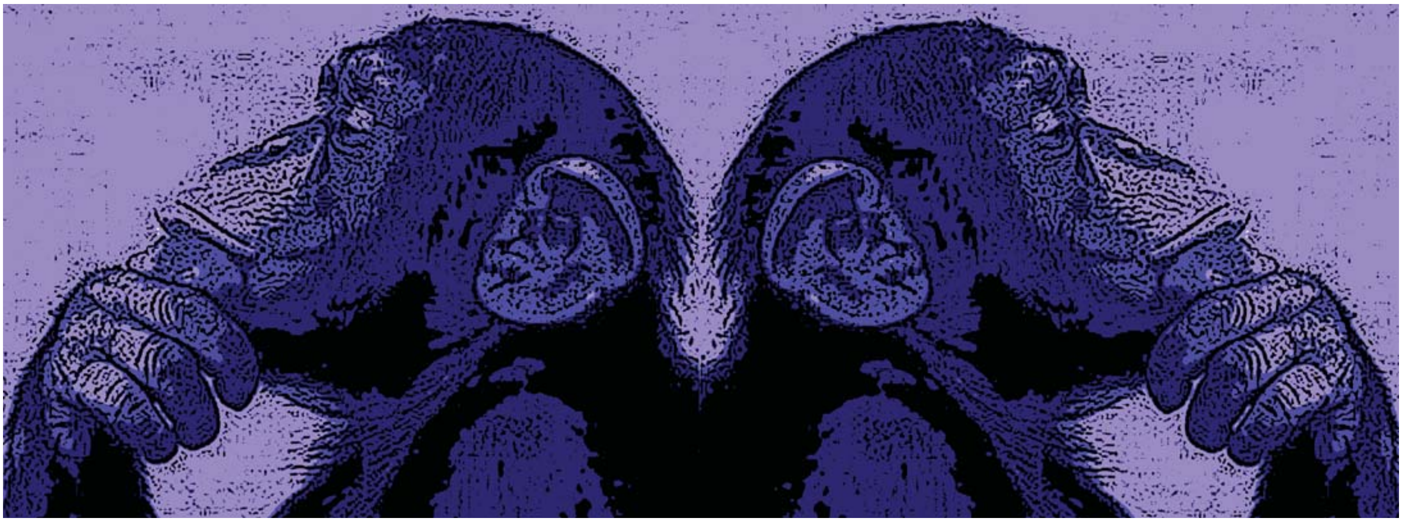
MONKEY SEE, MONKEY DO



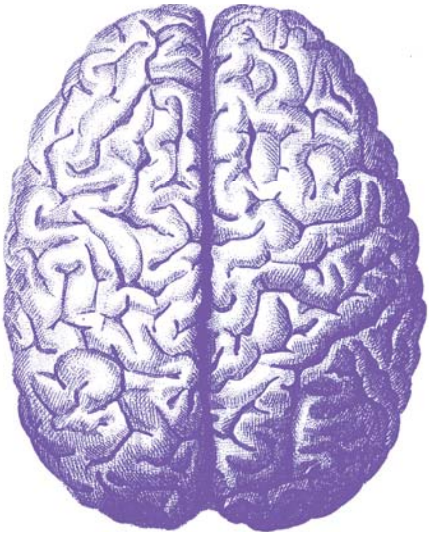
RIIKKA PIETILÄINEN-CAFFREY

Riikka Pietiläinen-Caffrey
Visiting Assistant Professor of Choral Music
Whitman College
pietilrk@whitman.edu

THE CHORAL CONDUCTOR AND THE MIRROR NEURON SYSTEM

Suppose I am holding a cup of water in my hand, but I tell an audience that the cup is filled with vinegar. Suppose I take a sip from the cup. Most likely the entire audience will grimace as I am drinking. In a choir rehearsal, if I model a deep breath at the beginning of a *fortissimo* passage, the choir will take a deep breath and enter with gusto. Current scientific research suggests that the explanation for the audience's reaction to the vinegar and the choir's reaction to breath may lie in the mirror neuron system—a system believed to be responsible for mimicry and creating empathetic emotions. More broadly, the mirror neuron system is associated with understanding actions and learning by imitation.[1] It is also responsible for the human ability to recognize intentions of actions performed by other humans.[2]

The mirror neuron system is part of our everyday communication, and as conductors we use it instinctively in our choral classrooms. We also send subconscious nonverbal messages that are transferred to singers. In recent years, various studies have been conducted on how observers will mimic body posture, tone of voice, pronunciation, facial expressions, and even breathing rates.[3] By understanding how the mirror neuron system functions and realizing how it can contribute to a choir's response, conductors can prevent and solve common issues related to a singer's alignment, breathing, expression, and tone production. This article will provide empirical data to support knowledge we have gained from our own experiences in the choral classroom and on stage, demonstrating how Rodney Eichenberger's iconic phrase "What they see is what you get"[4] can be scientifically explained by the mirror neuron system.



THE MIRROR NEURON SYSTEM

Modern-day science attributes the discovery of mirror neurons to a team of researchers led by Giacomo Rizzolatti from the University of Parma. These researchers noticed that neurons of a monkey's premotor cortex discharge "both when the monkey does a particular action and when it observes another individual (monkey or human) doing a similar action."[5] Two main hypotheses were drawn from the studies: imitation and action understanding are facilitated via the mirror neuron system.[6]

> The proposed mechanism is rather simple. Each time an individual sees an action done by another individual, neurons that represent that action are activated in the observer's premotor cortex. This automatically induced, motor representation of the observed action corresponds to that which is spontaneously generated during active action and whose outcome is known to the acting individual. Thus, the mirror system transforms visual information into knowledge.[7]

Neurophysiological and brain-imaging experiments suggest humans have a mirror neuron system similar to the primate neural system.[8] Whereas the mirror neuron system activates in monkeys only when an action has a target object, in humans it activates when observing actions even without the target object. In other words, a monkey's mirror neuron system will fire if it is observing a hand grasp an apple, but a human's mirror neuron system will also activate in response to a hand in motion forming an action, such as conductor's gesture. Rizzolatti and Craighero further state that these specific properties of the mirror neuron system might contribute to the capability of human imitation.[9] Learning in a choral rehearsal transpires largely via aural imitation. When working with untrained singers who do not read music, or even with trained singers who are learning new repertoire, language, or style, a significant portion of the learning process will occur via imitation.

Besides imitation and understanding the actions of other humans, the mirror

neuron system plays an important role in understanding intentions. A team of researchers led by Marco Iacoboni conducted studies using functional magnetic resonance imaging (fMRI).[10] Volunteers in the experiment were shown hand actions with demonstrated intention that allowed them to comprehend the action and hand actions without demonstrated intention. For example, if one has a plate of food in front of them and they pick up the fork, the intention (the goal) is to put the food in their mouth. If one has a fork in their hand but no food on the table, it is almost impossible to detect the intention. The experiment showed heightened mirror neuron activity for intentional actions. The team came to the conclusion that in addition to understanding actions, mirror neurons are responsible for interpreting human intention. This led to further studies on how different parts of the mirror neuron system relate to actions with different goals.[11]

GESTURAL COMMUNICATION

Rizzolatti and Arbib argue that speech evolved mostly from gestural communication and that the neurophysiological reason behind the evolution of language may lie in the mirror neuron system. We can understand the actions of a mime; likewise, two speakers who share no common language can still communicate via gesture, because the gestures for many actions are shared between diverse cultures. There is, then, an obvious parallel to the choral setting, where singers ideally rely on their conductor's nonverbal messages to sing at desired tempi, dynamics, phrasing and expression. Furthermore, this type of nonverbal gestural communication is obviously a necessity in concert settings.[12]

In 2001, Gentilucci and his team conducted experiments on the relationship between hand gestures and the size of the mouth opening. The study subjects were given two three-dimensional objects, one small and one large. They were supposed to grasp the objects and simultaneously open their mouths. The results showed that the size of the lip opening and the speed at which the lips opened increased when the movement was directed toward large objects. In another experiment the participants were asked to speak while grasping objects of different sizes. The results were again similar: grasping larger objects produced a wider lip opening and a louder volume. Further, the same results were found when the participants were shown pictures of *other people* grasping different-sized objects. Specifically, lip opening was at its widest and the spoken syllables at their loudest when the observed action was directed to a large object.[13] Translated to the choral setting, this could explain why large conducting gesture will produce louder choral sound, while a small gesture will help the choir sing *pianissimo.*

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ECHO NEURONS

Other than the visual cues and messages, the mirror neuron system also has a definite aural element. Marco Iacoboni's team suggests that the mirror neuron system will activate even to the sound of an action performed in the dark without the visual cues, such as hearing someone bite into an apple.[14] As early as 1930, Richard Paget had conducted experiments that shed light on audiovisual mirror neurons.[15] He used the example of eating because when we eat, our tongues and lips move in a specific manner. If, while making an eating gesture, we hum while letting air escape from our noses, we produce a sound that is almost universally recognized, similar to the universality of the gesture discussed above. Children, for example, are often encouraged to eat with commands such as "yum-yum" (English), "nam-nam" (Finnish)," or "nanna" (Arabic). These commands all resemble the universal sound of eating while also encouraging our mouths and tongues to move similar to the eating pattern. Rizzolatti and Craighero's hypothesis suggests that the premotor cortex—the part of the brain that controls repetitious or patterned motor skills—discharges in response to that sound, even without the actual digestive action.[16] They explain further that these auditory mirror neurons, which can also be called echo-neurons, developed from the audiovisual mirror neuron system.

An auditory "echo" element could be added to Eichenberger's theory. While mirror neuron research mostly concentrates on the visual, as in all music making, choral settings do have an obvious aural element. The conductor is the aural vocal model for every singer in the rehearsal, whether they are aware of the fact or not. Aurally, the singers will imitate the vocal concepts, timbre, and vowels the conductor is demonstrating. Singers will move their mouths and lips to form the vowels and sounds they are hearing, often without a conscious thought process. In addition to purposeful vocal modeling, which includes breathing, it is crucial for all conductors to use accurate terminology when explaining concepts related to vocal pedagogy. Verbal communication *must* match the nonverbal communication observed via mirror neurons. Verbal instructions, if inaccurate or wrong, will create confusion and possibly even tension or irritation in the singers. One example of wrong instruction is when a choral conductor asks the choir members to widen their sternums. Since the sternum is a flat bone, the instruction to "widen your sternum" is not only wrong but physically impossible.

FACIAL INTERACTION

The science behind the mirror neuron system explains how a conductor's facial expression elicits emotion and expression from the singers and how a singer's facial expressions are then transferred to the audience, thus determining how the audience will interpret and experience the performance. A number of studies have been conducted on how music elicits emotion. In a study by Livingstone, Thompson, and Russo, they state:

> When musicians engage in the *production* of an emotional performance, facial expressions support or clarify the emotional connotations of the music. When musicians complete an emotional passage, the bodily movements and facial expression[s] that were used during production may linger in a *post-production* phase, allowing expressive communication to persist beyond acoustical signal, and thereby giving greater impact and weight to the music.[17]

They explain further that observers will spontaneously mimic facial expression, even when these expressions are displayed subliminally.[18] Previous research indicates that the mirror neuron system may be the neurological reason for facial mimicry, which in turn simulates the emotional state of humans.[19] While choral singing is an audiovisual experience, studies in 1993 by Davidson indicate that expressive intentions were most clearly communicated visually.[20] The visual element in the form of facial expression showing unified, appropriate emotions is an important element of any choral concert.

To prove their theory, Livingstone, Thompson, and Russo conducted two experiments. The eight participants in the first experiment all had musical training. Reflective markers were placed on participant's faces, and the results were monitored using three-dimensional motion capture equipment, including infrared cameras. The data from the motion capture allowed the researchers to study the facial movements associated with emotional singing. The second experiment comprised four musically trained participants, and the data was recorded using electromyography.[21] In the second experiment, electrodes were placed on the participants' zygomatic major muscle (the muscle used when smiling) and corrugator supercilli muscle (the primary muscle used when frowning) to record muscular activity during emotional singing.

In both experiments, the participants were shown eighteen video recordings of a singer singing six phrases. Each of the six phrases was performed with three emotions—happy, sad, and neutral—and the participants were asked to observe and reproduce the given emotion. During the first experiment, participants were also asked to identify the given emotion from a list of expressive terms. The participants were able to identify the correct emotion with 97.62% accuracy. The results from the first experiment revealed that eyebrows and lip corners were the most expressive facial features for measuring facial muscle movement during different emotional states, which confirms what a choral conductor already knows from experience: that eyebrows are one of the most expressive and therefore important (and potentially dangerous) tools of a conductor.

> **"Musical activities occur in groups of varying sizes and involve imitation, intention, emotion, and synchronization of physical actions—all elements associated with the mirror neuron system.**

The second experiment indicated that the participants' zygomatic (smiling) muscle activity peaked in happy songs, while the corrugator (frowning) activity peaked during sad songs. Based on this experiment, Livingstone, Thompson, and Russo noted that emotional facial expressions enhance the auditory experience.[22] Further experiments by the author of this article showed significant confusion of listeners and of choir members when a sad text was sung with exultant joy or when the choir sang a happy pas-

sage with a mournful conductor. The emotional palette of the conductor is ideally much more refined than the three basic emotional states of happy, sad, or neutral, and careful score study and preparation should also include emotional intentions.

MUSICAL EXPERIENCE

Katie Overy and Istvan Molnar-Szakacs have linked the mirror neuron system with musical experience, explaining that music making is a multisensory social activity that requires auditory stimulation. Musical activities, such as choral singing, occur in groups of varying sizes and involve imitation, intention, emotion, and synchronization of physical actions—all elements associated with the mirror neuron system. Musical experiences in groups also necessitate that participants become involved in activities that facilitate social learning such as leadership, competition, and individual and group expression.[23]

Overy and Molnar-Szakacs's model, the Shared Affective Motion Experience (SAME), suggests that besides auditory signals, musical sounds are perceived as "intentional, hierarchically organized sequences of expressive motor acts behind the signal."[24] They propose that there are multiple levels of motor hierarchy, and the music will be understood and decoded on these levels based on the listener's level of expertise. A professional musician, for example, will decode the music from emotional objectives to technical aspects, but an amateur may only be able to understand basic aspects such as beat in addition to the emotional intents.[25] When working with amateur singers in a choral rehearsal, desired vocal timbre may be reached using examples such as light and heavy mechanism (feather vs. brick), while trained singers would be able to apply terms such as head, chest, and mixed voice.

Similar results were discovered in experiments conducted with dancers. Lynn Helding describes an experiment conducted with two groups of dancers, one consisting of members of the Royal Ballet of London, and the other of seasoned performers of *capoeira,* a Brazilian fighting dance. The subjects lay still while their brain functions were monitored with magnetic resonance imaging (MRI). The test subjects watched participants of each group perform. The mirror neuron system showed heightened activity when the subjects were watching the style in which they were trained to perform. The results were confirmed by a group of untrained dancers while they watched performances of both dance styles. Neither style attracted heightened neural activity in the untrained dancers.[26] The trained dancers, like the trained musicians, were able to experience and collect information about the performance in multiple motor activity levels.

When we work with professional and trained musicians, it is crucial to pay close attention to the messages that are shared via the mirror neuron system, both verbally and nonverbally. Nonverbal messages may include conductor's tone of voice when speaking to the ensemble, conductor's preparedness and knowledge of the music and score, and possible misalignment in conductor's posture and breathing. While singers will decode information as individuals, choral rehearsals are also emotional group learning situations where social drive may be heightened and both irritation and happiness spread fairly easily. Overy and Molnar-Szakacs propose that music can convey the actions and the emotional state of another person. They go so far as to suggest that "this in fact may be at the core of musical experience—not the nature of the acoustical signal per se, or the ability to perform complex motor skills, but the sense of human interaction."[27] Shared music making has the power to communicate both social and affective information, and produce the sense of being a unified ensemble.[28]

PRACTICAL APPLICATIONS

How does this research on the mirror neuron system relate practically to choral conducting and choral rehearsals? A number of studies conducted on an individual's perception of musical performances indicate that the listener will mimic not only the facial expression but the tone of voice, pronunciation, gesture, body posture, and breathing rates.[29] Singing in a choir requires synchronized physical actions by all participants; the choral experience is a social learning situation where the choir is "the monkey." Conductors can learn how to use the mirror neuron system to their advantage and address possible problems nonverbally or avoid them altogether. In a concert setting, nonverbal communication is the only tool a conductor has; even in a rehearsal setting, it is preferable to address musical issues first nonverbally. For example, the choir inhales loudly and slightly raises their shoulders in the beginning of every passage. The conductor should check his or her inhalation, and for the next entrance, release any shoulder tension and take a low, relaxed breath. Or the choir constantly sings too loud in a *pianissimo* passage. The conductor should again check his or her gesture to see whether the size and the quality of the gesture matches the desired dynamic level.

Most conductors are aware of the advantage of keeping the choir singing versus stopping to talk, especially at length, at which point many of the singers begin tuning out. Anyone still in doubt as to whether a choir relies more on nonverbal instructions may conduct a simple experiment that will testify to the power of mirror neurons. If a conductor who is facing a choir raises his or her right arm and verbally asks the singers to do so, many of the singers will raise their left arm, therefore mirroring the conductor's nonverbal cue.

How does the mirror neuron system affect a singer's stance? Some singers will always stand with more weight on one foot with their hands at their sides or directly in front in the fig leaf position. The conductor should pay attention to his or her feet to be sure they are shoulder-width apart and that weight is evenly distributed on both feet. A conductor's balanced alignment will produce similar alignment in singers, giving them a model for optimal vocal production that is visually pleasing to the ensemble and the audience.[30]

Extrinsic muscle tension will be observed and unconsciously imitated by the singers. With ideal alignment, the conductor has a tension-free neck—able to tilt the head both left and right, and up and down. Many conductors lean their heads to one side; if you see your students tilting their heads to one side, pay attention to your own neck alignment. Furthermore, habitual neck tension will contribute to overall body tension, possibly having a negative impact on a choir's tone production and vocal quality.[31]

A singer's awkward hand positions may also result from tension in the conductor's shoulder blades. A conductor should always be kinesthetically aware whether or not he or she is using the entire arm for conducting gestures. The patterns, if needed, can still be small and concise, but the involvement of the entire arm structure, including the collar bone and the shoulder blade, will result in free and organic gestures.[32] Choral rehearsals often last from 50 to 120 minutes, and most of the time singers will be holding their folders. Shoulder blade tension will not only affect awkward hand positions but will also affect the way singers are breathing.

To help the choir stay tension free and have a balanced alignment, one may benefit from teaching their singers what is known as "monkey—the position of mechanical advantage" in Alexander Technique. In "monkey," singers will stand hip-width apart with feet slightly turned out and start moving their knees forward toward the toes while bending at the hip joints and shifting the weight back. Arms will drop down and the spine will lengthen.[33] This position is very similar as the basic stance in many types of sports such as skiing, tennis, and tai chi, and it is most commonly used when sitting or standing up from a chair. This exercise will also usually create great merriment in the classroom, which, in addition to returning to a neutral, balanced body alignment, will give the singers and the conductor a momentary break from both verbal and nonverbal communication.

Most conductors know the importance of a preparatory breath and its effects on the choir's inhalation for the following phrase. Besides conductor's own inhalation, the other aspect may be the learned skill of human conversational interaction and the preparatory response time.[34] How to breathe while singing is beyond the scope of this article, but a few common misconceptions can be seen in the choral field, some of which may result from a conductor's own misconceptions and the singer's mirror neuron perception.

Noisy inhalations between phrases are often accompanied by raised shoulders. At a time when rigorous video exercise programs are readily available, some singers believe that breathing for singing includes "holding" the abdominals for inhalation. A conductor will need to pay attention to his or her own abdominals and release for the inhalation.[35] When the singers use the image of their conductor's proper bodily alignment, the mirror neuron system will trigger a significant release in their entire alignment. Another common misconception is the idea of the unmoving rib cage instead of ribs that move with every breath.[36]

Many singers also believe that loud inhalations will help them get more air and sing longer phrases. As an exercise, let the singers exhale all air out of their lungs, followed by a low and loud inhalation two times. On the third time, ask them to simply release their abdominals for an inhalation. Most singers find it surprising how much air they have. Singing requires coordinating the lungs and the abdominals. To experiment with the amount of release and coordination with the abdominal area, the conductor can try high, theatrical, pretentious laughter. This works especially well for staccato passages. Again, mirror neurons help the singers empathize with these given scenarios or mental images and connect to their own motor act of breathing.

The singer's mirror neuron system will respond to the quality and size of the conducting patterns. If the body, including abdominals, shoulders, and overall arm structure, is free of extrinsic muscle tension, conducting patterns can become more intentional and effective. If a conductor's gestures are large, the choir will sing loudly; if a conductor's gestures are small, the choir will sing quietly, regardless of the verbal instructions. Studies of the mirror neuron system are helpful for explaining scientifically what conductors already know by experience: the conductor can ask the choir to sing quietly numerous times, but if his or her conducting is not modeling the desired dynamic, the choir will not follow the verbal instructions and will instead follow the visual cues in the conducting gestures.

A conductor's gesture must also match his or her musical and emotional intent. Legato phrases require a conductor to model sustained or sweeping motions, and staccato passages will demand a more pointed ictus. If the choir is not responding in the desired way, the conductor can ask the choir to participate kinesthetically by, for example, pretending to push water in front of them for more sustained sound or to step with their feet for *marcato.*

Intentional gestures are also part of any warm-up that includes kinesthetic exercises. These gestures or kinesthetic exercises should involve a familiar motor act that can be used to assimilate the desired phrasing or vocal technique, such as tapping the fingers on one's arms similar to rain drops to sing staccato passages or spin the vocal tone evenly like whipping up a cream.

The facial expression and emotional state of a conductor is directly communicated to the singers via the mirror neuron system. Most singers have found themselves in situations where a conductor has said or done things that irritate, and as the irritation spreads, nothing the conductor says or does will make the situation better. At the described moment it is better to switch gears, take a short break, and reset one's own nonverbal communication. Stretches or shakes usually reset both conductor's and choir's alignment. It can also be helpful to have the choir walk around or even change the seating; this will allow the conductor to have a slightly different communicative surrounding.

Vocal modeling in the choral rehearsal is an aspect of the echo-mirror neuron system that is often shamefully disregarded. The choir will always attempt to imitate the sound the conductor is modeling. Constantly demonstrating the wrong technique or phrasing will cause the mirror neurons to memorize and reproduce the wrong sound. Modeling the unwanted sound is best used sparingly and should always be followed with the preferred sound using proper vocal technique. Both female and male conductors should also be cautious when modeling vocal production in the range of the opposite gender. While many male conductors can physically produce sounds in the female range, either in falsetto or reinforced falsetto, the actual vocal production for high notes is very different from that of female head or mixed voice. Similarly, while it might be physically possible for a female conductor to produce some of the tenor range, the best auditory

images are produced in chest or mixed register. Vocal modeling should always represent proper vocal technique in a range comfortable for the conductor.

ENHANCING MUSICAL GROWTH AND EXPERIENCE

The mirror neuron system will facilitate learning in a choral classroom, and it will affect alignment, breathing, expression, and tone production. A conductor needs to be kinesthetically aware of his or her own body, breathing, facial expressions, and gestures. Furthermore, one can correct and address a variety of possible issues without disruptive verbal instructions that can impede the flow of a rehearsal. As previously stated, there are a number of ways a conductor can address singers nonverbally by simply changing something in his or her own body, thereby transmitting nonverbal visual information to singers via the mirror neuron system. These changes can include but are not limited to conductor's alignment, breathing, hand and arm position, facial expression, quality and size of the conducting gesture, or even the distance between the singers and the conductor. As seen in the experiment with raising the hand, choral singers will observe, both consciously and unconsciously, a conductor's body movement. Obsessively moving body parts, such as pumping one's knees, may cause the singers to unconsciously imitate the conductor. In fact, unnatural movement of any body parts will distract the singers and draw their attention away from the conducting gesture and expressive singing.

Expressive and tension-free singing will be further transferred to our concert audiences through their mirror neuron systems. The choir will pick these cues and messages from the conductor, and the audience from the singers. By learning about mirror neuron functions, we can use them to enhance our students' musical growth and experience. Music making is an emotional process, and conductors have the responsibility to create a positive environment for learning and making music together. In an ideal choral rehearsal, we will support and educate our singers both verbally and nonverbally. Simply stated, monkey see, monkey do.

NOTES

[1] Giacomo Rizzolatti and Laila Craighero, "The Mirror-Neuron System," *Annual Review of Neuroscience* 27 (2004):169, 172.

[2] Marco Iacoboni et al., "Grasping the Intentions of Others with One's Own Mirror Neuron System," *PLoS Biology* 3, e79 (2005): 0529.

[3] Steven R. Livingstone, William Forde Thompson, and Frank A. Russo, "Facial Expression and Emotional Singing: A Study of Perception and Production with Motion Capture and Electromyography," *Music Perception* 26, no. 5 (2006): 475.

[4] Rodney Eichenberger, *What They See Is What You Get* DVD (Chapel Hill, NC: Hinshaw Music, 1994).

[5] Rizzolatti and Craighero, *The Mirror Neuron System,* 169.

[6] Ibid., 169-172.

[7] Ibid., 172.

[8] Ibid., 174, 176.

[9] Ibid., 174-176.

[10] A noninvasive method to study brain neurons.

[11] Iacoboni et al., "Grasping the Intentions of Others," 0529.

[12] Rizzolatti and Craighero, *The Mirror Neuron System,* 183-184.

[13] Ibid., 184-185.

[14] Iacoboni et al., "Grasping the Intentions of Others," 0529.

[15] Rizzolatti and Craighero, *The Mirror Neuron System,* 185.

[16] Ibid., 185-187.

[17] Livingstone, Thompson, and Russo, "Facial Expression and Emotional Singing," 475.

[18] Ibid.

[19] Ibid., 475-476.

[20] Ibid., 476.

[21] Electromyography is a technique that is used to evaluate and record electrical activity produced by skeletal muscles.

[22] Livingstone, Thompson, and Russo, "Facial Expression and Emotional Singing," 483-485.

[23] Katie Overy and Istvan Molnar-Szakacs, "Being Together in Time: Musical Experience and the Mirror Neuron System," *Music Perception* 26, no. 5 (2009): 489.

[24] Ibid., 492.

[25] Ibid., 489.

[26] Lynn Helding, "The Mind's Mirrors," *Journal of Singing* 66, no. 5 (2010): 586.

[27] Overy and Molnar-Szakacs, *Being Together in Time,* 494.

[28] Ibid., 499.

[29] Livingstone, Thompson, and Russo, "Facial Expression and Emotional Singing," 475.

[30] Tanya Chartrand and John Bargh, "The Chameleon Effect: The Perception-behavior Link and Social Interaction," *Journal of Personality and Social Psychology* 76 (1999): 893-910.

[31] Melissa Malde, MaryJean Allen, and Kurt-Alexander Zeller, *What Every Singer Needs to Know About the Body,* 2nd ed. (San Diego: Plural Publishing, Inc, 2013), 32.

[32] Ibid.,196-197.

[33] Alexander Technique Teachers Network, "Monkey—The Position of Mechanical Advantage," Accessed March 8, 2014 <http://alexandertechniqueteachers.net/blog/alexander-technique-exercises-monkey>.

[34] David McFarland, "Respiratory Markers of Conversational Interaction," *Journal of Speech, Language, & Hearing Research* 44, no. 1 (2001): 128.

[35] Malde, Allen, and Zeller, *What Every Singer Needs to Know About the Body,* 87.

[36] Ibid., 88.