

Abstracts from the Literature

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Editor's Note: Once again the current literature has provided material for a special review topic. The first four articles discuss the complexities of pianists' hand and finger functions from both biomechanical and neurobiological standpoints. Now, if these findings would only help us always play the right notes!—W.J.D.

Van Vugt FT, Jabusch H-C, Altenmüller E. Individuality that is unheard of: systematic temporal deviations in scale playing leave an inaudible pianistic fingerprint. *Front Psychol* 2013;4:134. doi: 10.3389/fpsyg.2013.00134.

This study investigates individuality of temporal deviations in musical scales in pianists when played without any deliberate expressive intention. Note-by-note deviations away from regularity form a remarkably consistent “pianistic fingerprint.” First, 8 professional pianists played C-major scales in two sessions separated by 15 minutes. Distances between deviation traces originating from different pianists were reliably larger than traces originating from the same pianist. Thus, a simple classifier that matched deviation traces by minimizing their distance was able to recognize each pianist with 100% accuracy. Investigators concluded that the fingerprints were mostly neuromuscular in nature rather than intentional or expressive. However, human listeners were not able to distinguish the temporal fingerprints by ear. Next, 18 pianists played C-major scales on a normal or muted piano. High recognition rates to this task further supported the view that auditory feedback is not necessary when

creating a temporal signature. Finally, 20 pianists' fingerprints or signatures were recognized 20 months later at above-chance levels, showing signature effects to be long-lasting. Even non-expressive playing of scales reveals consistent, partially effector-specific, but inaudible, individual differences. Authors suggest that machine learning studies into individuality in performance will need to take into account unintentional but consistent variability below the threshold of perception.

Furuya S, Nitsche MA, Paulus W, Altenmüller E. Early optimization in finger dexterity of skilled pianists: implication of transcranial stimulation. *BMC Neurosci* 2013;14:35. <http://www.biomedcentral.com/1471-2201-14-35>.

Noninvasive transcranial direct current stimulation (tDCS) facilitates motor functions in both healthy adults and stroke patients. However, little is known about neuroplastic changes induced by tDCS in highly trained individuals. Investigators assessed the effect of tDCS on dexterity of finger movement in healthy adult pianists. Twelve pianists practiced bimanual keystrokes in an in-phase manner while bilateral tDCS of the primary motor cortex was performed. Before and after the stimulation, each pianist was asked to perform the trained successive keystrokes and to repetitively strike a key with each of the fingers as fast and accurately as possible while voluntarily immobilizing the other fingers. Authors found that, in contrast to previous findings in untrained individuals, tDCS yielded overall no apparent improvement of fine finger motion control in the professional pianists. In some movement features, however, pianists who began training at a later age showed greater improvement of fine motor control following tDCS. Results help to support the idea that late-starting players benefit from tDCS, which authors interpret as early optimization of motor system neuroplasticity.

Goebel W, Palmer C. Temporal control and hand movement efficiency in skilled music performance. *PLoS ONE* 2013;8:1. doi:10.1371/journal.pone.0050901.

Skilled piano performance requires considerable movement control to accomplish the high levels of force, precision, and timing seen in professional musicians, who acquire technique over decades of practice. Efficiency of finger movement is especially important when pianists play at very fast tempi. Authors documented the finger movement kinematics of 12 highly skilled pianists as they performed a five-finger melody; all performed on a digital piano at successively faster tempi until they decided to stop. A 3D motion capture system tracked finger joint, hand, and forearm movements. Computed joint angle trajectories for each segment indicated that the finger MCP joints contributed most to vertical fingertip motion, while the PIP and DIP joints moved slightly opposite to the movement goal (into extension). An efficiency measure of the combined finger joint angles corresponded to the temporal accuracy and precision of the pianists' performance. Pianists with more efficient keystroke movements showed higher precision in timing and force measures. Keystroke efficiency and individual joint contributions remained stable at all tempi. Individual differences supported the view that keystroke efficiency is required for successful fast performance.

Pau S, Jahn G, Sakreida K, et al. Encoding and recall of finger sequences in experienced pianists compared with musically naive controls: a combined behavioral and functional imaging study. *Neuroimage* 2013;64:379–387.

Long-term intensive sensorimotor training alters functional brain representation of both motor and sensory systems and may result in structural changes. However, there is little known about how previous training impacts learning transfer and functional repre-

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<https://doi.org/10.21091/mpa.2014.1012>

sentation. Authors tested 14 amateur pianists and 12 musically naïve subjects in a short-term finger sequence training procedure (not actual piano playing) and measured associated functional representation with fMRI. The task included learning a finger sequence indicated by hand symbols and then replaying the sequence from memory, with and without auditory feedback. Pianists were found to activate motor areas and the mirror neuron system more strongly than musically naïve subjects during encoding (learning). In retrieval, musically naïve participants showed higher activation in similar brain areas. Thus, retrieval activations of the naïve group were comparable to encoding activations of pianists, who during retrieval performed the sequences more accurately despite lower motor activations. Findings also supported previous reports about coactivation of the auditory cortex after learned association with motor performance. When playing with auditory feedback, only pianists lateralized to the left auditory cortex. During encoding activation in the left primary somatosensory cortex, the height of finger representations was predictive for increased motor performance later on. Contrarily, decreased performance was associated with increased visual cortex activation while encoding. This study adds to previous reports about training transfer of motor knowledge resulting in superior training effects in musicians. Performance increase accompanied motor area activity and mirror neuron network during pattern encoding.

Steinberg N, Siev-Ner I, Peleg S, et al. Injuries in female dancers aged 8 to 16 years. *J Athl Training* 2013;48(1):118–123.

Most studies of injured dancers have been carried out on adult professionals; little data exist on young nonprofessionals. Authors wished to identify the types of injuries sustained by recreational dancers and to examine their association with age, joint range of motion, body structure, age at menarche, anatomic anomalies, and practice hours per week *en pointe*. They interviewed 569 injured female dancers, aged 8 to 16 years, categorizing injuries into four groups: knee injuries, foot and ankle tendinopathy, back injuries, and other injuries. At least one prior injury

had been sustained by 42.4% of the dancers, most commonly involving the knee (40.4%) and followed by other injuries (23.4%). The relative frequency of tendinopathy and back injuries decreased with age, whereas knee injuries increased. Injury types were significantly associated with ankle plantar flexion, hip external rotation, hip abduction, and knee flexion. Only three predictive variables emerged, all for back injury: scoliosis, age, and hip external rotation. Authors feel that dancers, dance teachers, and dance experts should be aware of the dancer's physical limitations (such as limited or excessive range of motion in certain joints) and anatomic abnormalities (such as scoliosis). In addition, dancers under 10 years of age should not be exposed to work overload or extensive stretching exercises.

Hawkshaw MJ, Pebdani P, Sataloff RT. Reflux laryngitis: an update, 2009-2012. *J Voice* 2013;27(4):486–494.

Laryngopharyngeal reflux (LPR), an extraesophageal variant of gastroesophageal reflux disease (GERD), is one of the most common and important disorders in otolaryngological practice. However, controversy persists regarding the accuracy of LPR diagnosis, its pathophysiology, and the efficacy of treatment. This review addresses current literature from late 2009 through the first half of 2012, building on a previous review encompassing 2006 through early 2009. Although controversies have not been resolved fully by these newer publications, additional research has expanded approaches to diagnosis and treatment of LPR. Recent studies shed light on its pathophysiology, hopefully improving treatment protocols and efficacy. New imaging techniques have proved particularly useful in assessing LPR. Research also has improved the understanding of the value of selected acid measurement techniques. *Helicobacter pylori* infection may be a more important component of LPR than appreciated previously, and LPR patients may benefit from diagnosis and treatment. The efficacy of treatment also remains controversial, although patients for whom medical treatment is not adequate may benefit from surgery, specifically fundoplication. In light of the continued controversies found during this review, authors encourage additional studies

into LPR pathophysiology, diagnosis, treatment, and long-term effects of LPR and LPR treatment.

Cooper SC, Hamann DL, Frost R. The effects of stretching exercises during rehearsals on string students' self-reported perceptions of discomfort. *Update: Applic Res Mus Educ* 2012; 30(2):71–76.

Critical evaluation and examination of musicians' performance-related medical problems is relatively new. Physical stature as well the type of instrument played can affect these problems. This study aimed to determine whether physical intervention—easily performed stretches of a brief duration—administered during rehearsals at approximately 10-minute intervals would affect orchestra students' perceptions of physical discomfort. Suggested sets of stretches included: (1) wrist rotations, shoulder-deltoid exercise, and forward neck roll; (2) oppositional finger-wrist press, hand-finger extensions, and fist clench/unclench; (3) hand wringing, arm-bicep curls, and shoulder-deltoid variation (ear to shoulder); and (4) handshakes, arm-triceps extension, and finger clench/unclench. Analyses focused on gender and grade; investigators found no significant differences, although the variable of instrument type showed a significant score difference before and after rehearsal. Participants' levels of discomfort decreased in contrast to a control group, whose scores increased. Since music educators play an important role in being proactive about injury prevention and rehabilitation, authors recommend that stretches be performed periodically during playing sessions to reduce discomfort associated with performance practice.

Wolman R, Wyon MA, Koutedakis Y, et al. Vitamin D status in professional ballet dancers: winter vs. summer. *J Sci Med Sport* 2013. <http://dx.doi.org/10.1016/j.jsams.2012.12.010>.

Serum 25-hydroxyvitamin D [25(OH)D] is produced when skin is exposed to sunlight. Thus, performers and athletes who train indoors are vulnerable to vitamin D deficiency. The purpose of the study was to evaluate the serum 25(OH)D status in UK professional dancers during periods of greater and lesser sunlight exposure (summer and winter) and to assess the impact on bone metabolism and risk of injury.

Nineteen elite classical ballet dancers (13 females, 6 males, average age 26) were monitored over a 6-month period (February through August) for 25(OH)D, parathyroid hormone (PTH), and blood serum bone turnover markers (CTX and PINP) along with injury data. Six of the 13 women took oral contraceptive agents. Data significance was set at $p \leq 0.05$. Significant changes were noted between the winter (Feb) and summer (Aug) test dates for 25(OH)D, PTH, and PINP. The use of an oral contraceptive had a significantly positive effect on serum 25(OH)D, PTH, and CTX. Soft tissue injury rates were significantly lower in summer compared to the winter period. Authors conclude that professional ballerinas are characterized by a high incidence of low serum 25(OH)D levels which improve marginally in the summer. These dancers also demonstrate higher incidence of injury during the winter. Oral contraception use seems to increase serum 25(OH)D levels and has a positive effect on bone

metabolism. Further studies on the impact of vitamin D₃ supplementation on markers of bone metabolism, muscle function, and injury profile would help to enhance understanding of this important aspect of metabolism in athletes and performers.

Sheibani-Rad S, Wolfe S, Jupiter J. Hand disorders in musicians: the orthopaedic surgeon's role. *Bone Joint J* 2013;95-B:146-150.

Like athletes, musicians are vulnerable to musculoskeletal injuries and conditions that can be career-ending or produce a severe financial and economic impact. All ages are affected, with a peak incidence in the third and fourth decades; women are slightly more likely to be affected than men. It is incumbent upon orthopaedic surgeons to be able to perform a thorough physical assessment, to be aware of the risk factors associated with musculoskeletal symptoms in musicians, and to have a detailed knowledge of the specific syn-

dromes they suffer and their specific treatment. This paper, two of whose authors are orthopaedically-trained hand surgeons, reviews many of the common hand disorders that afflict musicians and discusses the risk factors for their development and the methods of treatment. Specific instructions about history and examination details are given for those orthopaedists who have less than encyclopedic knowledge of musicians and instrument technique. The various types of disorders are classified for this paper into categories of overuse syndrome, entrapment neuropathies, focal dystonia, and osteoarthritis. A final section is devoted to the consideration of surgery as a treatment modality. Authors emphasize awareness of the musician's special and specific anatomical requirements, often differing between right and left hands. They correctly state, "The surgical assessment of a musician involves a plethora of issues that may not affect the general population."