, such as *chiaroscuro, twang, blade, balanced, forward, focussed* etc.

The role of intention in organising movement.

The central nervous system knows nothing of muscles, it only knows movements

John Hughlings Jackson (Jackson, 1889).

Early neuroscientific investigations found that electrical stimulation of certain parts of the cerebral cortex reliably gave rise to movement and sensations in a particular part of the body (Penfield & Boldrey, 1937; Penfield & Rasmussen, 1950). This contributed to the idea of a somatotopic relationship between points on the cortex and parts of the body (Schott, 1993). That relationship was pictorialised by an artist, Mrs H P Cantlie, and entered popular discourse (Schott, 1993). However, despite appearances, the implied one-to-one mapping between brain and body-part was not intended (Conant, Bouchard, & Chang, 2014; Simonyan & Horwitz, 2011). The image was meant as an *aide-memoire* (Schott, 1993). It was such a powerful picture though, that various versions of it have shaped thought about how the brain organises movement and, to an extent, still do today (Brown, Ngan, & Liotti, 2008; Conant et al., 2014; Havel et al., 2006; Simonyan, Ackermann, Chang, & Greenlee, 2016).

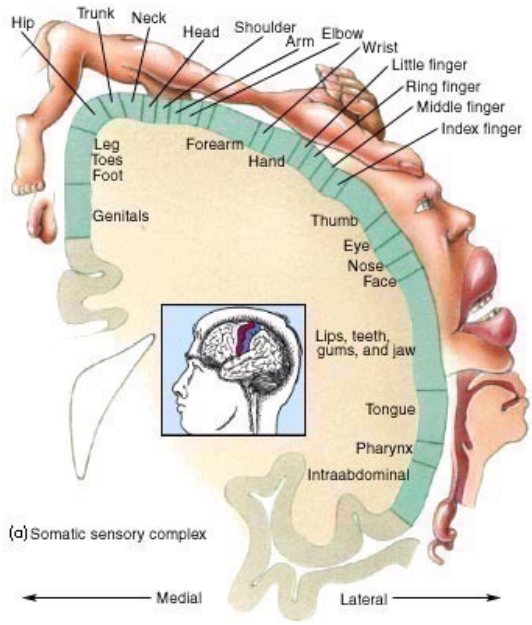

Figure 1 Motor Homunculus. Image credit: www.mhhe.com

This striking picture so ghoulishly suggests a somatotopic relationship between brain and body, that it sometimes obscures the more complex topography currently investigated. A topography in which it appears that parts of the body might be *multiply* represented, that these representations can have vague boundaries, be *intermingled*, *fractured*, and spread across several parts of the brain (S. Brown, Ngan, & Liotti, 2008; Conant et al., 2014; Havel et al., 2006; Simonyan, Ackermann, Chang, & Greenlee, 2016).

This alternative topography correlates with a different model for the way the brain organises movement (Marieb & Hoehn, 2007; Monfils et al., 2005). Instead of an "additive" model, where, say, in order to *point*, the "arm area" of the motor cortex activates in conjunction with the "finger area" to carry out the pointing, the organisation of movement

can be modelled as *suites of behaviour* or *synergies* (Graziano, 2016; Graziano & Aflalo, 2007; Schieber, 2001; Ting & McKay, 2007). A synergy is a group of muscles that are activated, and work, together to achieve a given task (Safavynia, Torres-Oviedo, & Ting, 2011; Ting & McKay, 2007). It has been proposed that movement is then organised in the brain on the basis of *task*, or *intent* (A. R. Brown & Teskey, 2014; Rizzolatti, Cattaneo, Fabbri-Destro, & Rozzi, 2014; Schieber, 2001). An intent to point coordinates movement through the activation of a distinct synergistic network (Capaday, Ethier, Vreeswijk, & Darling, 2013).

The role of intention in organising movement.

Different intentions appear to motivate the *same* part of the body *differently*. A finger used to *grasp* is activated differently from when that same finger is used, in a similar manner, to *scratch* (Rizzolatti et al., 2014). In the field of speech, similar movements in the jaw are activated differently depending on whether the intent is to talk or to chew (Green, Moore, Higashikawa, & Steeve, 2000; Moore, Smith, & Ringel, 1988). The lips are thought to be activated differently in speech and non-speech tasks (Ruark & Moore, 1997). The vocal folds likewise appear to be motivated according to task (Poletto, Verdun, Strominger, & Ludlow, 2004). The representation of the larynx in the human primary motor cortex is in close proximity to the representations of the lips, tongue and jaw, a network perhaps serving the task of vocalisation. In monkeys, the larynx area is closer to the pharynx. These

different topographies *perhaps* reflect the differential possibilities for volitional speech (Kumar, Croxson, & Simonyan, 2016). The intention to communicate in opera singers has been found to motivate a different response in the respiratory system from purely "technical" breaths (Foulds-Elliott, 2004). In general, different intentions seem to be served by different networks, even if "the same effectors are involved" (Weismer, 2006).

We might then ask: if movement is organised through intention, what role might intention play in improving movement? To consider this question, research into the development of motor skills and then into the rehabilitation of speech is considered.

The relative success of internal and external foci in motor learning.

Motor skills are those that rely on the movement and coordination of the human body. Motor learning is the development of motor skills and has been described as the "task-specific modification…of muscle synergies" (Hammond, 2002; Monfils et al., 2005).

When learning to move the body to fulfil a particular intent more accurately, to improve a motor skill, one of two types of focus can be adopted: internal or external. An external focus is one *outside* the body, onto an object, or onto the intended *effect* of the movement (the flight of the dart (Schorer, Jaitner, Wollny, Fath, & Baker, 2012), the swing of the golf club (An, Wulf, & Kim, 2013; Bell & Hardy, 2009; Wulf, Lauterbach, & Toole, 1999), the impact of the voice on the room (Atkins, 2017), or the movement of piano hammers (Duke, Cash, & Allen, 2011)). An internal focus, by contrast, is on a part of the

body: an attempt is made deliberately to adjust the coordination or position of that part of the body as movement occurs. The hope is that the adjustment enables the intention to be more effectively fulfilled (the dart is on target, the golf ball putted, the voice more resonant, the music more accurately played). It can be seen that an internal focus forces an anatomic intent, whereas an external focus might leave original intent intact.

A considerable amount of research has investigated the relative effectiveness of internal and external foci in improving motor skills. Much of the research is centred on sports science (Abdollahipour, Nieto, Psotta, & Wulf, 2017; An et al., 2013; Bell & Hardy, 2009; Lewthwaite & Wulf, 2017; McNevin, Shea, & research, 2003; Mornell & Wulf, 2018; Wulf, 2007, 2013, 2016; Wulf et al., 1999; Wulf, Shea, & Lewthwaite, 2010; Wulf & Lewthwaite, 2010) but some has been undertaken in various of the arts, including singing, speech, ballet and piano (R L Atkins, 2017).

The conclusion from much of the research is that an external focus is more effective than an internal in improving motor skills (Abdollahipour, Nieto, Psotta, & Wulf, 2017; An, Wulf, & Kim, 2013; Bell & Hardy, 2009; Duke, Cash, & Allen, 2011; Freedman, Maas, Caligiuri, & Wulf, 2007; Guss-West & Wulf, 2016; R. C. Jackson, Ashford, & Norsworthy, 2006; Land, Frank, & Schack, 2014; Marchant, Clough, Crawshaw, & Levy, 2009; Mentzel, 2016; Mornell & Wulf, 2018; Schorer, Jaitner, Wollny, Fath, & Baker, 2012; Wulf, 2007, 2013, 2016a; Wulf & Lewthwaite, 2010; Wulf, Shea, & Lewthwaite, 2010). Some studies found that the *further* from the body (the “more external”) the focus, the greater the

improvement (Bell & Hardy, 2009; McNevin et al., 2003). At least one study found an internal focus to be no better than no focus at all (Freudenheim, Wulf, Madureira, Pasetto, & Correo, 2010). A study into the improvement of woodwind playing found that an internal focus, for aspects of technique, led to a *worse* technical performance than an external focus on expression (Mornell & Wulf, 2018).

Focus and the improvement of singing.

The limited research that has so far been carried out into the effects of different foci in improving singing has found results in line with those above: external foci are more effective than internal at improving performance (R. L. Atkins, 2013; R. L. Atkins, 2017). In one study, participants were asked to sing whilst focussing on one of vibrato, the soft palate, or filling the room the room with sound. Ratings by expert listeners for ring and overall tone quality were higher the further the focus of attention moved from the singer (R. L. Atkins, 2017). It is also noteworthy that the singers in this study were not all able accurately to identify when they performed best: some reported that the internal focus condition produced their best performance, in disagreement with the listeners. Another study has found some support for the use of an external focus (singing to a point on the wall) over an internal focus (think about your breathing) in improving sung quality in amateurs (Mentzel, 2016). Interestingly, but probably irrelevantly as we shall see, one study found that an external focus improved oral-motor performance of the tongue in a non-speech task, whereas an internal focus impeded performance (Freedman et al., 2007). The

quantity of research is so far rather limited, but the early findings seem to be in line with many of those from sports science. More research though would be needed to establish with certainty that an external focus is more effective than an internal equivalent in improving sung performance.

Debates and clarifications.

The idea that an external focus is always more effective for motor learning is still debated (Collins, Carson, & Toner, 2016; J. Toner, Montero, & Moran, 2015; J. Toner, Montero, & Moran, 2016; J. Toner & Moran, 2014, 2016; Wulf, 2016a, 2016b). Subtleties and distinctions have been put forward. It has been suggested that expert performers might benefit from a temporary internal focus to reconfigure some aspect of their technique (Gray, 2004). Conversely, others have suggested that *novices* might benefit from internal focus instruction (Beilock, Bertenthal, Mccoy, & Carr, 2004). Another study found great flexibility and variety in the attentional foci reported by expert skaters: their focus points changed regularly during performance (Bernier, Trottier, Thienot, & Fournier, 2016). However, not many internal foci were reported, and it was not possible to assess their relative effectiveness. Questions have also been raised about the statistical validity and bias of some of the studies into motor skills, relying as they do on the extensive analysis of small sample sizes (Lohse, Buchanan, & Miller, 2016).

Part of the debate centres on clarifying exactly what is meant by an internal focus (J. Toner & Moran, 2016; Wulf, 2016b). A distinction has been made between an internal focus

and bodily awareness (Wulf, 2016b). An internal focus is an explicit attempt to affect the movement or coordination of part of the body: at the moment of action, the conscious focus of the mover is somewhere on or in the body, attempting to influence the movement of that part of the body. In contrast, bodily *awareness* can be maintained alongside an external focus: awareness is different from interference. Body awareness has been considered important in voice training (Nafisi, 2013).

Allowing for the ongoing debate and for further clarifications to emerge, the current balance of evidence suggests a carefully chosen external focus has more to recommend it than an internal equivalent.

Constraining Complexity.

Why might an internal focus be less effective than an external equivalent in improving motor skills? If someone is visibly mis-using a part of their body, it might seem efficient to correct that directly. Various studies have considered why this might not be the case. One theory advanced is the "constrained action hypothesis" (McNevin et al., 2003; Wulf, McNevin, & Shea, 2001). This hypothesis argues that an internal focus introduces a detrimental focus on the self that interferes with, constrains, automatic control processes and so disrupts coordination and efficiency. Supporting this, an internal focus has been found in some cases to reduce the efficiency of movement (Gray, 2011; Kuhn, Keller, Ruffieux, & Taube, 2017; Wulf & Lewthwaite, 2010). One study found that an internal focus led to greater muscle fatigue (K. Lohse, Buchanan, & Miller, 2016). An external focus, in

contrast, led to improved movement stamina. An external focus has also been associated with reduced brain and muscle activity in a given task (Vance, Wulf, Töllner, McNevin, & Mercer, 2004), and improved ability under pressure (R. C. Jackson et al., 2006). It has also been found that, if well chosen, a simple external focus can positively affect the response of the entire body (An et al., 2013).

Singing is a complex, highly coordinated activity where each articulator has many degrees of freedom. On one account the number of possible co-ordinations of the articulators of the vocal tract extends to one nonillion (Kent, 2015). Perhaps self-directed attempts to manage a single aspect of this complexity could be disruptive, whereas a carefully chosen external focus could inspire, coordinate and limit complexity in the service of a clearly defined intention. A well-chosen intention might also eliminate misuse, simply through the irrelevance of the misuse to the intention.

Internal Focus and the Alteration of Intent.

Overall, current evidence suggests that an external focus of attention is more effective than an internal equivalent. Exercises of anatomic intent require an internal focus, one that seeks to manipulate the body in some way (*elevate the soft palate so, position the tongue like this*)**:** perhaps they too are reduced in effectiveness because of their reliance on an internal focus. The very limited evidence so far available hints this could be the case.

We might speculate again, though, whether the problem is not the internal focus, but the change of *intent* that it necessitates. Maybe exercises of internal focus are less

effective because they alter the *intent* behind the movement during learning. Perhaps the alteration of intent leads to the constraint and disruption of automatic control processes Perhaps preservation of intent is important for learning. If so, problems with internal focus would merely reflect the loss of true intent. This is speculative in the case of focus research, but evidence from stroke and speech rehabilitation suggests a key role for intention in learning.

Intention in movement rehabilitation.

The role of intention in improving motor skills has been directly considered in the field of movement rehabilitation (Bayona, Bitensky, Salter, & Teasell, 2005; Kleim & Jones, 2008; Maguire, Sieben, & Bie, 2018; Safavynia et al., 2011). Several studies into rehabilitation after stroke have emphasised that a knowledge of the neuromuscular processes underlying movement can be crucial. A "state of the art" review into the effects of physical therapy for stroke rehabilitation in 2014 had as its full conclusion: "There is strong evidence for PT (physical therapy) interventions favoring intensive high repetitive task-oriented and task-specific training in all phases poststroke. Effects are mostly restricted to the actually trained functions and activities. Suggestions for prioritizing PT stroke research are given." (Veerbeek et al., 2014). The same paper emphasises that a crucial element in motor learning is that it is "aiming towards a clear functional goal".

Speech is often adversely affected by stroke, as well as by other disorders such as dysarthria and apraxia of speech. Speech therapy attempts to restore lost function. The

efficacy of different approaches in speech therapy has been investigated and, again, the findings point to a role for intention in successful speech restoration. The speech motor control system, like other movements, may also be organized by task, and speech therapies often reflect that both in approach and success (Bose & van Lieshout, 2012; Caudrelier, Schwartz, Perrier, Gerber, & Rochet-Capellan, 2018; Dworkin, Abkarian, & Johns, 1988; Mackenzie, Muir, Allen, & Jensen, 2014; Staiger, Schölderle, Brendel, Bötzel, & Ziegler, 2016).

The role of intention in speech therapy.

In speech and language pathology, a class of exercises known as non-speech oral motor exercises, (NSOMEs, also non-speech oral motor treatments, NSOMTs, or NSOMs) has been used for many years (Kent, 2015).

Whilst a precise definition of NSOMEs is debated (Kent, 2015; Lee & Gibbon, 2015), broadly they aim to improve the articulation and clarity of speech whilst, though, not speaking (Kent, 2015). NSOMEs can be sounded (quasi-speech sounds or babble) or silent, but they in some way exercise the articulators of speech, whilst not having communication as their aim. Examples of silent NSOMEs include lip-rounding, jaw moving, tongue protrusion, elevation or wagging and the isolated raising of the velopharyngeal arch (Kent, 2015; Lee & Gibbon, 2015; McCauley, Strand, Lof, Schooling, & Frymark, 2009; D M Ruscello, 2009; Dennis M Ruscello, 2008). Some NSOMEs use altered intentions, such as swallowing, sucking, blowing or yawning (Kent, 2015; Lee & Gibbon, 2015; D M Ruscello, 2009).

One of the aims of NSOMEs is to develop the strength and coordination of the muscles used in speech, using exercises that are not themselves speech (Lee & Gibbon, 2015; D M Ruscello, 2009; Schuette, 2011). The hope is that the strength, flexibility and coordination of the muscles used will be improved, and so speech will be improved. In this, NSOMEs can be seen to bear some similarity to various of the categories of exercises outlined above: they might (or must) proceed in absence of an intention to speak, just as exercises of anatomic, acoustic and altered intent might or must proceed in the absence of the intention to sing. It is this mirroring that makes findings from the research into their effectiveness relevant to the teacher of singing.

Recent reviews suggest that the majority of evidence provides little support for the use of NSOMEs in improving speech (Kent, 2015; Lee & Gibbon, 2015; D M Ruscello, 2009; Dennis M Ruscello, 2008; Schuette, 2011; Susanibar, Dioses, & Monzon, 2016). Debate continues about some of the precise definitions of the concepts involved: some researchers consider, importantly, that the concept of speech is not clearly defined, therefore its task or intention cannot be clearly defined (Kent, 2015; Maas, 2016). However, a considerable amount of research finds very little support for the use of NSOMEs in the improvement of speech, and the current balance of opinion seems against their use in speech therapy.

The task of speech.

The research into NSOMEs suggests that speech might be organised task-specifically. Some examples of the findings are given below, since they seem relevant to exercises of anatomic and borrowed intent in vocal pedagogy.

Tongue: One study found evidence that training the musculature of the tongue for speech was more effective when the training was task specific (Gommerman & Hodge, 1995). Non-speech tongue-thrusts have been found to have little effect on the improvement of the spoken /s/ phoneme in children (Forrest, 2002). The musculature of the tongue, and other oral musculature, is also different in kind from that of the limbs: stretching regimes that are effective for limb muscles but may not be for the tongue (Clark, 2005).

Larynx and Pharynx: A study found that the laryngeal musculature is activated according to task (Poletto et al., 2004). This study suggested the findings "limit the ability to use the same biomechanical models of muscle activity to predict movement across tasks". Velopharyngeal closure for speech can improve in speech-specific exercises but not in related NSOMEs (D M Ruscello, 2009). Swallowing is a different task from speech (Ziegler, 2003). Pharyngeal wall movement could be improved in non-speech tasks, but that improvement did not transfer to speech (D M Ruscello, 2009).

Jaw: A number of studies have shown that jaw movement control is task specific (Gentil & Gay, 1986; Moore & Ruark, 1996; Moore et al., 1988; Wilson, Green, Yunusova, & Moore, 2008). Research in very young infants at the earliest stage of development shows

that the jaw is used differently in speech from other behaviours such as sucking or chewing, suggesting task and development independence (Ruark & Moore, 1997). Even at 15 months old, babbling infants show similar jaw coordination to that found in adult speech, a coordination distinct from sucking or chewing (Moore & Ruark, 1996). Other studies also found that the organisation of the movement of the jaw for chewing was organised distinctly from the organisation for speech (Gentil & Gay, 1986). In general, the relevance of chewing and sucking to the motor activity of speech is questioned both in principle and practice (D M Ruscello, 2009).

Lips**:** Other orofacial musculature has been shown to be activated in a task-specific manner. Lip control is task specific (Bose & van Lieshout, 2012): even in infants, the lips were differently controlled in speech from chewing or sucking (Wilson et al., 2008).

In summary, *a wealth of clinical and experimental data provide evidence that "speech is special"* (Ziegler, 2003).

Double dissociations.

Further evidence for the special nature of speech comes from the dissociations found between speech and NSOMEs. Apraxia of speech does not affect the non-speech movements of the articulators, even though attempts to speak cannot activate those same anatomical structures (Bonilha, Moser, Rorden, Baylis, & Fridriksson, 2006; Ziegler, 2002). The reverse is also possible: the intention to speak can successfully activate a particular

articulator, whilst an NSOME cannot. Meaning*less* syllables can be articulated less quickly than their meaning*ful* equivalents: meaning*ful* syllables are more successful in improving speech than meaning*less* phonemes (Bose & van Lieshout, 2012; Nelson, Perkell, & Westbury, 1984; Staiger et al., 2016; Ziegler, 2003).

As seen above, learning does not seem to transfer between NSOMEs and speech. Successful mastery of an individual, meaningless, phoneme, did not transfer to that same phoneme when part of a meaningful syllable (Caudrelier et al., 2018). Even as NSOMEs are successfully improved, the equivalent speech movements may not be (Aichert & Ziegler, 2013; D M Ruscello, 2009). In contrast, the greatest possible overlap with "speech" leads to the greatest learning (Aichert & Ziegler, 2013; Caudrelier et al., 2018). These studies again suggest that speech skills are organised by task or intention, and that learning only occurs when intention to speak is preserved.

There is another dissociation: that between the lack of evidence supporting NSOMEs and their continued use. Though their use does now appear to be declining somewhat in Australia, the USA and the UK, recent graduates might still not be aware of the issues surrounding the use of NSOMEs (Brumbaugh & Smit, 2013; Lof & Watson, 2008; Miller & Bloch, 2017; Rumbach, Rose, & Cheah, 2018). It has been asked why, if indeed NSOMEs are not efficacious, they continue to be used. One writer "suggested that nonefficacious clinical techniques perpetuate because of their ease of understanding and implementation, factors

which often override the use of more scientifically based techniques" (Kamhi, 2004; Lof & Watson, 2010).

NSOMEs and intention in vocal pedagogy.

It has been suggested that NSOMEs fail to improve speech because they are not motivated by the intention to speak: NSOMEs are exercises of altered intent. They work the articulators of speech, but without the motivation of speech. The exercises appear irrelevant to the task of speech, so perhaps do not engage the synergy which motivates speech, and learning does not occur. An NSOME might not be effective, whilst a similar *speech-based* exercise, aiming at the same improvement, is.

These findings again point to a role for the preservation of intention in successful learning. In order to improve speech, the exercises used should be motivated by speech. Perhaps then, whatever intention is thought to inspire singing would best be preserved in exercises designed to improve it. If non-speech oral motor exercises are ineffective, perhaps non-singing oral motor exercises are as well.

No direct research into the role of intent in classical voice training is known by this author. The limited research into *any* vocal pedagogic method (as distinct from the anatomy or physiology of voice) is perhaps worthy of note for all pedagogues and singers. Reviews have commented on this (Crocco, Madill, & McCabe, 2017). If a reasonable conclusion from the research into NSOMEs is that there is a role for intention in successful

learning in speech therapy, we might ask whether the same applies in the field of vocal pedagogy.

Discussion.

This article has surveyed research into the relative effectiveness of different ways of improving the movement of the human body. The findings, directly or indirectly, suggest a role for intention. In exercises and instructions designed to improve movement, the intention that motivates a movement might best be preserved for effective learning to take place. There is direct evidence for this proposition from the research into stroke rehabilitation and speech therapy, and indirect from that into internal and external foci. Some of the research into focus in singing, which suggests that external foci are more effective, also hints at a role for intention in vocal pedagogy. Direct research would be revealing.

If the findings *were* thought relevant to vocal pedagogy, what implications would they have for exercises of altered intent?

Exercises and instructions of anatomic intent replace communicative intent with anatomic and require the adoption of an internal focus. Internal foci have been found to be not as effective for learning as external equivalents and removing the intent to communicate seems to render NSOMEs ineffective. Exercises of anatomic intent might suffer those same problems. It is worth re-noting, that even if NSOMEs themselves improved with practice, that improvement did not transfer to speech.

Exercises and instructions of borrowed intent seek to elucidate the physicality of singing through the physicality of, say, yawning, sobbing or swallowing. If movement is organised by intention, and motor learning is intention specific, these exercises might be limited in efficacy. Evidence from NSOME research has found exercises such as blowing, sucking and swallowing of limited use in improving speech.

Exercises and instructions of acoustic intent seem more helpful. They encourage an external focus and they appear closely related to the intent to sing. If the intent to sing is intending to make a sound to effect external change, exercises of acoustic intent share at least the sound part of that. They can easily share all of it with only a minor reframing. They also avoid the limitations of internal focus.

There is some evidence that acoustic intent does in fact play a role in vocal production. It has been proposed that the motor control system for speech is organised by auditory perceptual targets (Bouchard, Mesgarani, Johnson, & Chang, 2013; Gracco & Abbs, 1986; Guenther, Hampson, & Johnson, 1998; Hickok, 2012; Perkell et al., 1997). One paper suggests *it is uncontroversial that auditory brain regions play a role in speech production* (Skipper, Devlin, & Lametti, 2017). Experiments have shown that simultaneous auditory feedback which falsely alters the perception of intoned vowels causes speakers automatically to adjust articulator positions to compensate (Houde & Jordan, 1998; Purcell & Munhall, 2006; Shum, Shiller, Baum, & Gracco, 2011). This evidence might support the

historic pedagogic idea that acoustic intent coordinates the articulators in pursuit of sound and give backing to the use of acoustic intent in effecting physical change.

Conclusion.

This article surveys research that directly or indirectly considers the role of intention in learning. The findings might be summarised as follows:

- Intention appears relevant to the organisation of movement in the brain.
- Intention has been found important for the rehabilitation of movement after stroke.
- The lack of relevant intention is considered a reason why non-speech exercises appear to be ineffective in improving speech.
- The alteration of intention forced by the adoption of an internal focus *could* be a reason why internal foci seem less effective than external equivalents in learning.

It is reasonable to suggest then, that intention seems relevant for successful motor learning in a variety of fields, some closely related to singing.

If the preservation of intent were thought important for learning in vocal pedagogy, it would suggest that whatever the physical skills of elite classical singing are felt to be, those physical skills might best be learned through exercises and instructions that preserve whatever intention is felt to motivate a classical singer. If a physical change is needed for improved sound, it might best be effected *through* the sound rather than through the physicality. Even better, perhaps, it might be effected through the *purpose* of that sound.

Approaches that rely on anatomic or borrowed intent, on the other hand, might be investigated for efficacy.

More widely, intention offers a useful frame for thought in classical voice pedagogy. Instead of reaching for a physical analysis, a singer's "technical flaw" might be considered by asking what intention that flaw is attempting to serve. A solution might then be proposed that utilises an alternative intention. This perspective is of course not new: it is found in historic and current pedagogic methods. However, a reliance on intention can sometimes seem insufficiently "technical" or scientific: it can lack authority. This article hopes to go some small way to balance the issue.

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