PASIG MONTHLY CITATION BLAST: No.30 **May 2008**

Dear PASIG members:

The 2008 Olympics will take place in Beijing from August 8 through 24. As the PASIG encompasses gymnastics, PASIG member Gina Pongetti MPT, MA will be contributing information on gymnastics that will be included each citation blast over the next few months.

This series of "food for thought" is meant to stimulate you to think about what you are watching during the gymnastics preliminary and Olympic events. There will be a new "thought" about changes in the Code of Points (judging) and other interesting biomechanical challenges that gymnasts face.

Thought #1 With the change in the Code of Points, which is the governing value system placed on each element that an athlete performs, and the way that the scores are calculated, elements/tricks become harder and harder as the years progress. Because of the increase in athletes in the "pool" for selection for Elite level and Olympic teams, as well as the increase in number of gymnastics clubs in the US, repetitions have increased in order to master skills. A great example of this is tumbling passes on floor. A gymnast used to perform 3 in each routine, and now we are at an average of 5. How do you think this is going to change the injuries that we see trickling down to the recreational level, as well as the Elite level?

Below are competitions prior to the Olympics so that you can get to know the gymnastics athletes and skills. The following events will be covered on television by NBC, and may be shown live or delayed. Check your listings for information:

Visa Championships	May 22-24	Men's Artistic, Rhythmic, T&T, Women's US Classic	Houston

Visa Championships	June 5-7	Women's Artistic	Boston
US Olympic Trials	June 19-22	Team Trials	Philadelphia

Gina Pongetti MPT, MA

Again, a reminder to submit your abstract for CSM! We want to increase the research activities of the PASIG! CSM abstract submission is open as of March 18th and the deadline will be here sooner than you think (June 18th). Abstract topics can include pilot and full scientific research studies, case studies, clinical topics, or special interest reports. Go to http://www.apta.org/csm for more information and to connect to Scholar One Abstract Central for electronic submission.

Don't forget, the PASIG sponsors an annual student research scholarship. This award is to recognize students, who have had an abstract accepted to CSM, for their contribution to performing arts medicine and research. We encourage you to mentor your students in PA-related research and have them apply! If the PASIG Research Committee can assist students, please contact us. For more information on the research award please check our webpage (www.orthopt.org/sig_pa.php). Students with additional questions can contact PASIG President Leigh Roberts (lar@brventures.com).

For our topic this month, I've pulled relevant references on *gymnastics* that may also enhance watching the gymnastics competitions. The format is an annotated bibliography of articles on the selected topic focusing on the last decade. 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 are always welcome.

As always, please drop me an e-mail anytime.

Regards,
Shaw

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GYMNASTICS

These annotated references focus primarily on the biomechanics of artistic gymnastics. Hopefully, as you watch events that include asymmetric bars, parallel bars, vaulting, tumbling and other activities, these articles will enhance your understanding of how and your appreciation of what these athletes are performing.

Shaw Bronner PT, PhD, OCS
PASIG Research Chair

Ackland T, Elliott B, et al. (2003). Growth in body size affects rotational performance in women's gymnastics. Sports Biomech **2**(2): 163-76.

National and state representative female gymnasts (n = 37), aged initially between 10 and 12 years, completed a mixed longitudinal study over 3.3 years, to investigate the effect of body size on gymnastic performance. Subjects were tested at four-monthly intervals on a battery of measures including structural growth, strength and gymnastic performance. The group were divided into 'high growers' and 'low growers' based on height (> 18 cm or < 14 cm/37 months, respectively) and body mass (> 15 kg or < 12 kg/37 months, respectively) for comparative purposes. Development of gymnastic performance was assessed through generic skills (front and back rotations, a twisting jump and a V-sit action) and a vertical jump for maximum height. The results show that the smaller gymnast, with a high strength to mass ratio, has greater potential for performing skills involving whole-body rotations. Larger gymnasts, while able to produce more power and greater angular momentum, could not match the performance of the smaller ones. The magnitude of growth experienced by the gymnast over this period has a varying effect on performance. While some activities were greatly influenced by rapid increases in whole-body moment of inertia (e.g. back rotation), performance on others like the front rotation and vertical jump, appeared partly immune to the physical and mechanical changes associated with growth.

Asseman FB, Caron O, et al. (2007). Are there specific conditions for which expertise in gymnastics could have an effect on postural control and performance? Gait Posture.

The first aim of this study was to analyse the effect of elite training, linked to expertise, in gymnastics on postural performance and control. For this purpose, body sway of expert gymnasts was compared to other sportsmen, non-experts and non-gymnasts, in two different postures: bipedal (easy and unspecific to gymnasts) and unipedal (difficult and fairly specific). The second aim was to compare the groups in the same tasks but in a visual condition for which they were not trained, i.e. with eyes closed. Postural performance was assessed by centre of gravity motion, which was computed from centre of pressure motion, estimating postural control. A significant difference between the two groups was observed for postural performance in the unipedal posture and with eyes open only. Regardless of their posture, the groups were similarly affected by removal of vision. Expertise in gymnastics seemed to improve postural performances only in situations for which their practise is related to, i.e. unipedal with eyes open. These reveal the importance of choosing a relevant postural configuration and visual condition according to the people's training or by extension experience.

Bradshaw E (2004). Target-directed running in gymnastics: a preliminary exploration of vaulting. Sports Biomech **3**(1): 125-44.

Research to date has demonstrated the importance of running speed and an accurate take-off on gymnastics vaulting performance (Krug et al., 1998; Bohne et al., 2000). Current training practice for gymnastics vaulting is to stereotype the 15-25 m run-ups to the board, which assumes that a fast and reliable approach is best controlled predominantly without visual feedback. Incidences where gymnasts make errors during their run-ups, often landing onto the back of the board, occur frequently, even at the international level. The standard deviation method (e.g. Lee et al., 1982) for identifying visual regulation in long jump run-ups was employed in this first exploration of gymnastics vaulting to examine whether visual regulation processes are utilised. Secondly, the question of how a small

number of gymnasts can run fast during the approach and perform more difficult vaults was addressed. Five elite female gymnasts aged 13-15 years performed five round-off entry vaults. One panning 50 Hz video camera recorded each trial from an elevated platform to evaluate the approach step, hurdle, and round-off characteristics, whilst two 250 Hz cameras recorded vaulting performance. Two qualified judges viewed each vaulting trial and provided a performance score. A precursor for a fast take-off from the board when vaulting is to utilise vision early to control the approach kinematics ($p = 0.02$). High take-off velocity was directly related to judge's score ($p = 0.03$). Coaches need to supplement gymnasts' vault training to include exercises that improve the gymnasts' ability to visually regulate their gait pattern whilst running.

Coventry E, Sands WA, et al. (2006). Hitting the vault board: implications for vaulting take-off--a preliminary investigation. Sports Biomech **5**(1): 63-75.

Gymnastics vaulting relies on a specialized take-off board for propulsion during the take-off phase of the vault. There is little information on the vault board and its behaviour. The aim of this study was to characterize the behaviour of the vault board during handspring drill take-offs of young male gymnasts ($n = 36$). The side of the top surface of the vault board and the wooden base were marked with three reflective markers, placed at the end of the vault board nearest the vault table and the centres of the two rearmost coil springs. The vault board surface was divided into two areas, rear and middle, based on marker location. The gymnasts' groups were determined from the location of the gymnast's lateral malleolus at vault board contact. Landings with the malleolus directly above or behind the rearmost marker were considered rear landings; landings with the malleolus forward of the rearmost marker were considered middle landings. Marker movements were automatically digitized and the right malleolus was hand digitized at 120 Hz. The maximum vertical displacement, vertical deflection time, and vertical velocity at take-off of the vault board markers did not differ statistically between board contact groups (all $p > 0.05$). The lateral malleolus velocity components also did not differ between board contact groups. Some low to moderately strong correlations were observed between the various marker displacements, durations and take-off velocities. Modest correlations were obtained between board markers and right malleolus velocities. The results indicate that foot contact on the vault board, as defined here, did not result in differences in board marker behaviour or right lateral malleolus velocities. This information does not support the idea that vault board contacts at the rear of the vault board are worse than contacts near the middle of the vault board. More research is needed to ascertain the role of the vault board's vibration characteristics to whole body actions that are observed in the subsequent preflight phase.

Damisch L, Mussweiler T, et al. (2006). Olympic medals as fruits of comparison? Assimilation and contrast in sequential performance judgments. J Exp Psychol Appl **12**(3): 166-78.

The authors investigated the evaluative consequences of sequential performance judgments. Recent social comparison research has suggested that performance judgments may be influenced by judgments about a preceding performance. Specifically, performance judgments may be assimilated to judgments of the preceding performance if judges focus on similarities between the two. If judges focus on differences, however, contrast may ensue. The authors examined sequential performance judgments, using data gathered from the 2004 Olympic Games as well as data gathered in the laboratory with students or experienced gymnastics judges as participants. Sequential performance judgments were influenced by previously judged performances, and the direction of this influence depended on the degree of perceived similarity between the successive performances.

Filaire E, Jouanel P, et al. (2003). Effects of 16 weeks of training prior to a major competition on hormonal and biochemical parameters in young elite gymnasts. J Pediatr Endocrinol Metab **16**(5): 741-50.

The aim of this study was to investigate the response to 16 weeks of training on selected hormonal and biological parameters in seven international competition level female artistic gymnasts (14.5 +/- 1.2 years). Data were collected at the beginning of the first training week (W1) and in the 16th week (W16). Assessments also included anthropometric measurements, dietary intake for 7 days and Tanner staging. No gymnast had reached menarche and the puberty stages corresponded to Tanner's pubertal stage 2. The gymnasts were smaller than average for their age group, with a height:weight ratio above the 50th percentile. Energy intake was about 31% lower than recommendations. Significant decreases in IGF-I, IGFBP3, IGF-I:C ratio and triglyceride values and increases in uric acid and creatinine levels were noted. Cortisol values were high regardless of the period. This training provided evidence for alterations in resting somatotropic and adrenocorticotropic parameters.

Gervais P, Dunn J (2003). The double back salto dismount from the parallel bars. Sports Biomech **2**(1): 85-101.

The purpose of this study was to identify those mechanical determinants or their trends that distinguished a gymnast's best performance of the double back salto dismount on parallel bars from those judged to be inferior. Dismounts, in the tucked position, by nine Canadian gymnasts were analysed. Unique to this study was the inclusive analysis of multiple performances of the same skill by these athletes. It was felt that within-subject comparisons would reveal the kinematic variables on which the gymnast may focus in order to achieve their best performances. A non-parametric median sign test was used to compare mechanical variables, within subjects, between the dismount judged the best and those dismounts awarded a lower score. Three judges judged each dismount. In comparison to poorer performances of the dismount, statistical analyses revealed that athlete's best performances were characterised by (1) a higher release point, more vertical velocity yet with less angular momentum at take-off, (2) greater height, with a tighter and earlier tuck position during the flight phase, and (3) a greater range of motion and a more compact squat position at landing (all p's < .06).

Harringe ML, Lindblad S, et al. (2004). Do team gymnasts compete in spite of symptoms from an injury? Br J Sports Med **38**(4): 398-401.

BACKGROUND: Gymnasts practise many hours a week, and symptoms from injuries do not seem to stop them from continuing with practice. They may even compete with symptoms from injuries, which could increase the risk of reinjury, or of the occurrence of a more severe injury. OBJECTIVES: To investigate whether team gymnasts compete at high level in spite of symptoms from an injury. METHODS: 188 male and female competitors participating in the Swedish Cup for juniors and seniors answered a questionnaire about symptoms from injuries on the day of the competition. RESULTS: More than half the gymnasts (58%) competed despite having symptoms from an injury on the day of the competition. More seniors than juniors competed in spite of symptoms from an injury ($p = 0.006$). Two of three team gymnasts (65%) reported symptoms from the lower extremities and around one in five (22%) reported back symptoms. Fifty five per cent of the gymnasts reported recurrence of an injury at the same site (reinjury). CONCLUSIONS: There was a high prevalence of symptoms from injuries on the day of competition. This did not stop the team gymnasts from competing.

Hiley MJ, Readon MR (2005). The margin for error when releasing the asymmetric bars for dismounts. J Appl Biomech **21**(3): 223-35.

It has previously been shown that male gymnasts using the "scooped" giant circling technique were able to flatten the path followed by their mass center, resulting in a larger margin for error when releasing the high bar (Hiley and Yeadon, 2003a). The circling technique prior to performing double layout somersault dismounts from the asymmetric bars in women's artistic gymnastics appears to be similar to the "traditional" technique used by some male gymnasts on the high bar. It was speculated that as a result the female gymnasts would have margins for error similar to those of male gymnasts who use the traditional technique. However, it is unclear how the technique of the female gymnasts is affected by the need to avoid the lower bar. A 4-segment planar simulation model of the gymnast and upper bar was used to determine the margins for error when releasing the bar for 9 double layout somersault dismounts at the Sydney 2000 Olympics. The elastic properties of the gymnast and bar were modeled using damped linear springs. Model parameters, primarily the inertia and spring parameters, were optimized to obtain a close match between simulated and actual performances in terms of rotation angle (1.2 degrees), bar displacement (0.011 m), and release velocities (<1%). Each matching simulation was used to determine the time window around the actual point of release for which the model had appropriate release parameters to complete the dismount successfully. The margins for error of the 9 female gymnasts (release window 43-102 ms) were comparable to those of the 3 male gymnasts using the traditional technique (release window 79-84 ms).

Hiley MJ, Yeadon MR (2003). The margin for error when releasing the high bar for dismounts. J Biomech **36**(3): 313-9.

In Men's Artistic Gymnastics the current trend in elite high bar dismounts is to perform two somersaults in an extended body shape with a number of twists. Two techniques have been identified in the backward giant circles leading up to release for these dismounts (J. Biomech. 32 (1999) 811). At the Sydney 2000 Olympic Games 95% of gymnasts used the "scooped" backward giant circle technique rather than the "traditional" technique. It was speculated that the advantage gained from the scooped technique was an increased margin for error when releasing the high bar. A four segment planar simulation model of the gymnast and high bar was used to determine the margin for error when releasing the bar in performances at the Sydney 2000 Olympic Games. The eight high bar finalists and the three gymnasts who used the traditional backward giant circle technique were chosen for analysis. Model parameters were optimised to obtain a close match between simulated and actual performances in terms of rotation angle (1.2 degrees), bar displacements (0.014 m) and release velocities (2%). Each matching simulation was used to determine the time window around the actual point of release for which the model had appropriate release parameters to complete the dismount successfully. The scooped backward giant circle technique resulted in a greater margin for error (release window 88-157 ms) when releasing the bar compared to the traditional technique (release window 73-84 ms).

King MA, Yeadon MR (2004). Maximising somersault rotation in tumbling. J Biomech **37**(4): 471-7.

Performing complex somersaulting skills during the flight phase of tumbling requires the generation of linear and angular momenta during the approach and takeoff phases. This paper investigates how approach characteristics and takeoff technique affect performance with a view to maximising somersault rotation in tumbling. A five-segment planar simulation model, customised to an elite gymnast, was used to produce a simulation which closely matched a recorded performance of a double layout somersault by the elite gymnast. Three optimisations were carried out to maximise somersault rotation with different sets of initial

conditions. Using the same initial linear and angular momentum as the double layout somersault and varying the joint torque activation timings allowed a double straight somersault to be performed with 19% more rotation potential than the actual performance. Increasing the approach velocity to a realistic maximum of 7 ms(-1) resulted in a 42% reduction in rotation potential when the activation timings were unchanged but allowed a triple layout somersault to be performed with an increase of 31% in rotation potential when activation timings were re-optimised. Increasing also the initial angular momentum to a realistic maximum resulted in a 4% reduction in rotation potential when the activation timings were unchanged but allowed a triple straight somersault to be performed with a further increase of 9% in rotation potential when activation timings were re-optimised. It is concluded that the limiting factor to maximising somersault rotation is the ability to generate high linear and angular velocities during the approach phase coupled with the ability to adopt consonant activation timings during the takeoff phase.

King MA, Yeadon MR (2005). Factors influencing performance in the Hecht vault and implications for modelling. J Biomech **38**(1): 145-51.

This paper investigated the factors that influence Hecht vault performance and assessed the level of model complexity required to give an adequate representation of vaulting. A five-segment planar simulation model with a visco-elastic shoulder joint and a torque generator at the shoulder joint was used to simulate the contact phase in vaulting. The model was customized to an elite gymnast by determining subject-specific segmental inertia and joint torque parameters. The simulation model was matched to a performance of the Hecht vault by varying the visco-elastic characteristics of the shoulders and the arm-horse interface and the activation time history of the shoulder torque generator until the best match was found. Perturbing the matching simulation demonstrated that appropriate initial kinematics are necessary for a successful performance. Fixing the hip and knee angles at their initial values had a small effect with 3 degrees less rotation. Applying shoulder torque during the contact phase also had a small effect with only a 7 degrees range in landing angles. Excluding the hand segment from the model was found to have a moderate effect with 15 degrees less rotation and the time of contact reduced by 38%. Removing shoulder elasticity resulted in 50 degrees less rotation. The use of a five-segment simulation model confirmed that the use of shoulder torque plays a minor role in vaulting performance and that having appropriate initial kinematics at touchdown is essential. However, factors such as shoulder elasticity and the hands which have previously been ignored also have a substantial influence on performance.

Yeadon MR, Brewin MA (2003). Optimised performance of the backward longswing on rings. J Biomech **36**(4): 545-52.

Many elite gymnasts perform the straight arm backward longswing on rings in competition. Since points are deducted if gymnasts possess motion on completion of the movement, the ability to successfully perform the longswing to a stationary final handstand is of great importance. Sprigings et al. (1998) found that for a longswing initiated from a still handstand the optimum performance of an inelastic planar simulation model resulted in a residual swing of more than 3º in the final handstand.For the present study, a three-dimensional simulation model of a gymnast swinging on rings, incorporating lateral arm movements used by gymnasts and mandatory apparatus elasticity, was used to investigate the possibility of performing a backward longswing initiated and completed in handstands with minimal swing. Root mean square differences between the actual and simulated performances for the orientations of the gymnast and rings cables, the combined cable tension and the extension of the gymnast were 3.2º, 1.0º, 270N and 0.05m respectively. The optimised simulated performance initiated from a handstand with 2.1º of swing and

using realistic changes to the gymnast's technique resulted in 0.6º of residual swing in the final handstand. The sensitivity of the backward longswing to perturbations in the technique used for the optimised performance was determined. For a final handstand with minimal residual swing (2º) the changes in body configuration must be timed to within 15 ms while a delay of 30 ms will result in considerable residual swing (7º).