7. Preliminary tests of the effect of Kinaesthetic Motor Imaging (KMI) on muscles involved in singing using *Embodima ™* gestures

Though imagery is widely used in vocal pedagogy there have been almost no scientific studies into the effect this has on the activity of muscles that are involved in singing. The most direct way of studying this is to record the electrical signals that the muscles generate when they are active. This is difficult to achieve in most of the muscles of singing, being either too deep, hidden under other structures or, in the case of the neck and larynx, requiring the insertion of needles into the throat[1] – not a popular test for singers!

The easiest muscles to study are involved in breathing and posture. It was these muscles that were the subject of preliminary studies with Dr Damon Hoad at University College London and later with Dr Alan Watson at Cardiff University. Selected gestures from the *Embodima ™* lexicon were used in studies of post Grade 8 choral singers from University of Oxford, and 8 RWCMD vocal students. Adhesive electrode patches were attached to the skin to pick up signals from the muscles beneath using Electromyography (EMG)[2]. Video/audio recordings were also made.

The subjects, who had never encountered KMI/ Embodima gestures, were asked to sing a set of vocalises and a folk song (Bobby Shaftoe). Immediately afterwards they were asked to sing the same set of vocalises and song but this time *with* the gestures. Any change in the level of activity recorded in the muscles would indicate that the gesture had become *embodied*. Such a test could demonstrate the principle of KMI training in its simplest form.

Due to the difficulty of not being able to record from all of the muscles of singing due to position and accessibility, it is not possible to show all these co-ordinations at work. Here, therefore, for the sake of simplicity, we show the activity of single muscles. The object of

KMI is to activate whole sets of muscles, but here we show two examples from lateral abdominals and erector spinae only.
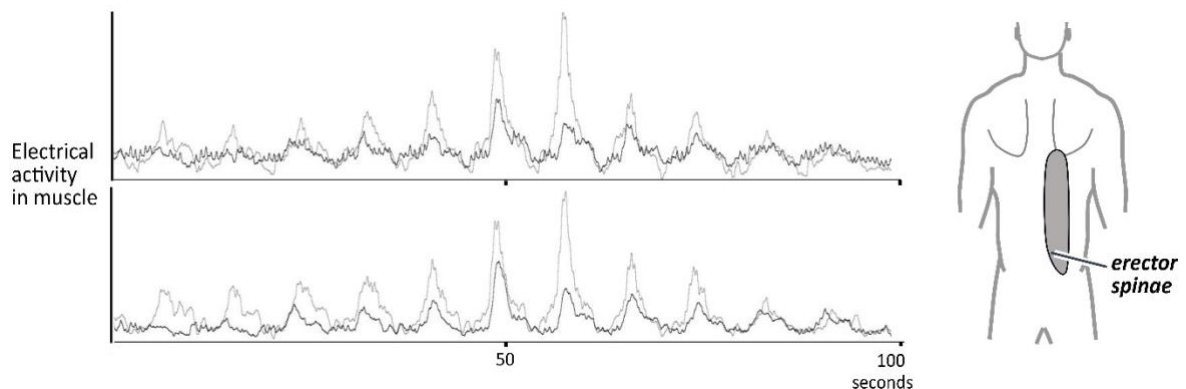

Figure 1 shows the effect of using the 'conger eel' gesture/image on the erector spinae muscles, (these are large postural/support muscles in the back). The 'conger eel' is a hand gesture that replicates the movement of the eel against resistance and is particularly related to abdominal support in connecting and maintaining breath in legato singing (see previous article). This was applied to the vocalise of rising and falling 8 note scales, increasing and decreasing pitch in semitones; (black=before, grey=after).
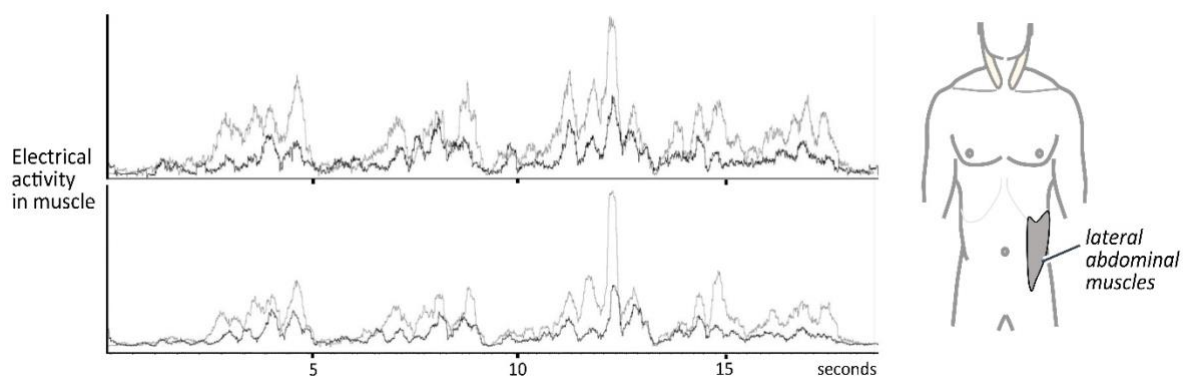

Figure 2 shows the end result of using *Embodima* gestures in the folk song 'Bobby Shaftoe'. Notice the increased activity in the lateral abdominal muscles which are active in exhalation, sustaining the vibration of the vocal folds during singing and maintaining vocal support. The key singing muscles tested are shown to be much more strongly engaged after application of KMI gesture; (black=before, grey=after).

Though these studies are of a preliminary nature, involving a relatively small number of singers and a limited range of singing tasks, they provide the first objective evidence that the use of KMI gesture leads to immediate changes in patterns of muscle use. Analysis of this data was either statistically significant ($p \leq 0.05$) or close to significant ($p \leq 0.06$).

As shown in these figures, the immediate response is strong and energetic. This is due to the way in which the gestures can activate the motor, pre-motor and primary sensory cortical areas of the brain to activate and co-ordinate muscles that are not controlled actively or singly, but in groups.

There is not room here to go into all the aspects of a variety of KMI tests carried out over nine years and we have presented the above findings from one small study. Results were also judged by expert vocal coaches drawn from AOTOS in a series of 'blind' audio assessments of the subjects taken during the EMG testing. They were asked to choose between anomised before/after recordings and opted for the KMI gestured recording in 80% of the subjects. Extensive pilot studies were also assessed in 2015 by Betty Roe MBE and Dame Felicity Lott.

[1] Hillel AD. 2001. The study of laryngeal muscle activity in normal human subjects and in patients with laryngeal dystonia using multiple fine-wire electromyography. Laryngoscope 111(4 Pt 2 Suppl 97):1-47.

[2] Watson AHD, Williams C, James BV. 2012. Activity patterns in latissimus dorsi and sternocleidomastoid in classical singers. Journal of voice 26(3):e95-e105.

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