PASIG MONTHLY CITATION BLAST: No.88 November 2013

Dear Performing Arts SIG members:

It's time to book your flight, hotel and conference! CSM is around the corner, and this year we are in Las Vegas. The website information for the conference is up, take a look:

http://www.apta.org/csm/

CSM 2014 PASIG programming in Las Vegas: Wednesday, February 5th
"A multidisciplinary approach in caring for the acrobatic athlete in the performing arts."
The speakers are:
Kerry Gordon, MS, ATC, CMT, CSCS, PES
Steve McCauley, ATC, CSCS
Chad Hason, MD
Tiffney Touton, PT, DPT, LAT, ATC, CSCS
Frank Perez, ATC

They will present on behind the scenes care of performers, epidemiology of injuries, assessments of hypermobile performers and management of hip and shoulder pathologies.

Remember, the PASIG business meeting follows immediately after the presentations, and all PASIG members, including students, are welcome to join! If you have research ideas or any ideas you would like to discuss at the meeting, or would like to meet with me about at CSM over coffee, please email me

soon. I truly hope to see you there! **PASIG membership is free to all orthopaedic section members,** so please join us.

This month's citation blast is on *Balance, Movement, Music, and Neuroplasticity in Performing Artists*, prompted by clinical questions, it is a compilation of abstracts demonstrating the connection between the nervous and the musculoskeletal systems. It was interesting reading-I hope you enjoy the articles as much as I did!

The practice of compiling abstracts has been an easy way for interns and clinicians to provide content for a citation blast as well as prepare for a clinical inservice or case study report. Please consider compiling Performing Arts-related abstracts for a citation blast this year. It's easy to do, and a great way to become involved with PASIG! Just take a look at our Performing Arts Citations and Endnotes, look for what's missing, and email me your contribution or ideas on future citation blasts.

http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes

Special request:

One of our Performing Arts SIG members requested citation blast content on gyrotonics and performing arts. Would anyone like to follow-up on this?

Best regards,

Annette

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Laura Reising, MS, PT, DPT, lbreising@gmail.com (EndNote Organizer)

Reminder to those interested in participating in the production of a wellness screen for the young, pre-professional dancer:
contact Brooke Winder, PT, DPT, OCS, brookeRwinder@gmail.com

PERFORMING ARTS CONTINUING EDUCATION, CONFERENCES, AND RESOURCES

Orthopaedic Section Independent Study Course. *20.3 Physical Therapy for the Performing Artist*.
Monographs are available for:
- Figure Skating (J. Flug, J. Schneider, E. Greenberg),
- Artistic Gymnastics (A. Hunter-Giordano, Pongetti-Angeletti, S. Voelker, TJ Manal), and
- Instrumentalist Musicians (J. Dommerholt, B. Collier).
Contact: Orthopaedic Section at: www.orthopt.org

Orthopaedic Section-American Physical Therapy Association,
Performing Arts SIG
http://www.orthopt.org/content/special_interest_groups/performing_arts
Performing Arts Citations and Endnotes
http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes

ADAM Center
http://www.adamcenter.net/
Publications:
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Conference abstracts:
http://www.adamcenter.net/#!vstc0=conferences

Dance USA
http://www.danceusa.org/
Research resources:
http://www.danceusa.org/researchresources
Professional Dancer Annual Post-Hire Health Screen:
http://www.danceusa.org/dancerhealth

Dancer Wellness Project
http://www.dancerwellnessproject.com/
Becoming an affiliate:
http://www.dancerwellnessproject.com/Information/BecomeAffiliate.aspx

Harkness Center for Dance Injuries, Hospital for Joint Diseases
http://hjd.med.nyu.edu/harkness/
Continuing education:
http://hjd.med.nyu.edu/harkness/education/healthcare-professionals/continuing-education-courses-cme-and-ceu
Resource papers:
http://hjd.med.nyu.edu/harkness/dance-medicine-resources/resource-papers-and-forms
Links:

http://hjd.med.nyu.edu/harkness/dance-medicine-resources/links
Informative list of common dance injuries:
http://hjd.med.nyu.edu/harkness/patients/common-dance-injuries
Research publications:
http://hjd.med.nyu.edu/harkness/research/research-publications

International Association for Dance Medicine and Science (IADMS)
http://www.iadms.org/
Resource papers:
http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=186
Links:
http://www.iadms.org/displaycommon.cfm?an=5
Medicine, arts medicine, and arts education organization links:
http://www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=5
Publications:
http://www.iadms.org/displaycommon.cfm?an=3

Performing Arts Medicine Association (PAMA)
http://www.artsmed.org/
http://www.artsmed.org/symposium.html
Interactive bibliography site:
http://www.artsmed.org/bibliography.html
Related links:
http://www.artsmed.org/relatedlinks.html
Member publications:
http://artsmed.org/publications.html

(Educators, researchers, and clinicians, please continue to email me your conference and continuing education information and I will include it in the upcoming blasts.)

Balance, Movement, Music, and Neuroplasticity in Performing Artists

Balance in performing artists, vestibular and movement training on rhythm awareness, the role of the music on posture, and neuroplasticity in performing artists became an interest of mine when I noticed several performing arts patients and dance students with balance difficulties and rhythmic challenges. I had questions such as "How do the vestibular, sensorimotor, visual, and auditory systems work together in the rehabilitation of the performing artist vs. the non-performer? Does playing different music, moving intentionally with the music, counting, and singing with music change the response to specific balance exercises?

I have included citations of articles that address these questions, all interesting finds, all prompting more thoughts. I hope you enjoy them as much as I did, and come up with research questions of your own.

Ideas for future studies that came from seeking literature on my patient-related questions are as follows: 1. A study on Y-balance testing laterality and 3 factors: with music, without, moving intentionally to the music. 2. A study on hippocampal changes with rehabilitation using vestibular vs. visual rehabilitation. 3. A study on music and balance with music and visualization of balance vs. music and distraction or vs. music and metronome. Food for thought, perhaps one of you will do a study inspired by what you read in this blast. The crossover between rehabilitation of artists and evidence-based artistic rehabilitation is still muddy in current practice and needs investigation. If anyone would like to perform a study and needs help getting started, the PASIG research committee can assist you and get you connected to other PASIG folks for collaboration and mentorship.

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Bazner, H. and M. G. Hennerici (2007). "Painting after right-hemisphere stroke - case studies of professional artists." Front Neurol Neurosci **22**: 1-13.

Changes in the style of professional artists as an immediate consequence of cerebrovascular disease are an intriguing phenomenon for the neuroscientist. While left-hemisphere damage is commonly provoking alterations in verbal production and comprehension, right-hemisphere stroke often leads to left-sided visuospatial neglect. We present a case series of 13 professional artists with right-hemisphere stroke and compare examples of their poststroke artwork with their prestroke artwork.

Carrick, F. R., E. Oggero, et al. (2007). "Posturographic changes associated with music listening." J Altern Complement Med **13**(5): 519-526.

OBJECTIVES: The aim of this study was to ascertain whether listening to music might cause changes in human stability and be useful in fall prevention and rehabilitation. The aim was also to find what percentage of subjects without neurologic signs or symptoms associated with falling had less than ideal stability. DESIGN: Computer dynamic posturography (CDP) provided stability scores in 266 subjects without a history of falls or vertigo. Subjects were randomized into several different music listening groups and one control group. The music listening groups were given a daily specific music listening task and CDP was obtained 10 minutes, 1 week, and 1 month after the subject's treatment in a blinded fashion. RESULTS: Tests of postural stability have shown that 73% of 266 subjects without neurologic signs or symptoms were found to have balance abnormalities associated with an

increased probability of falling. We have demonstrated positive changes in stability scores in these subjects who underwent a variety of music listening tasks, with the music of Nolwenn Leroy found to be significantly superior to other music tested. CONCLUSIONS: Listening to certain types of music has the potential to change human stability and promote change in the field of fall prevention and rehabilitation with a potential to decrease disability.

Cheng, H. S., C. L. Law, et al. (2011). "Preliminary results of dancing exercise on postural stability in adolescent females." Kaohsiung J Med Sci **27**(12): 566-572.

Twenty-six female student dancers of Chung-hua school of Art (mean age 17.5 +/- 0.5 years) and twenty-five healthy active female collegiate students (mean age 18.1 +/- 1.0 years) participated in this study to investigate the effects of dancing exercise on postural stability of adolescent female through a comparison study of two cohorts. The groups were matched in height and weight. Participants were excluded for left-side dominance, sustained lower extremity injury, any known vestibular system dysfunction, uncorrected visual problems, and other neurological conditions. Static and dynamic standing balances were measured by means of Biodex Stability System in six conditions include bilateral, dominant, and nondominant single leg stances with eye-open and eye-closed conditions. To investigate the difference between static and dynamic stabilities, two protocols were performed: the first protocol consisted of four positions including static position, Level 8, Level 4, and Level 1, respectively. They were instructed to maintain a level platform as stably as possible for a period of 30 seconds for each test and given a 30-second rest between tests. The second protocol was descending stability level that was gradually changed from Level 12 to Level 1 for 60 seconds. Balance indices included overall stability index, anterior-posterior stability index (APSI), and medial-lateral stability index. The results of first protocol showed that there were significant differences in overall stability index score between study and control groups at Level 8 with dominant single leg standing in the eye-open condition and the APSI score at Level 8 and at Level 4 with dominant single-leg standing in the eye-closed condition. There was no significant difference in the second protocol. The possible explanation is loss of familiarization adaptation because of level change consequently in both the groups, not step-by-step as in the first protocol study. Furthermore, a positive correlation was found between the dancing experience and the APSI at Level 8 and Level 4 with dominant single-leg standing in the eye-closed condition. In conclusion the findings implied that dancing exercise results in better postural stability and less visual dependence on postural control in adolescent females.

Forti, S., E. Filipponi, et al. (2010). "The influence of music on static posturography." J Vestib Res **20**(5): 351-356.

It is well known that high intensity sounds modify balance by activating the saccule, which is sensitive to both vestibular and acoustic stimuli. Few studies have examined the effects of music on the postural responses in

healthy subjects. The aim of this study was to evaluate the influence of different types of music (Mozart, Kohler, Kohler with a carrier of 12 KHz and subjects' favourite music) on twelve healthy subjects standing on a stabilometric platform. With each type of music, all subjects underwent static posturography with eyes opened and eyes closed, and with and without foam pads. We evaluated the length and the surface of body sway and the correlation between them, and we analyzed the visual, vestibular and somatosensory sub-components. Listening to different types of music did not significantly change the stabilometric variables, with the exception of listening to Mozart's Jupiter, which caused a significant reduction in the visual component with a consequent increase in both the vestibular and somatosensory inputs. Further studies are needed to determine the effect of Mozart's music in modifying the sensory strategy in the rehabilitation of patients with vestibular impairments.

Galarza, M., C. Isaac, et al. (2013). "Jazz, Guitar and Neurosurgery: the Pat Martino Case Report." World Neurosurg.

We present the case of a professional jazz guitarist with temporal lobe epilepsy secondary to an arteriovenous cerebral malformation. He underwent a left temporal lobectomy in 1980. Following surgery, he presented with severe retrograde amnesia as well as complete loss of musical interest and capabilities. The patient's musical abilities recovered over time and he regained his previous virtuoso status. In 2007 his medical history, neuropsychological functions, and structural MRI were examined and revealed a remarkable degree of recovery of memory and musical abilities in the context of extensive temporal lobe resection. The neuropsychological findings and neuroanatomical features of the MRI were analyzed to try to understand the high degree of recovery of both long-term memory and musical processing abilities in this musician. This case also reveals the possibility of an unusual degree of cerebral plasticity and re-organization. Additionally, it emphasizes the question of musical virtuosism. This report shows that the musical capabilities of professional musicians, in specific cases, can completely recover even when much of the left temporal lobe has been removed.

Golomer, E., F. Rosey, et al. (2009). "The influence of classical dance training on preferred supporting leg and whole body turning bias." Laterality **14**(2): 165-177.

A rightward turning bias has been more frequently noted during adult classical dance practice than during spontaneous rotations. Training could play a role in inducing a preferred direction. We observed the preferred direction for executing four spontaneous whole-body full turns (pirouettes), with eyes open or closed, in pre-pubertal untrained girls and classical dance students. Of untrained girls, 58% showed a leftward turning bias (LTB) and 42% a rightward turning bias (RTB), independently of vision, lateral preferences, and supporting leg. Only one dancer showed a consistent LTB while the majority showed a RTB, with a tendency to use the left leg to turn

towards the right. These results suggest that the role of the vestibular and visual systems is minimal for untrained girls, and suggest a training influence for dancers. The dance students' choice of a supporting leg for turning may exploit some biomechanical properties facilitating the pirouette.

Hanggi, J., S. Koeneke, et al. (2010). "Structural neuroplasticity in the sensorimotor network of professional female ballet dancers." Hum Brain Mapp **31**(8): 1196-1206.

Evidence suggests that motor, sensory, and cognitive training modulates brain structures involved in a specific practice. Functional neuroimaging revealed key brain structures involved in dancing such as the putamen and the premotor cortex. Intensive ballet dance training was expected to modulate the structures of the sensorimotor network, for example, the putamen, premotor cortex, supplementary motor area (SMA), and the corticospinal tracts. We investigated gray (GM) and white matter (WM) volumes, fractional anisotropy (FA), and mean diffusivity (MD) using magnetic resonance-based morphometry and diffusion tensor imaging in 10 professional female ballet dancers compared with 10 nondancers. In dancers compared with nondancers, decreased GM volumes were observed in the left premotor cortex, SMA, putamen, and superior frontal gyrus, and decreased WM volumes in both corticospinal tracts, both internal capsules, corpus callosum, and left anterior cingulum. FA was lower in the WM underlying the dancers' left and right premotor cortex. There were no significant differences in MD between the groups. Age of dance commencement was negatively correlated with GM and WM volume in the right premotor cortex and internal capsule, respectively, and positively correlated with WM volume in the left precentral gyrus and corpus callosum. Results were not influenced by the significantly lower body mass index of the dancers. The present findings complement the results of functional imaging studies in experts that revealed reduced neural activity in skilled compared with nonskilled subjects. Reductions in brain activity are accompanied by local decreases in GM and WM volumes and decreased FA.

Hufner, K., C. Binetti, et al. (2011). "Structural and functional plasticity of the hippocampal formation in professional dancers and slackliners." Hippocampus **21**(8): 855-865.

The acquisition of special skills can induce plastic changes in the human hippocampus, a finding demonstrated in expert navigators (Maguire et al. (2000) Proc Natl Acad Sci USA 97:4,398-403). Conversely, patients with acquired chronic bilateral vestibular loss develop atrophy of the hippocampus, which is associated with impaired spatial memory (Brandt et al. (2005) Brain 128:2,732-741). This suggests that spatial memory relies on vestibular input. In this study 21 professional dancers and slackliners were examined to assess whether balance training with extensive vestibulo-visual stimulation is associated with altered hippocampal formation volumes or spatial memory. Gray matter voxel-based morphometry showed smaller volumes in the anterior hippocampal formation and in parts of the parieto-

insular vestibular cortex of the trained subjects but larger volumes in the posterior hippocampal formation and the lingual and fusiform gyri bilaterally. The local volumes in the right anterior hippocampal formation correlated negatively and those in the right posterior hippocampal formation positively with the amount of time spent training ballet/ice dancing or slacklining at the time of the study. There were no differences in general memory or in spatial memory as assessed by the virtual Morris water task. Trained subjects performed significantly better on a hippocampal formation-dependent task of nonspatial memory (transverse patterning). The smaller anterior hippocampal formation volumes of the trained subjects may be the result of a long-term suppression of destabilizing vestibular input. This is supported by the associated volume loss in the parieto-insular vestibular cortex. The larger volumes in the posterior hippocampal formation of the trained subjects might result from their increased utilization of visual cues for balance. This is supported by the concomitant larger volumes in visual areas like the lingual and fusiform gyri. Our findings indicate that there is a spatial separation of vestibular and visual processes in the human hippocampus.

Israel, I., C. Lecoq, et al. (2005). "Vestibular memory-contingent whole-body return: brave exocentered dancers." Ann N Y Acad Sci **1039**: 306-313.

A whole-body, self-driven return from passive rotation (90 degrees to 270 degrees) test was executed by male and female subjects, and by professional female ballet dancers. To accomplish the return task, subjects were free to use the egocentered reference frame (inversion) or the exocentered one (completion). The results show that with inversion all kinetic parameters were reproduced, whereas the completion performance was highly variable. Although inversion was the default strategy, female subjects used more completions than male subjects, and female dancers still more, although not more accurately. The high variability noted in completion shows a deficiency in integrating vestibular signals for updating the egocentric representation of an external target during passive body rotations, even in dancers. Furthermore, with completions after 180 degrees stimuli, the results suggest that both ego- and exocentered reference frames cannot be used simultaneously.

Phillips-Silver, J. and L. J. Trainor (2007). "Hearing what the body feels: auditory encoding of rhythmic movement." Cognition **105**(3): 533-546.

Phillips-Silver and Trainor (Phillips-Silver, J., Trainor, L.J., (2005). Feeling the beat: movement influences infants' rhythm perception. Science, 308, 1430) demonstrated an early cross-modal interaction between body movement and auditory encoding of musical rhythm in infants. Here we show that the way adults move their bodies to music influences their auditory perception of the rhythm structure. We trained adults, while listening to an ambiguous rhythm with no accented beats, to bounce by bending their knees to interpret the rhythm either as a march or as a waltz. At test, adults identified as similar an

auditory version of the rhythm pattern with accented strong beats that matched their previous bouncing experience in comparison with a version whose accents did not match. In subsequent experiments we showed that this effect does not depend on visual information, but that movement of the body is critical. Parallel results from adults and infants suggest that the movement-sound interaction develops early and is fundamental to music processing throughout life.

Phillips-Silver, J. and L. J. Trainor (2008). "Vestibular influence on auditory metrical interpretation." Brain Cogn **67**(1): 94-102.

When we move to music we feel the beat, and this feeling can shape the sound we hear. Previous studies have shown that when people listen to a metrically ambiguous rhythm pattern, moving the body on a certain beat--adults, by actively bouncing themselves in synchrony with the experimenter, and babies, by being bounced passively in the experimenter's arms--can bias their auditory metrical representation so that they interpret the pattern in a corresponding metrical form [Phillips-Silver, J., & Trainor, L. J. (2005). Feeling the beat: Movement influences infant rhythm perception. Science, 308, 1430; Phillips-Silver, J., & Trainor, L. J. (2007). Hearing what the body feels: Auditory encoding of rhythmic movement. Cognition, 105, 533-546]. The present studies show that in adults, as well as in infants, metrical encoding of rhythm can be biased by passive motion. Furthermore, because movement of the head alone affected auditory encoding whereas movement of the legs alone did not, we propose that vestibular input may play a key role in the effect of movement on auditory rhythm processing. We discuss possible cortical and subcortical sites for the integration of auditory and vestibular inputs that may underlie the interaction between movement and auditory metrical rhythm perception.

Smith, P. F., C. L. Darlington, et al. (2010). "Move it or lose it--is stimulation of the vestibular system necessary for normal spatial memory?" Hippocampus **20**(1): 36-43.

Studies in both experimental animals and human patients have demonstrated that peripheral vestibular lesions, especially bilateral lesions, are associated with spatial memory impairment that is long-lasting and may even be permanent. Electrophysiological evidence from animals indicates that bilateral vestibular loss causes place cells and theta activity to become dysfunctional; the most recent human evidence suggests that the hippocampus may cause atrophy in patients with bilateral vestibular lesions. Taken together, these studies suggest that self-motion information provided by the vestibular system is important for the development of spatial memory by areas of the brain such as the hippocampus, and when it is lost, spatial memory is impaired. This naturally suggests the converse possibility that activation of the vestibular system may enhance memory. Surprisingly, there is some human evidence that this may be the case. This review considers the relationship between the vestibular system and memory and suggests that the evolutionary age of this primitive sensory system as well as how it

detects self-motion (i.e., detection of acceleration vs. velocity) may be the reasons for its unique contribution to spatial memory.

Trainor, L. J., X. Gao, et al. (2009). "The primal role of the vestibular system in determining musical rhythm." Cortex **45**(1): 35-43.

Previous studies have indicated that physical movement on either every second or on every third beat of an unaccented auditory rhythm pattern can disambiguate whether it is perceived in double time as a march or in triple time as a waltz. Here we demonstrate that this disambiguation can also be accomplished by direct galvanic stimulation of the vestibular system. The galvanically induced sensation, without any actual movement, that the head moved from side to side on either every second or on every third beat of the ambiguous auditory rhythm pattern strongly biased whether adults perceived it as being in double or in triple time. These results imply that the vestibular system plays a primal role in the perception of musical rhythm.

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