Music and Medicine OnlineFirst, published on December 18, 2009 as doi:10.1177/1943862109357191

Music and Medicine
000(00) 1-11
© The Author(s) 2009
Reprints and permission: http://www.sagepub.com/journalsPermissions.nav
DOI: 10.1177/1943862109357191
http://mmd.sagepub.com
SAGE

Locomotion-Encoded Musical Movements (LEMMS): A Proposed Use for Four Categories of Vertebrate Locomotion in Music Medicine Application and Research

Andrew Warshaw[1]

Abstract

This article advances a descriptive model of the relationship between music played percussively and fundamental locomotor movement patterns that originate in the vertebrate phylum, including human motor development. The model incorporates four categories of *developmental movement patterns*, borrowed from classificatory schemes well established in the fields of movement education, training, and analysis. The model posits correspondences between these movement patterns and the movements used in playing percussion music, resulting in a system of Locomotion-Encoded Musical Movements (LEMMS) and an array of musical artifacts termed Locomotion-Encoded Musical Patterns (LEMPS). Examples of LEMMS and LEMPS illustrate the utility of the model in specifying inherent relationships between music and movement. Results and discussion center on the LEMMS scheme's unique characterization of affective and formal aspects of music, its significance to current models of the body in music performance and cognition, and its potential value in music medicine.

Keywords

neurologic music therapy, music improvisation, music medicine, rhythmicity, locomotion, movement patterns

Music promotes health through facilitation of movement. The principle is both ancient and contemporary. Bicaise, a 17th-century French professor of medicine, extols the health benefits of dancing and identifies music as dancing's source. He calls dance "an effect of the mind's movements, by which it moves and swings the body in accordance with all that the mind receives from musical sounds, poetry and songs" (Arcangeli, 2000, p. 15). An 11th-century Arabic text by Baghdad Christian physician Ibn Butlan states that the "harmonic accord" between dance and music is "responsible for the benefits they bestow upon human health, . . . [such that] the mere watching of a performance is acknowledged as having a positive influence" (Arcangeli, 2000, p. 6).

To post-Enlightenment thinking, these descriptions of the symbiosis of music and dance may seem quaint or esoteric. Even Plato, in teaching that rhythm is "order in movement" and that "music and rhythm [*sic* movement] find their way into the soul," raises a preponderance of terminological questions. Today, theorization of the relationship of music and movement, particularly in a therapeutic context, aspires to more exactitude. Movement is a primary and precisely targeted objective in a vast array of health initiatives for which music is a supportive method. There is a role for music in rehabilitating motor problems symptomatic of traumatic brain injury and in remediating communication disorders (Baker, Tamplin, & Kennelly, 2006), in neurosurgical rehabilitation and work with multi-handicapped children (Wigram & De Backer, 1999), and in securing the physical and emotional bonding of infants and mothers (Trevarthen, 1999). Music is used in treating dysarthrias (Tamplin, 2008) and sports injuries (Saalfield, 2008), in sports training (Atkinson, Wilson, & Eubank, 2004), and with patients in vegetative states (Magee, 2005); to increase range of motion in burn victims (Neugebauer, Serghiou, Herndon, & Suman, 2008); and to stimulate physical, social, and cognitive health in older adults (Wigram, Peterson, & Bonde, 2002).

Contiguous with this expanding spectrum of therapeutic possibilities, and supported by extraordinary technological advances, research on fundamental mechanisms of the movement-music relationship is extensive. Experimentation in brain imaging targets neural networks that support and link musical and motor activities (Zatorre, Chen, & Penhune, 2007). Levitin and Tirovolas (2009) describe the identification of networks of structures "thought to be the neurological basis for the emotional processing of music" (p. 219), in which activation is increased by the

Supplementary material for this article can be found on the *Music and Medicine* Web site at http://mmd.sagepub.com/supplemental.

[1] Marymount Manhattan College, New York, USA

Corresponding Author:
Andrew Warshaw, Associate Professor of Music and Dance, Marymount Manhattan College, 221 East 71st Street, New York, NY 10021.
Email: awarshaw@mmm.edu

real-world content of visual stimuli (Eldar, Ganor, Admon, Bliech, & Hendler, 2007), ostensibly including movement, and is supported by the mirror neuron system's role in representation of action, as hypothesized by Molnar-Szakacs and Overy (2006). Research concerning locomotion has rendered highly evocative studies of music-movement relationships, such as Friberg and Sundberg's (1999) link between ritardandi in music and the motions of runners coming to a stop; Todd, Cousins, and Lee's (2007) demonstration that metrical perception may be affected "by the biomechanical characteristics of [an auditor's] locomotion" (p. 2); and Giordano and Bresin's (2006) determination that listeners can identify a wide variety of emotional expression in the sound patterns of walking.

Still, music-movement theorization remains an open field. As Zatorre et al. (2007) observe, in reviewing current models of auditory-motor interaction, "support for these models has come from studies of human speech, animal vocalizations and auditory spatial processing.... The question is whether existing models can account for the types of auditory–motor interplay that are so crucial and unique for music performance" (p. 550). For many music medicine applications in which movement is a critical factor—such as the choice of music for receptive methods in music therapy (Grocke & Wigram, 2007), or music therapeutic improvisation designed to elicit whole-body participation of the patient-musician, "dynamic form" (Pavlicevic, 2000, p. 276) among a great variety of others (Bruscia, 1987, 1988; Wigram, 2004)—current research that targets how the brain works while doing music may eventually yield insights for clinical practice. The biology of entrainment (Molinari, Leggio, Martin, Cerasa, & Thaut, 2006; Phillips-Silver & Trainor, 2008; Thaut, 2006; Todd et al., 2007), the capacities of the mirror neuron system to process auditory representations (Lahav et al., 2007), the role of motor programs in musical performance (Godøy, 2004; Halpern, 2006; Langheim, Callicott, Mattay, Duyn, & Weinberger, 2002), and Trevarthen and Malloch's (2000) model of communicative musicality are four areas in which increasingly detailed and complex accounts of music-movement relationships can be expected to emerge. To the extent that these investigations expand so that they are useful in describing entire music-movement relations, as during the whole course of a piece of music or as in a movement-and-music structure, such as a dance or a music therapy session, then these areas can also be expected to yield expansive clinical insights for music therapy.

To date, models of how music and movement interact, as partners in a single event, are important disciplinary elements of choreomusicology (Hodgins, 1992; Jordan & Morrison, 2006), ethnomusicology (Chernoff, 1979), and anthropology (Hagen & Bryant, 2003), among other fields. Each of these investigations, however, weighs a differently constrained set of concerns about the music-movement relationship than does the model to be proposed here. Hagen and Bryant's theory examines the synchronous functioning of music and dance to produce social cohesion, but has little to say about specific attributes of particular pieces of music or particular movements, or the relationships between them. Chernoff's insights into cross-modal aesthetic sensibilities in Ghana advance no general theory of music-movement integration beyond those principles expressed by the Dagomba people examined in his book. The choreomusicological model proposed by Hodgins, as well as the broad interests of Jordan and Morrison in exploring how choreography and music work together in concert dance, point toward useful general principles of music-movement correspondences. However, their main concern is the analysis of music and movement intended for an audience. Their priorities are primarily auditory and visual, because the kinesthetic dimensions of music and dance, to an audience, are inferred and internalized in the acts of observing. The model proposed here is also concerned with music-movement relationships as they are heard and seen but is more fully contingent on the auditory, visual, and kinesthetic experiences of those who are making music and movement.

Pedagogical systems, perhaps epitomized by Dalcroze Eurhythmics (Seitz, 2005), in which bodily experience is a fundamental resource in developing musical skill and insight, are concerned with many dimensions of music-movement relationships. The same can be said of approaches to musical training, interpretation, and performance that prioritize movement as a modality for expressive possibilities in music (Pierce, 2007). These approaches reference movement both as a metaphor for what happens in music and as a reality that needs to be attended to in its own right, for music to come to a healthy and beautiful expression. In a sense, the concerns of the model proposed here are more distinct than those of such comprehensive approaches to pedagogy and performance. What is particular to the Locomotion-Encoded Musical Movements (LEMMS) model is its claim that human movement is not merely the agency of music, or merely a referent of it, but is itself one of music's concerns, a fundamental dimension of experience that music serves to manifest. In this model, some music cannot be adequately understood without reference to the bodily movement incorporated in it. The LEMMS model advances a set of terms for describing how and when this phenomenon is at work. Both the terminology and the objectives of the terminology make it different from approaches whose ends are primarily music pedagogical or performance based.

One other area of research into music performance needs to be considered here, because it aspires, in a holistic fashion, to account for how music and movement are contingent on one another. Wanderly has shown how clarinetists add "non-obvious," "ancillary," or "accompanist" gestures, which do not play a direct role in production of sound, to the instrumental gestures of sound production (Wanderly, 1999). Upon analyses of multiple performances by one player and alternate performances by several, Wanderly, Vines, Middleton, McKay, and Hatch (2005) concluded that these gestures are "not randomly produced or just a visual effect, but rather they are an integral part of the performance process" (p. 98). This affects the sound of the instrument (tempo, phrasing, and metrical decisions), the performer's comfort or fluidity, and the actions by which a performer visually cues an observer about expressive intentions. Similar, and perhaps even more consequential, is Jane Davidson's (1993) research, which shows that these ancillary movements may convey expressive intention to an observer more accurately than the sound of the performance they accompany. Movement is on multiple levels critical to any music making context, yet, as

Davidson (2002) writes, "few . . . texts provide information about how to use the body effectively to produce a musically effective performance" (p. 245). Davidson speaks here of ancillary, expressive movement, but she is convincing in a more general sense, as well. From music performance to music perception to music medicine, there is an ongoing need for constructs to explain the uncanny complementary relationship of music and movement, to address how the two come to support each other so well, complement each other so thoroughly, and refer to each other so ineluctably. Such a construct is my intention here.

Locomotion-Encoded Musical Movements

I propose that in percussive music,[1] there is encoded information referencing a small set of fundamental movement patterns. These patterns correspond precisely with four principal types of locomotion in use throughout the vertebrate kingdom,[2] including human motor development. These movement patterns are expressed in music discretely and identifiably, as elements fully integrated into musical structures and prime determinant of their forms; thus, they contribute significantly to the character of music in which they appear. They contribute to affect—to music's emotive and psychological import. They can be identified in the movements that musicians use (as Locomotion-Encoded Musical Movements, or LEMMS),[3] and in the manifested music, including its sounds and its notated representations (in appearances I term Locomotion-Encoded Musical Patterns, or LEMPS). Applying an awareness of these patterns to musical passages results in a uniquely nuanced and surprising view of vertebrate locomotor movement as essential musical content.

Background Concepts

The LEMMS/LEMPS construct is based on the work of several trailblazing movement theorists. Dr. Temple Fay, a neurosurgeon on the faculty of Temple University and the founding vice president of the American Academy of Cerebral Palsy, first proposed a taxonomy of vertebrate movement for use in a medical/therapeutic setting (Fay, 1947; Wolf, 1968). Fay developed his taxonomy to support hands-on treatment of cerebral palsy patients. His foundational hypothesis was that a variety of movement patterns of different evolutionary "levels" (movement strategies that appeared discretely during the course of vertebrate evolution—spinal undulation, crawling, creeping, brachiating, walking) are hard-wired into various levels of vertebrate brains.[4] Fay theorized that a hierarchical progression of similar "pattern movements" would be representative of increasing levels of complexity of the human nervous system. Thus, these patterns might offer patients with traumatic brain injuries and lesions an array of options for accomplishing critical movement tasks, if a patient were guided by a therapist to the optimal level of the evolutionary movement legacy.[5]

Ultimately, the role of Fay's ideas in the LEMMS concept has nothing to do with his therapeutic claims, nor with recapitulationist concepts that model biological or social relationships on the similarities between phylogenetic and ontogenetic movements. Currently, the significance and coherence of Fay's ideas are best considered in a dynamic systems approach (Thelen, 1995), in which the movement patterns he postulated are neither preprogrammed movement instructions from the past nor blind engines of motor development but, instead, are efficient, evolutionarily tested means of locomotion that suit humans so well and are so naturally arrived at by each of us that they can be considered paradigmatic. Analyses of human movement with components similar to Fay's can be found in the work of a number of leading theoreticians, including the "patterns of connectivity" in the work of Rudolf Laban's protégé Irmgard Bartenieff[6] (Bartenieff, 1974; Hackney, 2002) and the Kestenberg Movement Profile (KMP) created by Judith Kestenberg (Loman, Ender, & Burden, 1999).

The iteration of Fay's work used in the LEMMS model follows that of Bonnie Bainbridge Cohen, an occupational therapist, movement educator, and founder of the School for Body-Mind Centering, who has developed, over the past four decades, a persuasive reconceptualization of Fay's terminology, applying it to non-brain-injured populations in the course of movement education and training.[7] Cohen integrates Fay's categories with concepts traditionally used by occupational and physical therapists to explain the organization of movement—the primitive reflexes, righting reactions, and equilibrium reactions by which movements are initiated and maintained (Cohen, 1989b). However, her debt to Fay is evident when she avails herself equally of phylogenetic metaphor and ontogenetic imagery in illustration of what she calls the Basic Neurological Patterns (or BNP; she also refers to them as *developmental movement patterns*) of human development (Cohen, 1993). The BNP, linked with the more traditional reflexes and reactions, comprise an area of study that Cohen calls developmental movement. Cohen attributes four of the BNP directly to her reading of Fay (Cohen, 1984).

These four developmental movement patterns appear with paraphrases of Cohen's accounts of them in sources cited above (see Figure 1).

Spinal movement. A progression of movement impulses in the order mouth-head-neck-spine-tail. Exemplified by snakes and fish, spinal patterning is also present in higher order vertebrates, subsumed within the fuller capabilities of higher order patterns and used for specialized functions. Spinal patterning supports the infant as he lifts his head or the diver as she arcs backward through space.

Homologous movement. Involves simultaneous flexion or extension of upper limbs and/or lower limbs. The frog leaps with a symmetrical push through the lowers and a reach through the uppers. The dog, horse, and tiger, at a run, push off both lowers and reach into space through both uppers, with the power and focus potential in this pattern. An infant reaches both arms toward a parent or extends both arms forward in space to progress from sitting into creeping.

Homolateral movement. Same-side limbs, upper and lower together, either flex or extend together. Right and left sides of the body are clearly differentiated. Only a few animals

Figure 1. Four of Cohen's basic neurological patterns

Source: Baby, reptile and amphibian drawings by Janice Geller, published in Cohen, B. (1984), "Perceiving in Action: The Developmental Process Underlying Perceptual-Motor Integration," *Contact Quarterly*, *9*(2). Athlete images published in Cohen, B. (1989a), "The Alphabet of Movement: Primitive Reflexes, Righting Reactions, and Equilibrium Responses, Part 1," *Contact Quarterly*, *14*(2); Cohen, B. (1989b), "The Alphabet of Movement: Primitive Reflexes, Righting Reactions, and Equilibrium Responses, Part 2," *Contact Quarterly*, *14*(3). Reprinted by permission of *Contact Quarterly* and Contact Collaborations, Inc. and Bonnie Bainbridge Cohen.

(giraffes, camels, some lizards) use the homolateral as a primary locomotion strategy; it appears as a preparatory stage or an alternate, problem-solving strategy, in most others. A baby pulls herself to standing by holding on to the couch, then extends the same-side arm and leg to "cruise" her way sideways along the couch's length. The archer in Figure 1 uses the support of homolateral patterning to brace her front arm and leg against the force of the drawn bow.

Contralateral movement. The reach of the upper limb on one side of the body draws the lower limb of the opposite side of the body into motion, to catch the falling weight of the body. This movement pattern predominates in a great majority of reptiles and mammals, including the runner in Figure 1.

The BNP Expressed in Instrumental Music

The conceptual progression from Cohen's taxonomy of developmental movement patterns to a theory that includes their musical application is only a small step. When an animal locomotes, its limbs strike the ground. When a percussionist—drummer or pianist, for instance—plays, his or her limbs strike the surface of an instrument.[8] I am proposing the term *strike patterns* to describe discrete categories of temporal relationships resulting from the effect of a player's limbs on an instrument's surface. A small variety of strike patterns, each based on one of the four BNP above, provide the foundational terminology for the LEMMS construct and for analysis of encoded locomotion in music.[9]

Elements of the LEMMS Model

The LEMMS Terminology

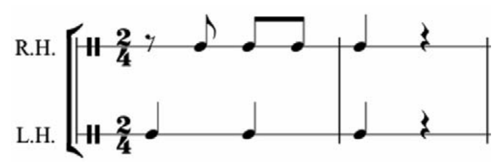
Homologous strike occurs when both upper limbs (or, in the case of percussionists or organists, both lower limbs) strike an instrument in unison, as in Example 1:

Example 1. Shostakovich, Prelude I, mm. 1-8, 24 Preludes and Fugues.

Homolateral strike occurs when the strikes of the limbs are clearly and deliberately differentiated left from right. This differentiation may be maintained through several species of organization: Example 2 illustrates homolateral strike by strict alternation between right and left limbs.

Example 2. Stravinsky, Les Noces, First Tableau, Rehearsal #1, mm. 1-8, Pianos II, IV.

A second type of homolateral strike occurs when one limb repeatedly strikes a surface and the other limb is clearly at rest. A third occurs in Example 3, with strikes on an instrument by even pulses in one hand, while strikes from the other hand accent regular occurrences of the pulse. As long as the accenting action occurs in a single limb only, and the accenting limb does not end any phrase on an offbeat,[10] differentiation between the sides is preserved and the pattern organization remains homolateral.



Example 3. Homolateral strike by differentiation of hands with no syncopation.

In Example 4, accents pass between the hands, the essence of contralateral patterning. The two hands complete each other's phrases.

Example 4. Contralateral strike by accents passing between the hands.

Any syncopation between the hands creates contralaterality. Asymmetrical rhythms between the hands will often create contralaterality, as well.

It should be noted that appearances of lower order patterns, such as the homologous, are often subsumed within passages of higher order patterns (a contralateral formation may have instances of homologous strikes within) so that the patterns combine in networks that fortify and enrich each other. (See video clip "Strike Patterns" available as online supplementary material to this article.)

The "Minds" of the Patterns

Cohen's conception of the BNP includes the idea that each involves unique affective dimensions, both kinetic and psychological. These create important qualitative distinctions that Cohen terms the "minds" of the patterns (Cohen, 1984). Homologous movement is often, by the examples of animals that exemplify it—the frog, the kangaroo—direct, forceful, and elemental. Of the "primitive reflexes" supporting homologous movement, the Babkin Reflex "establishes bilateral midline focus [and] underlies mouth-hand coordination . . . an essential element in developing personal relationships . . . and the ability to focus." The Moro Reflex "allows the infant to symmetrically widen [homologously] through its chest and upper limbs and then to recover with an embrace" (Cohen, 1989b, p. 144). Cohen calls homologous movement "the ground from which we develop our inner and outer intention" that "take[s] us into personal relationship with others."

Underlying homolateral movement, the Asymmetrical Tonic Neck Reflex (ATNR) extends the arm and leg on the face side when the head is rotated to the side. It prepares eye-hand coordination and reaching. It facilitates movement we use in transitional situations, such as rising from the ground to standing.

Thus, the homolateral pattern mind "underlies our ability to differentiate . . . and is the foundation for how we reach out towards our goals—uniting attention with intention" (Cohen, 1989b, p. 149). The contralateral mind "underlies the integration of all the three planes and spirallic movement," Cohen writes. "This underlies the integration of complex ideas" (p. 152).

As particular as these formulations may seem, they are exactly paralleled in the work of Laban/Bartenieff. Bartenieff taught four patterns of connectivity: head/tail (Cohen/Fay's spinal), upper/lower (Cohen/Fay's homologous), body halves (Cohen/Fay's homolateral), and cross-lateral (Cohen/Fay's contralateral). In *Making Connections*, Peggy Hackney's (2002) indispensible guide to Bartenieff's concepts, she discusses implications of each pattern of connectivity. With upper/lower connectivity, "we support ourselves . . . stand on our own two feet . . . push away and set boundaries . . . reclaim our personal power" (p. 162). With body halves, "one side learns to provide a supportive stable stance, while the other practices mobility. . . . The simplicity of One side/Other side is satisfying" (p. 174). The cross-lateral "makes possible the complexities . . . of three-dimensional space. . . . Cross-laterality (particularly . . . with spiraling) aids in the ability to conceptualize complex interrelationships" (p. 198).

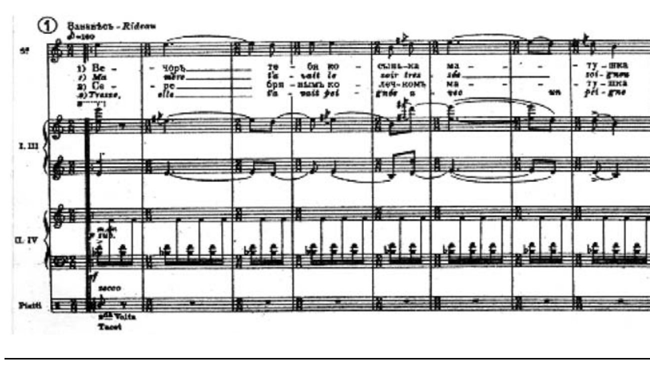
These elisions and paraphrases of Cohen and Laban/Bartenieff are oversimplifications of influential and protean movement education systems. Fortunately, the work of each is echoed by more than just the work of the other. The Kestenberg Movement Profile (KMP), a tool for movement analysis widely used within the dance/movement therapy community, is also based on Laban's system of movement notation but includes psychological analysis of the observed movement (Kestenberg was a psychoanalyst). Loman, Ender, and Burden (1999), in a chapter of a book about the KMP, explore a tight correlation between the BNP and the KMP phases of development, psychoanalytic templates that reference locomotion, behavior, social integration, emotions, and characteristic forms of expression. That Cohen's developmental movement work integrates so neatly with the KMP phases is due largely to the concept of pattern mind.

The interrater reliability of these percepts, taught by a handful of charismatic teachers and widely disseminated without a scientifically accepted biological or brain basis, is important to address. Several factors argue for a functional validity of the developmental movement patterns, even without experimental verifications of their "minds." The first is that maturational accounts of human movement development are not radical concepts. Although they have been surpassed by dynamical systems approaches, they are not antithetical to the latter, only subsumed as elements within (see Piek, 2006). They have a common sense, even though the decisive attributes that Cohen and Bartenieff have given to these movement stages are unverified. One should keep in mind the extraordinarily wide net of contexts in which the minds of developmental movement patterns—fact or metaphor—have proven valuable concepts. In addition to their current canonical acceptance in movement education, the contexts in which students and readers of Cohen have demonstrated the efficacy of the developmental pattern mind concepts by practicing them, and writing about them, are many. A sample includes psychotherapy (Aposhyan, 1999, 2004; Frank, 2005), communication (Goldman, 1994), neuroaffective touch research (LaPierre, 2003), body intelligence metrics (Anderson, 2006), somatic practices (Eddy, 2009), movement curricula for children with emotional disturbances (Gottlob & Oka, 2007), shiatsu and oriental body therapy (Palmer, 1995), choreography (Hånmålåinen, 2007), physical education (Gomez, 1988), yoga anatomy (Kaminoff, 2007), body awareness (McHose & Frank, 2006), arts education policy (Schwartz, 1993), and recovery from torture (Gray, 2001). The list for Bartenieff would be inestimably longer. It is possible that the developmental movement pattern minds may prove to be, in a scientific sense, metaphors. Nonetheless, they have experiential consistency, coherency, and effectiveness in application to date that suggest they are more.

Pattern mind makes the affective dimensions of developmental pattern activity vivid. As such, it is a particularly useful attribute for adapting the patterns to musical constructs.

LEMMS and LEMPS as Musical Elements

Example 5 contains a superimposition (in vertical musical space) of homologous and homolateral strike patterns. The enduring fervor and strangeness of the passage shown here, almost a century after it was written, owes much to the stark positioning of a tensely static, strictly alternating homolateral strike pattern in Pianos II and IV, under propulsive homologous strike doublings in Pianos 1 and III. Strict alternation homolateral strike is a special case of homolateral patterning: It differentiates the left and right sides of the body, as the homolateral must, but homolateral movement also tends ever toward asymmetry, and the strictly alternating homolateral strike pattern in Pianos II and IV must be slightly rigid and mechanical to resist spilling into accentuation on one side or the other (it feels like that to play the passage). This rigidity contributes to the ferocity of the excerpt, as much as the mixed meter, the chirping ornamentation of the vocal line, and the polytonality. Locomotion pattern content is an important element in this passage.



Example 5. Stravinsky, Les Noces, First Tableau, Rehearsal #1, mm. 1-8. Homologous strike in Pianos I, III; homolateral strike by alternating hands in Pianos II, IV.

Over the past several years, in a series of articles, performances, and presentations,[11] I have been investigating the roles of LEMMS and LEMPS in musical structures. Some areas of focus have been (a) to extend the construct so that some varieties of pitchwise activity can also be identified as expressive of developmental movement patterns (download online video clip "Sweep Patterns"); (b) to use principles of motor equivalence (see Godøy, 2004) to identify LEMMS in the actions of single limbs, including fingers; (c) to explore saliencies of pattern relationships in musical structures—the varieties of LEMPS transitions, transformations, and juxtapositions through which meaningful pattern relationships are expressed (download online video clip "HomolateralPno, ContralateralPerc," an experiment in pattern sequence, where the higher order contralateral strike percussion pattern represents an "upshift" in pattern energy from the homolateral strike piano pattern); and (d) to use pattern terminology to understand the overall design of pattern activity in pieces of music. I have coined the term *kinemorphic* to refer to this design, which I imagine as existing in at least five dimensions: the vertical dimension of pitch activity, the horizontal dimension of musical time, and the three dimensions of Cartesian space. Kinemorphic modeling presents many complexities, but even in simple form, it can begin to account for LEMPS characteristics, or tropes, that typify a composer, a style, or the changes of a musical meme within the work of a composer or a style. Example 6 illustrates one of the most common tropes of classical music, the "downshift" into a homologous strike pattern that coheres and consolidates energy in the progression toward a cadence.

Example 6. Beethoven, Sonata, Op. 7, end of exposition. "Downshift" from homolateral strike to homologous strike in the last two measures of the second system.

The final area of focus has been (e) to develop a notational system, for composition and structured improvisation, that integrates movement pattern information with information in traditional Western musical notation. (Download online video and image file "Study #2.")

Discussion

The postulates of the LEMMS model—definitional characteristics of developmental patterns in musical forms; principles that govern relationships among the patterns; a method for symbolically representing the patterns and their kinemorphic organization; and perhaps, a biological or brain basis for distinctions between the patterns and their affective characteristics—are still in formulation. Therefore, the LEMMS model is not ready for experimentation to determine its validity or the scope of its usefulness, or the design of clinical music medicine procedures that draw on it. The purpose of this article is not to substantiate the LEMMS model but to spur a discussion of its elements and its potentialities for music medicine and encourage others to investigate.

Music Therapy and the LEMMS Model

A good framing question may be one that Concetta Tomaino, music therapist and director of The Institute for Music and Neurologic Function at Beth Abraham Hospital in The Bronx, New York, posted on the organization's Web site: "Can we develop auditory rhythmic-based cues which will consistently 'turn on' motor initiation, so that people who are unable to move on their own can recover greater motor function and control?" (Tomaino, 2006). Could music analogues of BNP (or Bartenieff's "connectivity patterns") turn on motor initiation? The question inspires conjectures that Cohen, an occupational therapist, and Bartenieff, a physical therapist when alive, would likely enjoy (see Cohen, 1984, for her account of using the developmental patterns in work with infants; see Hackney, 2002, pp. 5, 6 for an account of Bartenieff's therapeutic touch), for it is not hard to formulate queries about the use of musical selections, chosen or created on the basis of pattern content and expression, in therapeutic contexts. Whether in support of proprioceptive training, or of articulatory modalities to restore and extend range of motion; in muscle strengthening; in support of behavioral or cognitive therapies for recovery from emotional or physical trauma; or in therapy for communicative or emotional disorders, selective listening to pattern-based music would provide a range of discrete types of auditory stimulation. Will the patient who cannot push evenly through both upper limbs be fortified in his efforts by listening to musical passages rich with homologous strikes? Could movement to music featuring contralateral strike organization facilitate a brain-injured patient's recovery of cross-diagonal coordination? Musical examples of development patterns may not, by themselves, be the cues that turn on motor function, but it is, however, a welcome standard.

There are additional receptive uses of pattern music, such as in palliative care, for which categorization by pattern content could be useful. To improvisational music therapy, the LEMMS terminology provides a set of physical actions and musical patterns that summon specific psychological states, characterize types of conversationality between players or within the psyche of a single player, and potentially offer predictive models of the effects of pattern textures, pattern structures, and pattern relationships. With an improvisational structure that prioritizes a single pattern coordination, players can generate a wide-ranging musical vocabulary, with various melodic motives, rhythms, and chord progressions, yet maintain an affective unity—a plausible goal of improvisation in a music therapy setting. (Download online video clip "Homologous Strike Duet.")

Implications of Music Performance Models

There are several music medicine implications of putting the LEMMS model in dialogue with current research concerning the body in performance. To Wanderly's and Davidson's work on the significance of ancillary and expressive gesture, the LEMMS model brings a question: Is it possible that certain instances of performers' ancillary movement could be better explained in terms of movement scenarios, rather than as expressive of musical intentions? Concerning physical movement patterns that Wanderly et al. (2005) observed as consistent over several performances of a piece by a single musician, should these primarily be considered in terms of their musical expressivity, or might they sometimes more acutely reflect developmental movement pattern necessities—a need for homolateral stability, or the joy of a contralateral spiral within the body, either in response to the music or in support of its physical creation? The analyses are not mutually exclusive, but the LEMMS model, by viewing music making as a locomotor movement activity, thus prioritizes movement for movement's sake, even in a musical context. This may problematize both the psychology and even the ergonomics of a musician's "ancillary gestures." What are a musician's objectives when playing? Are they always musical? And what is the normative way to play a musical instrument at any given moment? If a body is constantly changing its patterns of connectivity, what movements are ancillary, and which are de rigeur?

A final, more general observation on ergonomic implications of the LEMMS model follows: As the support of the developmental patterns becomes better understood by a player (who discovers, for example, that summoning the spirallic energy of the contralateral clarifies a four-limb pattern at the drum set), targeted challenges of strength or coordination at an instrument can be approached with a movement toolset applicable to any physical configuration.

Refining the LEMMS Propositions

The entire notion of ancillary musical gesture raises important questions for the LEMMS model. Just as Wanderly (1999) defined some physical gestures as superfluous to his analysis, there will be distinctions to make about which of an instrumentalist's movements do and do not express pattern effects. That constraint may speak to future attempts to determine whether actions in planes other than the vertical-sagittal strike plane play a role in the LEMMS taxonomy.

Many refinements of the LEMMS concept are necessary before it is ready for inclusion in music cognition modeling or research and, thus, sufficiently understood to evaluate its music medicine implications. For instance, cortical networks thought to be domain specific for language processing are currently being investigated for their potential roles in musical processing, but the focus of this work seems to be mainly in areas of pitch and chord sequences (Koelsch et al., 2002). Might there be syntactical and formal relationships between elements of movement pattern expression? It is unreasonable to wait for neuroimaging to answer this: at least some answers are in music itself, in pieces already composed, in pieces to be made. Ethnomusicologist John Bailey's work on "motor-grammars" of instrumental music describes how the physical movements used in playing an instrument may combine, in quasi-grammatical fashion, to shape the characteristic structures of musical styles and pieces (Baily, 1977; Baily & Driver, 1992). Are there neurodevelopment movement tendencies or neurodevelopment musical predispositions that would tend to nominate certain LEMMS patterns as likely generators of motor-grammars? The more musicians who experiment with this idea, the more quickly we will know.

The critical postulate of a mind expressed through pattern movement in sound or music needs to be investigated behaviorally before it is likely to be the subject of neuroimaging. Video files available as supplementary media to this article demonstrate that for musicians, at least, the developmental movement categories involve clear parameters of linked behavior and expression. Now, it needs to be determined, with listeners as well as with musicians, just how recognizable are the effects of individual patterns.

Another important LEMMS question involves the circumstances under which listeners actually perceive LEMPS at all. Ricciardi et al. (2009) indicate that sightless individuals use a mirror-neuron schema that allows them to mentally account for the physical action implied by sounds. This supports concepts such as Godøy's (2004) motor-memetic theory of musical perception, which holds that the physical actions of a musician, as perceived or imagined by a listener, are critical intrinsic components of musical meaning. The LEMMS construct needs an account of the auditory mechanisms by which LEMPS are perceived, not only because music therapists need theoretical bases on which to select music as pattern cues, but because musicians themselves, in experimenting with the LEMMS ideas, need to know what it means to hear these patterns, identify them, and respond to them.

Sustained investigation of the LEMMS proposal would reflect and contribute to a widespread academic and professional involvement in music and movement that goes well past media and entertainment. Powerful movement-based medical technology at hand today provides some of the most urgent incentives to refine the LEMMS concept. Motion capture, already in medical use for applications involving prosthetics, evaluation of surgical results, the analysis of motion impairment, and research in kinesiology, might benefit from a taxonomy that links motion data, rhythmic patterns, and kinematics. There is an ongoing need for more sophisticated understanding of musical components in therapeutic initiatives and for physiological, kinesiological, and musicological depth in media creation that links music and bodies. Insight concerning movement pattern expression in sound and image is timely and has the potential to drive and inform new empirical and experimental research.

Notes

1. Music on strings also fits the model, but space constraints prevent its discussion here. A presentation given by the author at the Philoctetes Center for Multidisciplinary Imagination, NYC, has been posted online at http://www.philoctetes.org/Past_Programs/Musical_Creatures_How_Vertebrate_Locomotion_Shapes_Human_Music.
2. Two important types of vertebrate locomotion not implicated in this model are flight and brachiation. The model develops correspondences between music and *earthbound* locomotion.
3. They are undoubtedly also elements in the ancillary movements that Wanderly and Davidson discuss.
4. Fay attempted to distinguish the human use of these movement modalities in terms of "high-brain," "mid-brain," and "low-brain" movement patterns (Wolf, 1968), distinctions that are not germane to the application of his ideas as discussed here.
5. Scientific and clinical opinion of Fay's ideas was generally respectful in the years immediately following their formulation, then spectacularly waned, largely because Fay's successors and adherents made unverifiable claims concerning the use of "pattern movement" procedures in "re-patterning" brain-injured children and developing super-learning in non-brain-injured children. Such claims have been discredited in a variety of studies, as reviewed by the American Academy of Pediatrics (Ziring et al., 1999). However, the International Somatic Movement Education and Therapy Association has recently established an operational definition for therapeutic "movement patterning" (Eddy, 2009) that creates a therapeutic context for movement precepts such as Fay's, without the burden of unverifiable claims for their efficacies.
6. Laban was perhaps the most eminent theoretician of movement of the 20th century. Bartenieff founded the Laban/Bartenieff Institute of Movement Studies in New York City, one of the two principal institutions dedicated to Laban's work. Dancers and movement educators around the world employ the developmental movement concepts and vocabulary derived from Bartenieff's patterns of connectivity, which she articulated to fill a gap in Laban's account of full body movement (Hackney, 2002, p. 8).
7. Cohen's version of Fay's pattern movements has gained widespread acceptance in the field of movement education, forming part of the dance education standards adopted by the National Dance Education Organization (2005).
8. It does not seem to make a difference, in the experience of musicians attentive to the use of these movement patterns, whether an instrument is in the same plane relative to the body of the player as is the ground to an animal. Whether playing a bass drum in a parade band or playing a Taiko drum with hands raised over the head, the act of striking is consistent. A turtle on its back makes the same movements as a turtle right-side up. The musician reaches a limb out into space, strikes, and pulls it back toward the body.
9. The musical significance of spinal patterns is not described in this article but is described, along with other work on the LEMMS model, in several papers and presentations available at www.mmm.edu/faculty/awarshaw.
10. "Offbeat" and "on beat" do not, of course, describe universal rhythmic conceptions. I use the terms in a conventional Western sense, confident that their functional analogues in the music of other cultures, including other Western music cultures, will consistently yield pattern organization consistent with what is described here.
11. See papers, videos, and links at www.mmm.edu/faculty/awarshaw.

Acknowledgments

Musicians in supplementary videos: Damien Bassman, percussion; William Moulton, piano.

Declaration of Conflicting Interests

The author declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

Anderson, R. (2006). Body intelligence scale: Defining and measuring the intelligence of the body. *The Humanistic Psychologist*, *34*(4), 357-367.

Aposhyan, S. (1999). *Natural intelligence.* Philadelphia: Lippincott Williams & Wilkins.

Aposhyan, S. (2004). *Body-mind psychotherapy.* New York: Norton.

Arcangeli, A. (2000). Dance and health: The Renaissance physicians' view. *Dance Research: The Journal of the Society for Dance Research*, *18*(1), 3-30.

Atkinson, G., Wilson, D., & Eubank, M. (2004). Effects of music on work-rate distribution during a cycling time trial. *International Journal of Sports Medicine, 25*, 611-615. DOI: 10.1055/s-2004-815-715.

Baily, J. (1977). Movement patterns in playing the Herati dutar. In J. Blacking (Ed.), *The anthropology of the body* (Association of Social Anthropologists Monograph, 15; pp. 275-330). London: Academic Press.

Baily, J., & Driver, P. (1992). Spatio-motor thinking in playing folk blues guitar. *The World of Music*, *34*(3), 57-71.

Baker, F., Tamplin, J., & Kennelly, J. (2006). *Music therapy methods in neurorehabilitation: A clinician's manual.* London: Jessica Kingsley.

Bartenieff, I. (1974). Space, effort and the brain. *Main Currents*, *31*(1), 37-40.

Bruscia, K. (1987). *Improvisational models of music therapy.* Springfield, IL: Charles C Thomas.

Bruscia, K. (1988). A survey of treatment procedures in improvisational music therapy. *Psychology of Music*, *16*, 10-24.

Chernoff, J. (1979). *African rhythm and African sensibility.* Chicago: University of Chicago Press.

Cohen, B. (1984). Perceiving in action: The developmental process underlying perceptual-motor integration. *Contact Quarterly, 9*(2). Reprinted in B. Cohen (1993). *Sensing, feeling, and action* (pp. 98-113). Northampton, MA: Contact Editions.

Cohen, B. (1989a). The alphabet of movement: Primitive reflexes, righting reactions, and equilibrium responses, Part 1. *Contact*

Quarterly, 14(2). Reprinted in B. Cohen (1993). *Sensing, feeling, and action* (pp. 141-156). Northampton, MA: Contact Editions.

Cohen, B. (1989b). The alphabet of movement: Primitive reflexes, righting reactions, and equilibrium responses, Part 2. *Contact Quarterly, 14*(3). Reprinted in B. Cohen (1993). *Sensing, feeling, and action* (pp. 141-156). Northampton, MA: Contact Editions.

Cohen, B. (1993). *Sensing, feeling, and action.* Northampton, MA: Contact Editions.

Davidson, J. (1993). Visual perception of performance manner in the movements of solo musicians. *Psychology of Music*, *21*, 103-113.

Davidson, J. (2002). Body movement. In R. Parncutt & G. Macpherson (Eds.), *The science and psychology of music performance: Creative strategies for teaching and learning* (pp. 237-250). New York: Oxford University Press.

Eddy, M. (2000). Developing a perceptual motor screen for quantitative and qualitative assessment. *Currents.* Northampton, MA: BMC.

Eddy, M. (2009). A brief history of somatic practices and dance: Historical development of the field of somatic education and its relationship to dance. *Journal of Dance and Somatic Practices, 1*(1), 5-27. DOI: 10.1386/jdsp.1.1.5/1.

Eldar, E., Ganor, O., Admon, R., Bliech, A., & Hendler, T. (2007). Feeling the real world: Limbic response to music depends on related content. *Cerebral Cortex*, *17*, 2828-2840.

Fay, T. (1947). The importance of pattern movements in the rehabilitation of cerebral palsy patients. An educational philosophy for exceptional children. *Proceedings of the Spring Conference on Education and the Exceptional Child of the Child Research Clinic, Woods School, Langhorne, Pennsylvania, 14*, 28-37. Reprinted in J. Wolf (1968). *Temple Fay: Progenitor of the Doman-Delacato treatment procedures* (pp. 98-108). Philadelphia: Temple Books.

Frank, R. (2005). Developmental somatic psychotherapy. In N. Tofton (Ed.), *New dimensions in body psychotherapy* (pp. 115-127). Berkshire, UK: Open University Press.

Friberg, A., & Sundberg, J. (1999). Does music performance allude to locomotion? A model of final *ritardandi* derived from measurements of stopping runners. *The Journal of the Acoustical Society of America*, *105*(3), 1469-1484.

Giordano, B., & Bresin, R. (2006). Walking and playing: What's the origin of emotional expressiveness in music? In M. Baroni, A. R. Addessi, R. Caterina, & M. Costa (Eds.), *Proceedings of the 9th International Conference on Music Perception & Cognition* (p. 436). Bologna: The Society for Music Perception & Cognition and European Society for the Cognitive Sciences of Music.

Godøy, R. (2004). Gestural imagery in the service of musical imagery. In A. Camurri & G. Volpe (Eds.), *GW2003, LNAI 2915* (pp. 55-62). Berlin Heidelberg: Springer-Verlag.

Godøy, R., & Jensenius, A. (2009). Body movement in music information retrieval. *Proceedings of the 10th International Society for Music Information Retrieval Conference (ISMIR 2009)*, pp. 45-49.

Goldman, E. (1994). *As others see us: Body movement and the art of successful communication.* New York: Routledge.

Gomez, N. (1988). Moving with somatic awareness. The body-mind centering approach to growth and health. *Journal of Physical Education, Recreation and Dance*, *59*(7), 90-94, 96.

Gottlob, S., & Oka, Y. (2007). Movement curriculum for pre-school children with emotional disturbances: A three-stage developmental approach. *Journal of Dance Education*, *7*(1), 4-24.

Gray, A. (2001). Healing the relational wounds of torture through dance movement therapy. *Dialogus, 5*(1), 2-6. Retrieved November 5, 2009, from http://www.ptvla.org/docs/dialogus/Dialogus_may2001.pdf

Grocke, D., & Wigram, T. (2007). *Receptive methods in music therapy: Techniques and clinical applications for music therapy clinicians, educators and students.* London: Jessica Kingsley.

Hackney, P. (2002). *Making connections: Total body integration through Bartenieff fundamentals.* New York: Routledge.

Hagen, E. H., & Bryant, G. A. (2003). Music and dance as a coalition signaling system. *Human Nature*, *14*(1), 21-51.

Halpern, A. (2006). Cerebral substrates of musical imagery. *Annals of the New York Academy of Sciences, 930*, 179-192. DOI: 10.1111/j.1749-6632.2001.tb05733.x

Hånmålåinen, L. S. (2007). The meaning of bodily knowledge in a creative dance-making process. L. Rouhiainen (Ed.), *Ways of knowing in dance and art* (Acta Scenica, 19; pp. 56-78). Helsinki: Theatre Academy.

Hodgins, P. (1992). *Relationships between score and choreography in twentieth-century dance: Music, movement, and metaphor.* Lewiston, NY: Mellen Press.

Jordan, S., & Morrison, S. (Eds.). (2006). Sound moves [Special issue]. *The Opera Quarterly*, *22*(1).

Kaminoff, L. (2007). *Yoga anatomy.* Champaign, IL: Human Kinetics.

Koelsch, S., Gunter, T., von Cramon, D., Zysset, S., Lohmann, G., & Friederici, A. (2002). Bach speaks: A cortical "language-network" serves the processing of music. *NeuroImage*, *17*(2), 956-966.

Lahav, A., Saltzmann, E., & Schlaug, G. (2007). Action representation of sound: Audiomotor recognition network while listening to newly acquired actions. *The Journal of Neuroscience*, *27*(2), 308-314. DOI:10.1523/JNEUROSCI.4822-06.2007.

Langheim, F., Callicott, J., Mattay, V., Duyn, J., & Weinberger, D. (2002). Cortical systems associated with covert music rehearsal. *NeuroImage, 16*, 901-908. DOI: 10.1006/nimg.2002.1144.

LaPierre, A. (2003). From felt-sense to felt-self: Neuroaffective touch and the relational matrix. *Psychologist-Psychoanalyst*, *23*(4), 43-46.

Levitin, D., & Tirovolas, A. (2009). Current advances in the cognitive neuroscience of music. *The Year in Cognitive Neuroscience 2009: Annals of the New York Academy of Sciences, 1156*, 211-231. DOI: 10.1111/j.1749-6632.2009.04417.xC

Loman, S., Ender, A., & Burden, K. (1999). The interface between the Kestenberg Movement Profile and body-mind centering. In J. Amighi, S. Loman, P. Lewis, & K. M. Sossin (Eds.), *The meaning of movement: Developmental and clinical perspectives of the Kestenberg Movement Profile* (pp. 249-261). Amsterdam: Gordon & Breach.

Magee, W. (2005). Music therapy with patients in low awareness states: Approaches to assessment and treatment in multidisciplinary care. *Neuropsychological Rehabilitation*, *15*(3/4), 522-536.

McHose, C., & Frank, K. (2006). *How life moves: Explorations in meaning and body awareness.* Berkeley: North Atlantic Books.

Molinari, M., Leggio, M., Martin, M., Cerasa, A., & Thaut, M. (2006). Neurobiology of rhythmic motor entrainment. *Annals of the New York Academy of Sciences*, *999*, 313-321.

Molnar-Szakacs, I., & Overy, K. (2006). Music and mirror neurons: From motion to 'e'motion. *Social Cognitive and Affective Neuroscience, 1*, 235-241. DOI: 10.1093/scan/nsl02

National Dance Education Organization. (2005). *Standards for learning and teaching dance in the arts: Ages 5-18*. Retrieved from http://www.ndeo.org/standards.asp

Neugebauer, C., Serghiou, M., Herndon, D., & Suman, O. (2008). Effects of a 12-week rehabilitation program with music & exercise groups on range of motion in young children with severe burns. *Journal of Burn Care and Research, 29*(6), 939-948. DOI: 10.1097BCR.ob013e31818b9e0e

Palmer, B. (1995). The development of energy. *Journal of Shiatsu & Oriental Body Therapy*, *3*, 11-16.

Pavlicevic, M. (2000). Improvisation in music therapy. *Journal of Music Therapy*, *37*(4), 269-285.

Phillips-Silver, J., & Trainor, L. (2008). Vestibular influence on auditory metrical interpretation. *Brain and Cognition, 67*, 94-102. DOI: 10.1016/j.bandc.2007.11.007

Piek, J. (2006). *Infant motor development.* Champaign, IL: Human Kinetics.

Pierce, A. (2007). *Deepening musical performance through movement: The theory and practice of embodied interpretation.* Bloomington: Indiana University Press.

Ricciardi, E., Bonino, D., Sani, L., Vecchi, T., Guazzelli, M., Haxby, J., Fadiga, L., & Pietrini, P. (2009). Do we really need vision? How blind people "see" the actions of others. *The Journal of Neuroscience Online*, *29*(31), 9719-9724.

Saalfield, A. (2008). Finding rhythm in rehabilitation. *Athletic Therapy Today*, *13*(6), 13-14.

Schwartz, P. (1993). Creativity and dance: Implications for pedagogy and policy. *Arts Education Policy Review*, *95*(1), 8-16.

Tamplin, J. (2008). A pilot study into the effect of vocal exercises and singing on dysarthric speech. *Neuro Rehabilitation*, *23*(3), 207-216.

Seitz, J. (2005). Dalcroze, the body, movement and musicality. *Psychology of Music, 33*(4), 419-435. DOI: 10.1177/0305735605056155.

Thaut, M. (2006). Neural basis of rhythmic timing networks in the human brain. *Annals of the New York Academy of Sciences*, *999*, 364-373.

Thelen, E. (1995). Motor development: A new synthesis. *American Psychologist*, *30*(1), 79-95.

Todd, N., Cousins, R., & Lee, C. (2007). The contribution of anthropometric factors to individual differences in the perception of rhythm. *Empirical Musicology Review*, *2*(1), 1-13.

Tomaino, C. (2006). *Using rhythm for rehabilitation*. Retrieved September 19, 2009, from http://www.bethabe.org/MT_and_Motor_Rehabil220.html

Trevarthen, C. (1999). Musicality and the intrinsic motor pulse: Evidence from human psychobiology and infant communication. *Musica Scientiae, Special Issue: Rhythm, Musical Narrative, and Origins of Human Communication*, pp. 155-215.

Trevarthen, C., & Malloch, S. (2000). The dance of well-being: Defining the musical therapeutic effect. *Nordic Journal of Music Therapy*, *9*(2), 3-17.

Wanderly, M. (1999). Non-obvious performer gestures in instrumental music. In Braffort, et al. (Eds.), *GW'99, LNAI 1739* (pp. 37-48). Berlin Heidelberg: Springer-Verlag.

Wanderly, M., Vines, B., Middleton, N., McKay, C., & Hatch, W. (2005). The musical significance of clarinetists' ancillary gestures: An exploration of the field. *Journal of New Music Research*, *34*(1), 97-113.

Wigram, T. (2004). *Improvisation: Methods and techniques for music therapy clinicians, educators and students.* London: Jessica Kingsley.

Wigram, T., & De Backer, J. (Eds.). (1999). *Clinical applications of music therapy in developmental disability, paediatrics and neurology.* London: Jessica Kingsley.

Wigram, T., Peterson, I., & Bonde, L. (2002). *A comprehensive guide to music therapy: Theory, clinical practice, research and training.* London: Jessica Kingsley.

Wolf, J. (Ed.). (1968). *Temple Fay: Progenitor of the Doman-Delacato treatment procedures.* Philadelphia: Temple Books.

Zatorre, R., Chen, J., & Penhune, V. (2007). When the brain plays music: Auditory-motor interactions in music perception and production. *Nature Reviews Neuroscience, 8*, 547-558. DOI: 10.1038/nrn2152.

Ziring, P., Brazdziunas, D., Cooley, W., Kastner, T., Kummer, M., González de Pijem, L., et al. (1999). American Academy of Pediatrics. Committee on Children with Disabilities. The treatment of neurologically impaired children using patterning. *Pediatrics*, *104*, 1149-1151.

Bio

Andrew Warshaw is a composer and writer and associate professor of music and dance at Marymount Manhattan College.