PASIG MONTHLY CITATION BLAST: No.22 **July 2007**

Dear PASIG members:

I hope this Blast finds each of you well and enjoying your summer. Many of us are busy screening our dance company members (Dance/USA Annual Post-Hire Health Screen for Professional Dancers) as they begin rehearsals for the next year. Several companies will also begin a trial of a common surveillance tool for tracking injuries and costs. This begins to move dance companies towards adapting similar tools that have worked successfully in athletic teams across the US. One question I have: How can we move forward in this area with musicians and orchestras?

The PASIG has put together a slate of candidates running for office. Thanks to each candidate for stepping up and volunteering your time. You'll be rewarded 10-fold in the work you accomplish, the colleagues you meet, and the lasting friendships you form by serving. I hope that each PASIG member will participate in voting this fall and consider increasing your participation in the PASIG by running for office in the future.

Our topic this month is "*Postural Stability*", contributed by Valerie Williams, SPT (Slippery Rock University). The format is an annotated bibliography of articles on the selected topic from 1996 – 2006. Each month's citations will be added to EndNote libraries available on the PASIG webpage for our members to access and download. (Information about EndNote referencing software can be found at http://www.endnote.com, including a 30-day free trial). If you'd like to suggest a topic or create one, please let me know.

As always, your comments and entry contributions to these Citation Blasts or other PA research ideas are always welcome. Please drop me an e-mail anytime.

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SPECIAL TOPIC: POSTURAL STABILITY

Postural stability is the ability to maintain the body's position in space. It depends upon the ability to maintain the center of mass within the body's base of support. Postural stability is controlled by the visual, vestibular, and proprioceptive systems. Changes in function of these systems can affect the ability to maintain balance. Dancers, ice skaters, and gymnasts need to be able to maintain postural stability on varying surfaces and unusual postures depending on their performance requirements. This annotated bibliography cites articles that describe the ability of dancers to maintain postural stability, as well as the contributions of the different systems involved. I hope you will find this bibliography useful for understanding the factors related postural stability specific to dancers.

Valerie Williams, SPT

Crotts D, Thompson B, Nahom M, Ryan S, Newton RA (1996). Balance abilities of professional dancers on select balance tests. *J Orthop Sports Phys Ther*, 23: 12-17.

Documentation that dancers have better balance abilities than nondancers is important because of the number of dancers who sustain injury and then are referred to physical therapists for treatment. The purpose of this study was to compare balance abilities of professional dancers with nondancers on selected balance conditions. Fifteen dancers and 15 age- and gender-matched nondancers maintained one-legged stance under six combinations of visual and support surface conditions (Foam and Dome Test modified from two feet to one foot). Each condition was maintained for 30 seconds. A composite balance score was obtained for each subject by summing the number of seconds the individual maintained balance for each test condition. There was a significant difference in the mean composite balance score (across the six balance conditions) for the dance group compared with the control group (731 seconds and 563 seconds, respectively). Under sensory challenged conditions, it appeared that dancers were better able to maintain their postures upright against gravity. The balance strategies and techniques learned by professional dancers should be carefully analyzed to determine if they could be incorporated into treatment programs for nondancers who have balance instability and dancers who are injured.

Golomer E, Dupui P (2000). Spectral analysis of adult dancers' sways: sex and interaction vision-proprioception. *Int J Neurosci*, 105: 15-26.

In subjects of both sexes with or without dance training, dependence on vision and proprioception for postural control was studied by destabilizing these cues on a free seesaw. Fast Fourier transform processing allowed spectral frequency analysis of the platform sways recorded by an accelerometer. Two frequency bands of the total spectral energy were used: the lower (0 – 2 Hz) and the higher (2 – 20 Hz) frequency bands. Dancers were significantly less dependent on vision but use more proprioception than untrained subjects. Professional dance training appears to shift sensorimotor dominance from vision to proprioception, and this evolution seems more marked for males than females. Female and male dancers had

similar dynamic performances, but for males, the better neuromuscular coordination may be associated with biomechanical factors.

Golomer E, Dupui P, Sereni P, Monod H (1999). The contribution of vision in dynamic spontaneous sways of male classical dancers according to student or professional level. *J Physiol*, 93: 233-237.

We investigated the involvement of vision in the regulation of dynamic equilibrium in male children and young adults performing a physical activity requiring a high level of spatial skill: self-induced body sways of ballet dancers on a free unstable platform, 45 professional male dancers (Paris Opera) participated in the study. They included two student groups (beginners and confirmed) and two performer groups (adolescent and adult). They maintained their equilibrium on the platform under different visual and position conditions. The displacements of the seesaw platform were calculated from accelerometer measures. Fast Fourier transform processing of stabilograms allowed spectral frequency analysis. The total spectrum energy and the energies of the three frequency bands (0-0.5 Hz, 0.5-2 Hz, 2-20 Hz) were determined. For all groups, ANOVA indicated that values were higher for eyes-closed than for eyes-open conditions. The visual dependence differed according to age: for 14-year-old students the postural control for dynamic equilibrium was less visually dependent for 11-year-old students. The 18-year-old dancers, although professional, were more dependent on vision than 14-year-old student dancers. These 18-year-old dancers were still adolescent because they had recently undergone growth acceleration, which could disturb their proprioceptive references and internal body representations. Thus, visual input may dominate over the other sensory inputs in the regulation of postural control.

Hugel F, Cadopi M, Kohler F, Perrin P (1990). Postural control of ballet dancers: a specific use of visual input for artistic purposes. *Int J Sports Med*, 20: 86-91.

Dance is a specific expression of human motor behavior. This artistic physical activity depends upon an effective technical training with important postural components and necessitates the codification of sensory inputs to build mental representations of the action to be produced. Proprioception and vision being two fundamental sensory modalities in classical ballet, this study attempted to determine the importance of the visual input for postural control during the practice of this activity. First, this work compared the performances of 18 professional ballet dancers and 46 non-dancers on a platform of forces during static posturographic tests in open or closed eyes situation. Then, we studied how professional dancers achieve balance in postures specific of classical ballet: on demi-pointe and on pointe. The results indicate that visual inputs are important in classical ballet since dancers only performed better than controls in eyes open conditions. The similar results obtained on pointe with eyes open or closed conversely suggest that training in classical ballet develops specific modalities of balance which are not transferable to posture control in daily life situations.

Leanderson J, Eriksson E, Nilsson C, Wykman A (1996). Proprioception in classical ballet dancers: a prospective study of the influence of an ankle sprain on proprioception in the ankle joint. *Am J Sports Med,* 24: 370-374.

We studied prospectively the influence of ankle sprains on proprioception as measured by recording the postural sway of classical ballet dancers. Excellent balance and coordination are important for classical ballet dancers, and postural stability requires adequate proprioception from the ankle joint. Fifty-three professional dancers from the Royal Swedish Ballet, Stockholm, and 23 nonathletes, the control group, participated in the investigation. Postural sway was recorded and analyzed with a stabilimeter using a specially designed, portable, computer-assisted force plate. Six dancers sustained ankle sprains during

followup. The recordings were obtained of these dancers before and after the injuries. The stabilometry results differed among the male and female dancers and the control group as follows: 1) the male dancers demonstrated a smaller total area of sway, and 2) both the male and female dancers had a smaller mean sway on the left foot than on the right (no mean difference in sway was found between the left and right foot in the control group). In comparison with the condition before injury and with the uninjured foot, the postural stability of the dancer was impaired for several weeks after the ankle sprain. Postural stability gradually improved during rehabilitation and improvement still occurred several weeks after professional dancing had resumed.

McMillan A, Proteau L, Lebe RM (1998). The effects of pilates-based training on dancers dynamic posture. *J Dance Med Sci*, 2: 101-107.

Dancers are required to execute varied and complex movements that put stress on their body. There is an increased risk of injury when the dancer executes these complex movements with insufficient technical control or with bad posture. A form of corrective gymnastics popular among dancers is the Pilates method of conditioning and exercise. The present experiment was designed to examine the effects of training with Pilates-based exercises on dancers dynamic posture. Participants from the Ecole Superieure de Danse du Quebec trained individually twice a week, with a teacher in Pilates-based exercises (mat and Universal Reformer) for a period of three months. They were also assigned some of the mat exercises as homework. The participants were divided into a control and an experimental group. The participants' dynamic posture was evaluated during the execution of a grand plie. Data were collected both prior to and after the training period with a WATSMART system. The participants of the experimental group were found to be more stable in the upper body region than their controls. This suggests that training with Pilates-based exercises improves dynamic body control.

Perrin P, Deviterne D, Hugel F, Perrot C (2002). Judo, better than dance, develops sensorimotor adaptabilities involved in balance control. *Gait & Posture*, 15: 187-194.

Objectives: Training allows sportsmen to acquire new balance control abilities, possibly differing according to the discipline practised. We compared, by means of static and dynamic posturographic tests, the postural skills of high-level judoists, professional dancers and controls, in order to determine whether these sports improved postural control. Results: With eyes open, judoists and dancers performed better than controls, indicating a positive effect of training on sensorimotor adaptabilities. Yet, with eyes closed, only judoists retained a significantly better stance. Conclusions: These data indicate that the practice of a high-skill activity involving proprioceptive afferences especially improves both performance and balance control.

Ramsay JRE, Riddoch MJ (2001). Position-matching in the upper limb: professional ballet dancers perform with outstanding accuracy. *Clin Rehab*, 15: 324-330.

Objectives: To investigate the accuracy in position-matching in the upper limb in two groups of subjects who were physically movement aware. Design: A mixed-group design was used. Objective measurement of the accuracy in position-matching at the shoulder and elbow in both dominant and nondominant arms consisted of photographic record of the position-matching test, with goniometric measurement. Settings: Physiotherapy department at the Birmingham Royal Ballet and School of Health Science, University of Birmingham. Subjects: Two subject groups: physiotherapy students (n = 10), professional ballet dancers (n = 10). Results: A mixed design analysis of variance found significant differences between the accuracy in position-matching at both the shoulder and elbow joints in the two groups ($p < 0.05$), with the ballet dancers having greater accuracy then the physiotherapy students. A

significant difference in the joint positions tested were demonstrated ($p < 0.05$) with the positions of abduction at the shoulder and extension of the elbow showing greatest accuracy in matching. There was no significant difference found between the dominant and nondominant upper limb in position-matching. Conclusion: Professional ballet dancers demonstrated greater accuracy in position-matching the upper limb, implying that mass and continuing practice can improve a motor sensory skill.

Schmit JM, Regis DI, Riley MA (2005). Dynamic patterns of postural sway in ballet dancers and track athletes. *Exp Brain Res,* 163: 370-378.

We compared the variability and spatiotemporal profile of postural sway of trained ballet dancers to college varsity track athletes under variations in the availability of vision and rigidity of the support surface. We found no differences between the groups according to the variability measures, but variability increased for both groups with eyes closed and on a foam surface. Recurrence quantification analysis revealed that the postural sway of dancers was less regular (lower recurrence), less stable (lower maxline), less complex (lower entropy), and more stationary (lower absolute trend) than that of track athletes. Dancers, possibly as a result of focused balance training, exhibited different dynamic patterns of postural sway.

Simmons RW (2005). Neuromuscular responses of trained ballet dancers to postural perturbations. *Int J Neurosci,* 115: 1193-1203.

The balance of trained ballet dancers and non-dancer controls was mechanically perturbed in order to evaluate the time of onset of muscle activation and the consistency of muscle activation. Results supported the prediction that ballet dancers have significantly faster long-latency (LL) neuromuscular responses than controls and are significantly more consistent in muscle activation. These findings indicate a superior postural control mechanism in trained dancers and may explain the ability of dancers to maintain static balances over a small base of support.

Simmons RW (2005). Sensory organization determinants of postural stability in trained ballet dancers. *Int J Neurosci,* 115: 87-97.

Trained ballet dancers and nondancer controls completed six balance tests using computerized dynamic posturography. The tests facilitated assessment of the type of sensory organization used to maintain postural control under conditions ranging from quiet standing to a situation in which visual and/or somatosensory information was systematically removed or made unreliable. Results indicated that ballet dancers and controls have comparable balance ability during eyes open and eyes closed conditions. However, when somatosensory information alone or in combination with visual information was made unreliable, dancers were significantly less stable than controls and utilized a hip strategy to maintain postural control.