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Performance and Health Concepts in Artistic Gymnastics

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Performance & Health?




British Gymnastics




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Artistic Gymnastics

Women's - floor exercise, vault (table), balance beam, uneven bars.



Men's - floor exercise, vault (table), rings, horizontal bar, parallel bars, pommel horse.






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TAKO (Category 1)
Take-off or push-off from a solid or elastic surface (optimum production of the body's take-off velocities)

LAND (Category 5)
Landings (maximum absorption of mechanical energy).



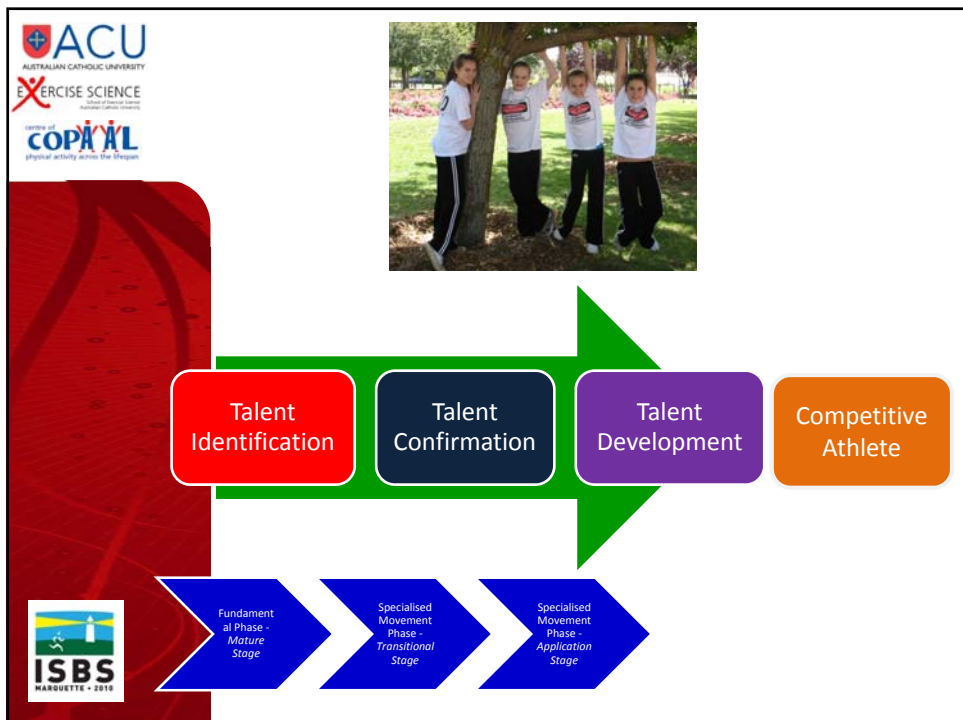
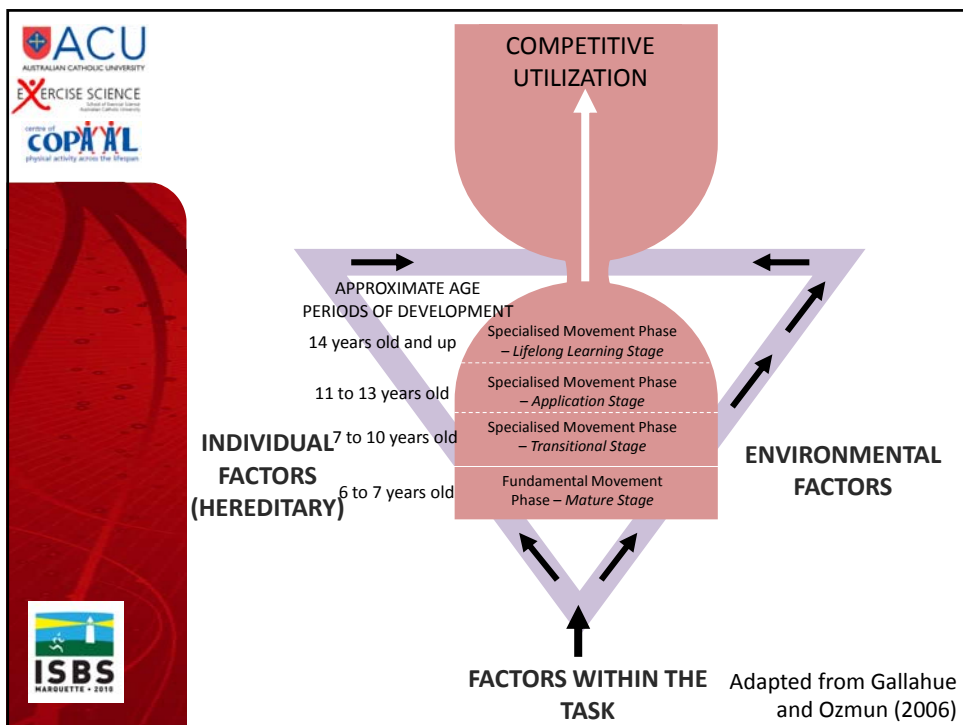
Brüggemann (1994)






The development of sound technical skills in gymnastics requires suitable motor abilities (e.g. capacity to run, jump, leap, and swing), coordination, and static and dynamic stability.

(de Albuquerque and De Tarso Veras Farinatti, 2007).





- Kindergym
- Recreational (GymFun)
- National competitive program (Levels 1-10)
- International development program (IDP 3, 5, 6, 8, 10; Junior, Senior)







Code of Points






Biomechanical Perspectives

Photo © Randy Chow




- Governance and Rules
- Positive and Negative Effects of Impact
- Impact on Training





Governance and Rules


- Influences routine composition (D score) and therefore performance
- Influences technical execution (E score) but only if reinforced by the judges
- Influences safety



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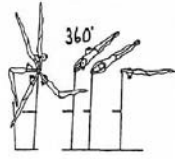
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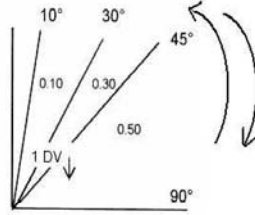


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7.4.2 Swings – elements with turns that

- do not reach handstand
- do not pass through vertical and
- continue movement after turn in opposite direction





D- Panel


- > 10° – Credit 1DV lower than element to hstd

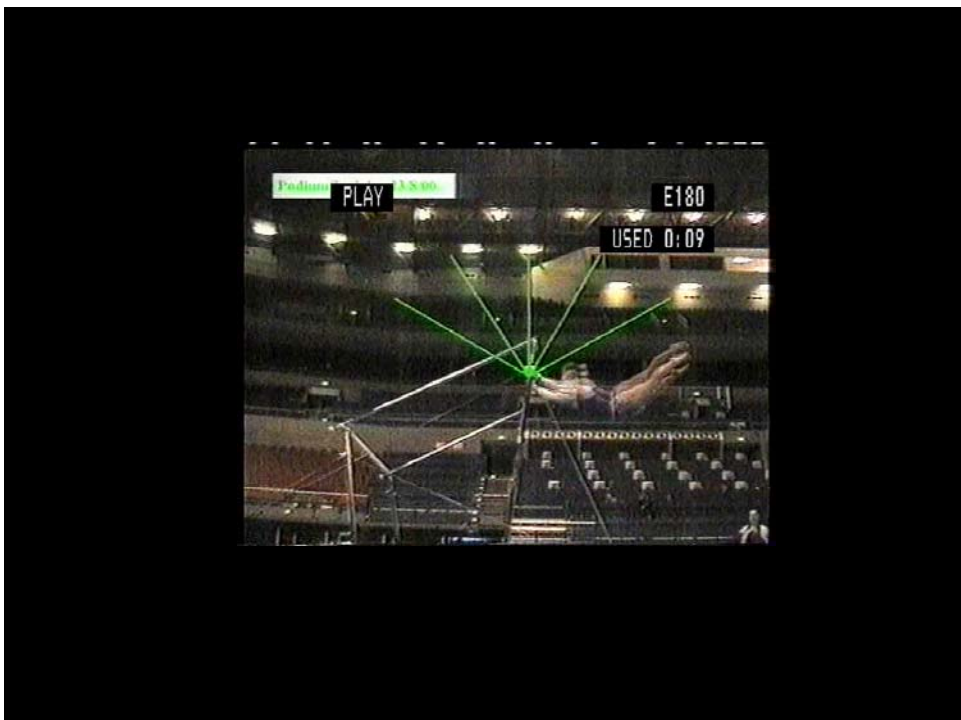
E- Panel

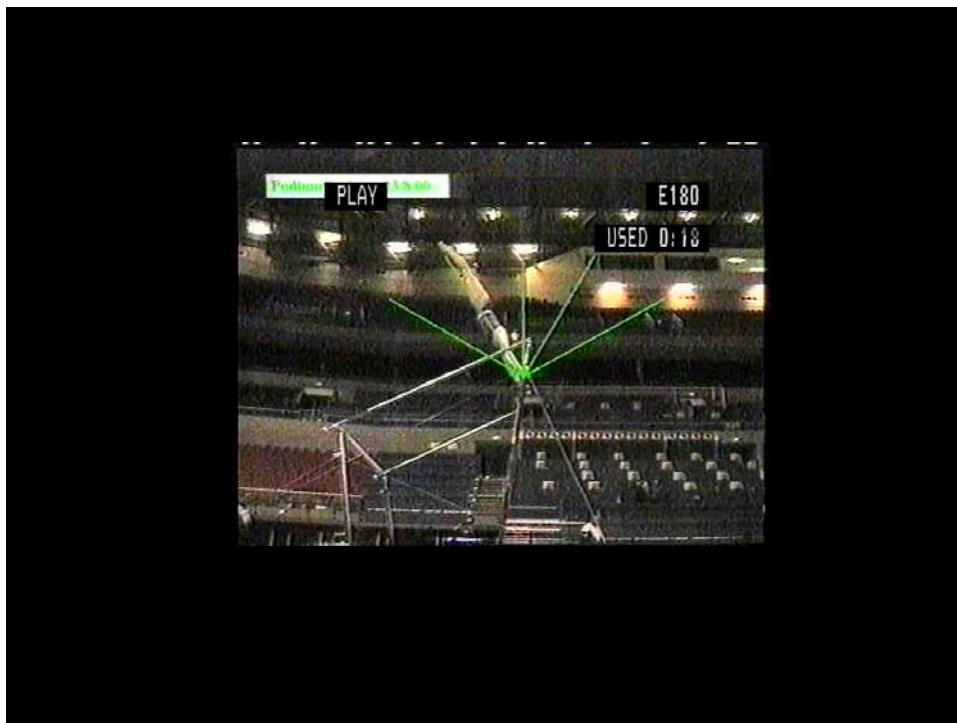
- > 10° – 30° – 0.10
- > 30° – 45° – 0.30
- > 45° – 0.50



Swing elements with ½ (180°) turn:

- All body parts must reach horizontal to receive DV, otherwise No DV will be credited








ARTICLE 6 – Table of General Faults and Penalties


Faults		Small	Med.	Large	Very Large
		0.10	0.30	0.50	1.00 or more
By E- Panel Judges (E' – E')					
Landing Faults <i>(all elements including dismounts)</i>		If there is no fall the maximum landing deduction may not exceed 0.80			
– Legs apart on landing	each time	X			
– Too close to the apparatus (UB & BB)		X	X		
Movements to maintain balance:					
– extra arm swings		X			
– additional trunk movements to maintain balance	each time	X	X		
– extra steps, slight hop	each time	X			
– very large step or jump (<i>guideline – more than shoulder width</i>)	each time		X		
– body posture fault	each time	X	X		
– deep squat	each time			X	
– brushing apparatus with hands-arms, but not falling against the apparatus	each time		X		
– support on mat/apparatus with 1 or 2 hands	each time				1.00
– fall on mat to knees or hips	each time				1.00
– fall on or against apparatus	each time				1.00

15



Feet must be held together, side-by-side when landing with deductions for:

- A visible gap between the feet (0.1)
- A step or hop (0.3)
- A deep squat (0.5)
- A fall (1.0)







Judging Judge

WHILE it was difficult—but not impossible—for men to exceed an E-score 9.0 (except for on vault), the highest score during the women's qualification was 8.9. It was given only twice, both time vault (Kayla Williams and Hong Un-jo). The women's all-around final produced three scores in the 9.0s (Brianna Simons on vault; Rebecca Bross, 9.10 on beam; Yang Yilin, 9.0 on vault), and the apparatus finals yielded one (Williams, 9.175 on vault).

Romanian women's coach Nicolae Forminte told IG the new, stringent judging standards are not good for the sport. "They have the target, for example, for 10, and they get a 9.8, [a gymnast] knows she's very close to perfection. ... As a coach who is in the gym all the time with the gymnasts, I see the effect of all the changes. I see the gymnasts. More gymnasts are sticking their tumbling landings on floor, with new rule. "That is for her health [he points to his lower back], because the step backward was allowed for the reason that the lady was not as strong as a man and is not healthy for the body," he says. "We have to find a way to fix these things. I don't know what is in the mind of the judges, but for me, as a person who works in the gym, I see unfortunately so many injuries. It maybe helps the judges to judge, but it doesn't help the gymnast."





Nicolae Forminte

THOMAS SCHREIER

Forminte also believes a female gymnast should not have to stick her tumbling landings on floor, which is a new rule. "That is harder for her health [he points to his lower back], because the step backward was allowed for the reason that the lady was not as strong as a man and is not healthy for the body," he says. "We have to find a way to fix these things. I don't know what is in the mind of the judges, but for me, as a person who works in the gym, I see unfortunately so many injuries. It maybe helps the judges to judge, but it doesn't help the gymnast."



Does this need to be changed back?





Terminal Landings





Primary aim is to;
Stop the body's momentum
(vertically, horizontally, sideways)



By;
(1) Cushioning the impact; and
(2) Dissipating the forces



Ideal Landing Technique



- Head up
- Arms forward
- Hips flexed
- Knees bent
- Weight centered over ankles
- Feet roughly shoulder width apart
- Toe-heel landing

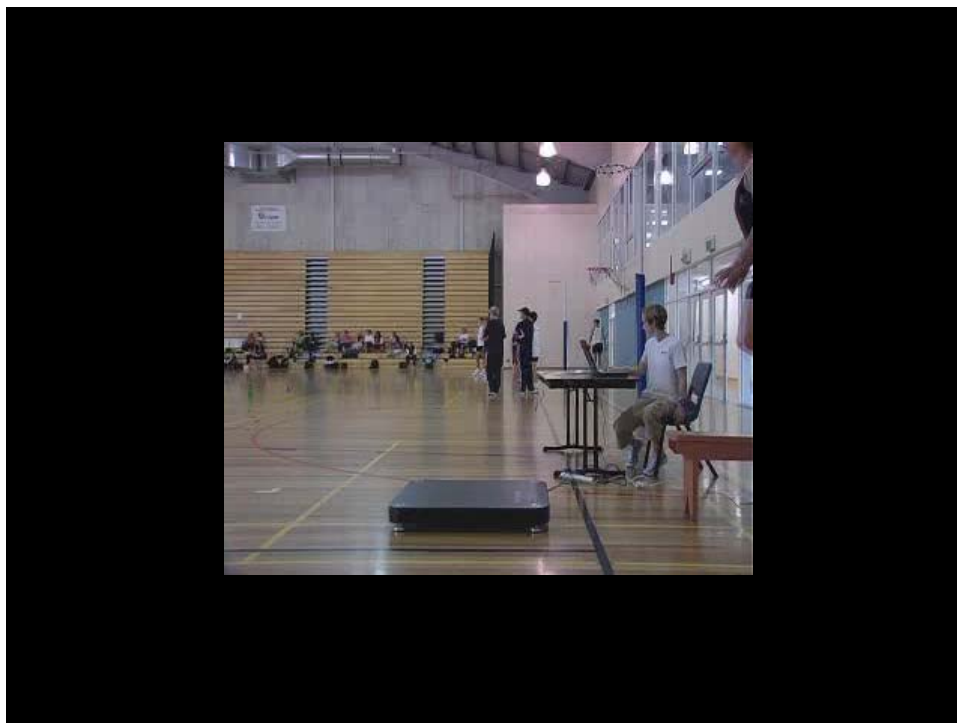
“Controlled hip & knee bend when landing”

Tillman et al. (2004)


Lessons from Netball

Squad	Two Foot Landing	Right-Left Landing	Left-Right Landing
Senior (n=16)	7.68 ±1.73 BW	4.80** ±0.77 BW	4.88** ±1.08 BW
Development (n=7)	7.87 ±1.88 BW	5.14* ±0.76BW	4.90** ±0.71 BW
Junior (n=16)	9.00 ±1.81 BW	-	-
Average	8.18 ±0.72 BW	4.97* ±0.24 BW	4.89** ±0.01 BW

Unpublished data – significantly different to two foot landing *<0.05, **<0.01











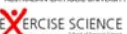

An investigation into a potential change to the footwork rule by allowing an additional step after landing found that the players altered their technique and had the same impact forces

Otago (2004)


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Governance and Rules: Review

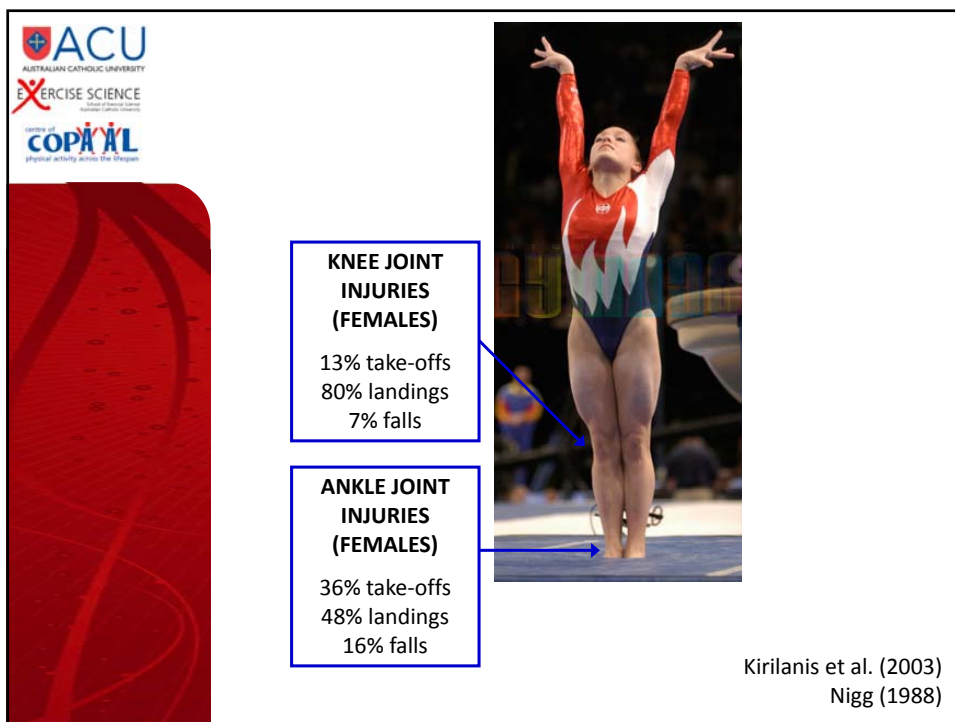
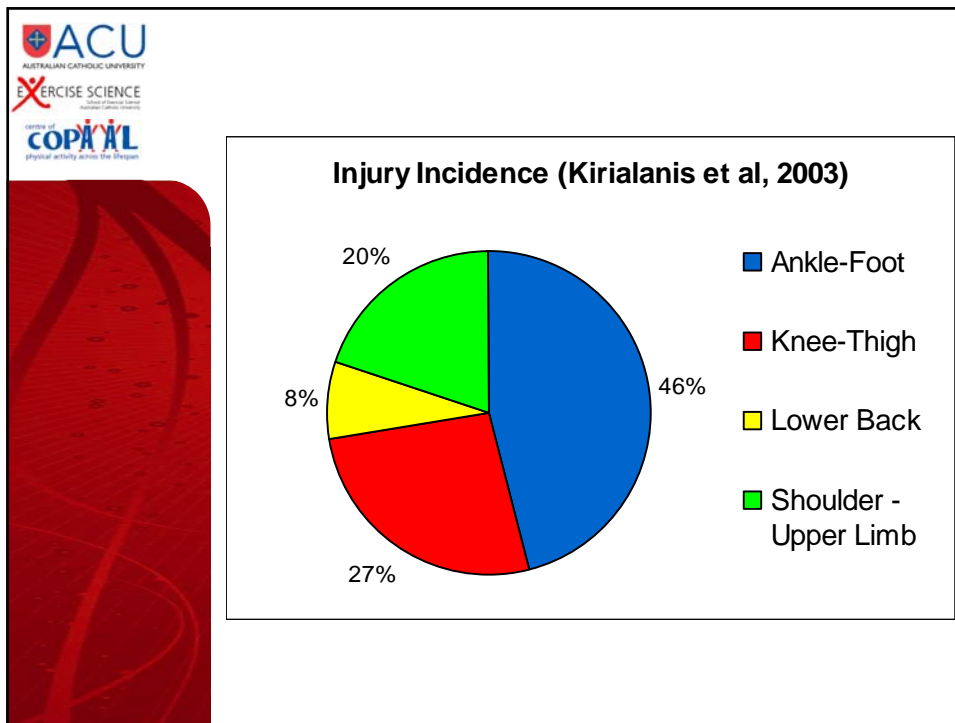
- Has a large impact on the performance and safety of gymnasts
- Any change to COP must be done with caution
- Biomechanical research should provide input on evaluating any potential changes e.g. Change to landing rules for women on floor

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Effects of Impact



Gymnastics involves single or sequential impacts with a surface either preceding and/or at its conclusion



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KNEE JOINT INJURIES (FEMALES)
13% take-offs
80% landings
7% falls

ANKLE JOINT INJURIES (FEMALES)
36% take-offs
48% landings
16% falls

GRF's typically 5 BW in training & 11 BW in competition

Kirilanis et al. (2003)
Nigg (1988)

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Knee Joint RF's typically 1-2 BW's

Ankle Joint RF's typically 2-3 BW's

Controlled landing typically 5 BW in training

Nigg (1988)

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Knee Joint RF's typically 6-9 BW's

Ankle Joint RF's typically 6-11 BW's

↑ Competition (minimal crouch) landing typically 11 BW


Nigg (1988)


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The amount of knee flexion has a greater influence on the magnitude of the impact force, than the height dropped


Stacoff et al. (1988)

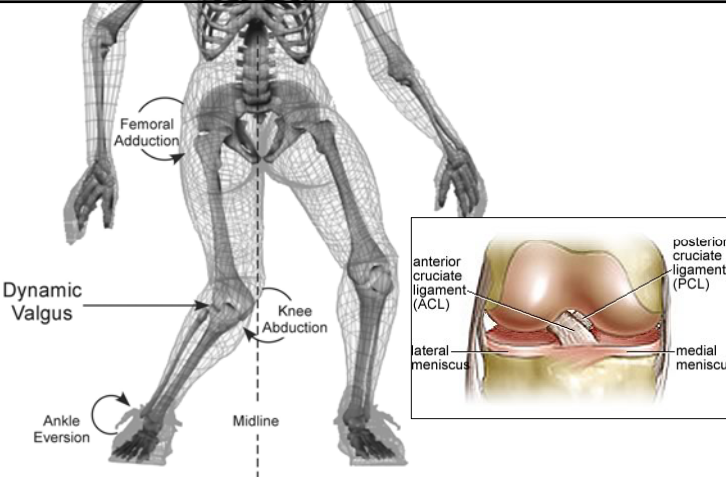




The impact forces can be as high as 18 BW if the landing is uneven or there is unusual foot placement

Panzer et al. (1988)






An unusual or uneven foot placement can result in increased dynamic valgus knee loads & increases the load on the ACL several-fold

Hewett et al. (2005)

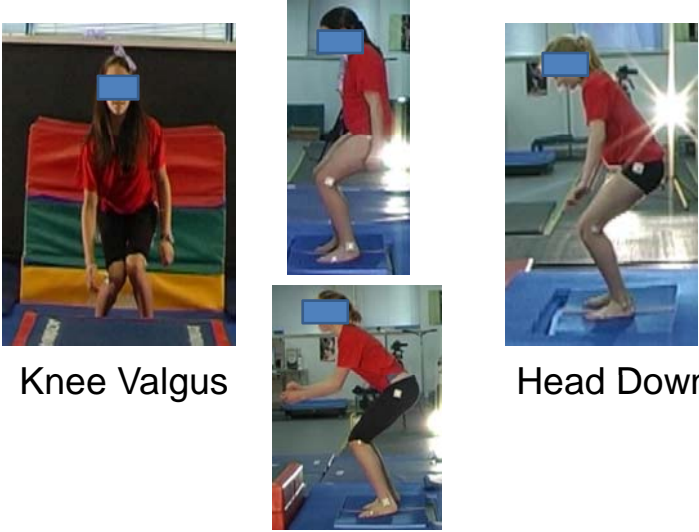
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Attenuating more force on one leg amplifies the risk of injury and also leaves the contralateral limb weaker and imbalanced, and unable to absorb the forces associated with the athletic task.



Kovacs et al. (1999)
Ford et al. (2003)

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Knee Valgus

Head Down


Stopping forward motion through the toes



- Handedness and footedness (lead limb) during gymnastics skills and everyday life [LATERALITY]
- One limb becomes conditioned for mobilization [DOMINANT LIMB] and the other for stabilisation
- Clinically, most estimate higher risk limbs as those with an asymmetry of more than 10 % (Grace, 1985)





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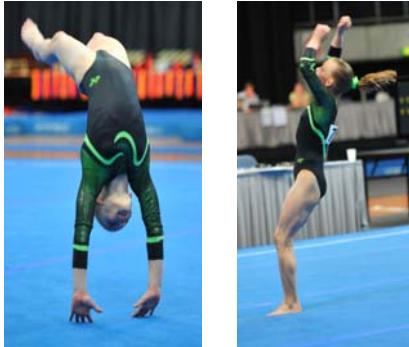
In level 4-6 gymnasts, only 2 gymnasts out of 15 (13%) tested had functionally symmetrical landings, with one gymnast having a staggering 73% asymmetry ($X=18.14 \pm 20.46\%$).

In IDP gymnasts, 11 out of 25 gymnasts (44%) displayed functionally symmetrical landings ($X=6.85 \pm 14.59\%$, Max=32.74%).

Lilley et al. (2007)
Unpublished data






Sequential Landings



Has three purposes;


- (1) To cushion the impact,
- (2) To provide elastic propulsion, and
- (3) Obtain correct posture for take-off





Controlled primarily by adjustments to leg stiffness for specific skills/tasks

Musculoskeletal stiffness is created during ground contact time, as a result of the ratio created by maximal ground reaction force and maximal leg compression.


Farley et al (1991)






Leg stiffness is achieved through adjustments to the pre-contact muscle recruitment & muscle activation levels, as well as the geometry of the ankle, knee, & hip

Komi (2000)






RUNNING

Modified mainly by the knee action

↑ Stiffness at faster velocities



HOPPING/HURDLING

Modified mainly by the ankle action

↑ Stiffness at faster velocities

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REBOUND JUMP

Modified by the knee and ankle action
↓GCT ↑stiffness

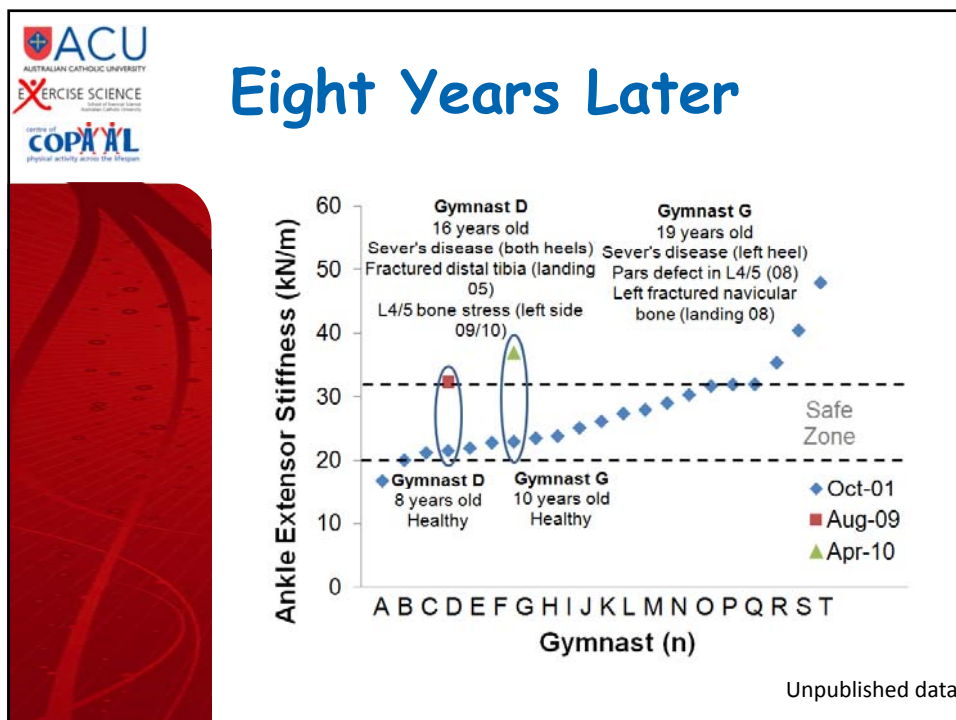
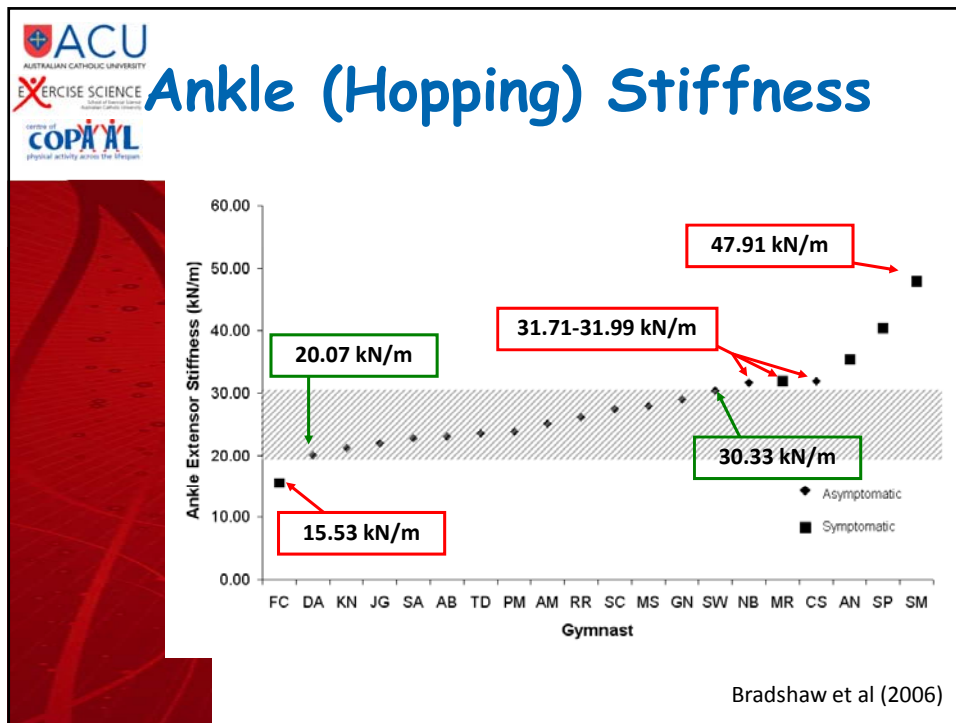


PUSH-OFF

Modified mainly by the shoulder action
↓GCT ↑stiffness

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Positive Effects of Impact

Parameter	1 TIBIA	2 TIBIA	3 TIBIA
BONE	3.11	2.60	3.76
SSIBL	593.26	1507.41	1889.34
TOTAREA	1289.75	490.00	462.75
TOTDEN	258.73	1079.82	1100.42
TOTDEN	196.01	178.75	296.25

Greene et al (2009)
 Moresi et al (2010)

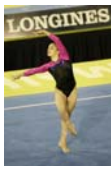




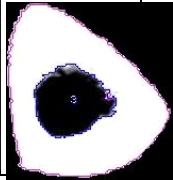
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4% Distal Tibia: Trabecular Bone
 - area, density, SSI

14, 38% Distal Tibia: Cortical Bone
 - area, density, SSI

Greene et al (2009)
 Moresi et al (2010)

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BONE HEALTH				
Participants (n)	25	34	30	28
Bone Measures				

Greene et al (2009)
Moresi et al (2010)

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- The trabecular bone tissue is believed to be the most responsive to strain through loading activity (Huickes *et al.*, 2000) and is best achieved with gymnastics.
- The T&F athletes had a higher cortical SSI and may have a correspondingly lower stress fracture risk (Wachter *et al.*, 2002). These skeletal responses may be due in part to the significantly differing overall calf size (girth), and also the differing sports surfaces for training and competition in gymnastics and athletics.

Greene et al (2009)
Moresi et al (2010)

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Effects of Impact: Review

- Negative effects = potential injury
- Positive effects = positive bone building

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Influences on Training

The most important test of biomechanical research or input is whether it eventually improves performance and/or influences coaching and training practice



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- Qualitative video feedback is a common element of training

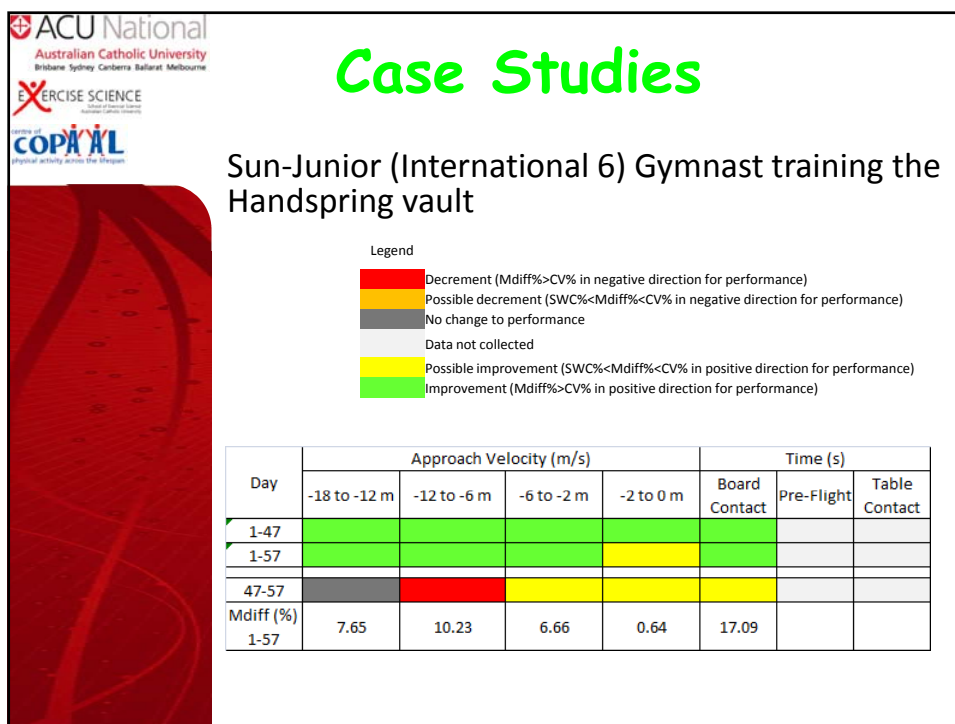
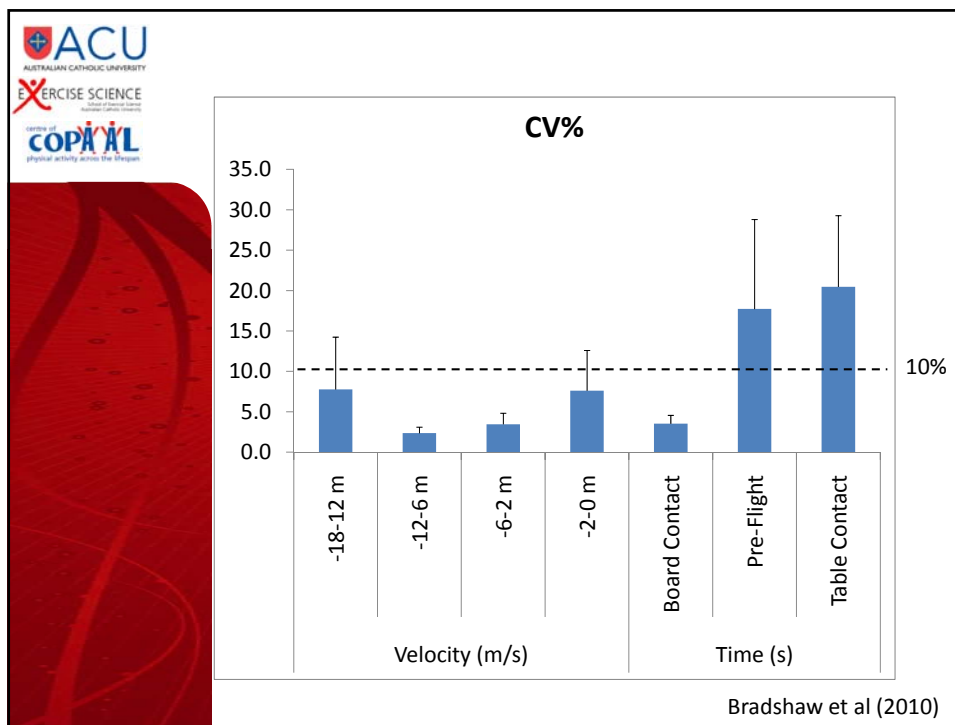


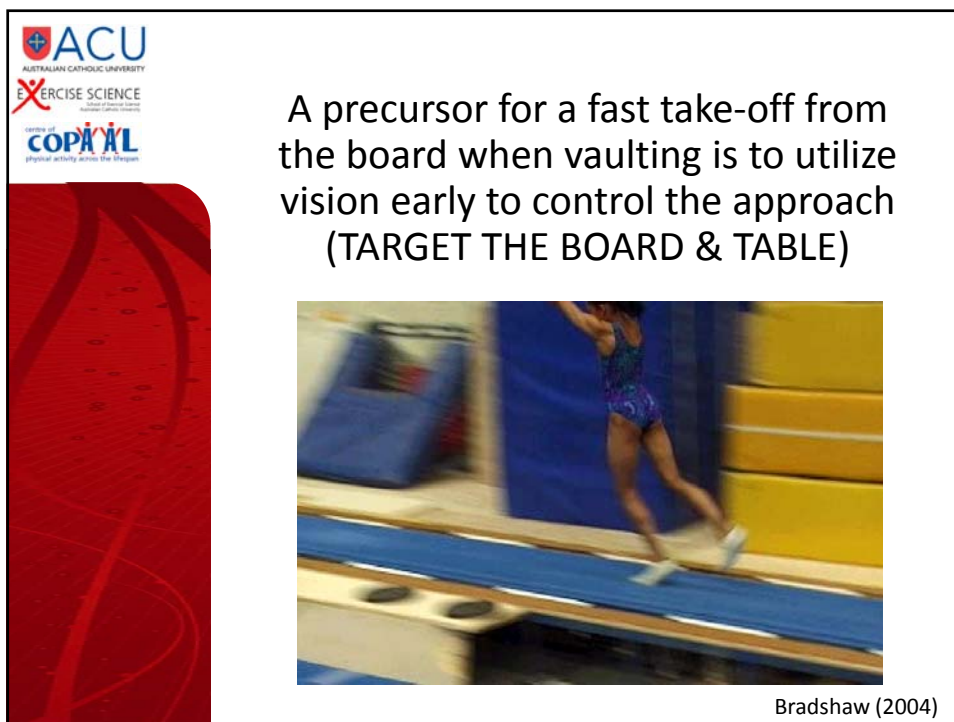
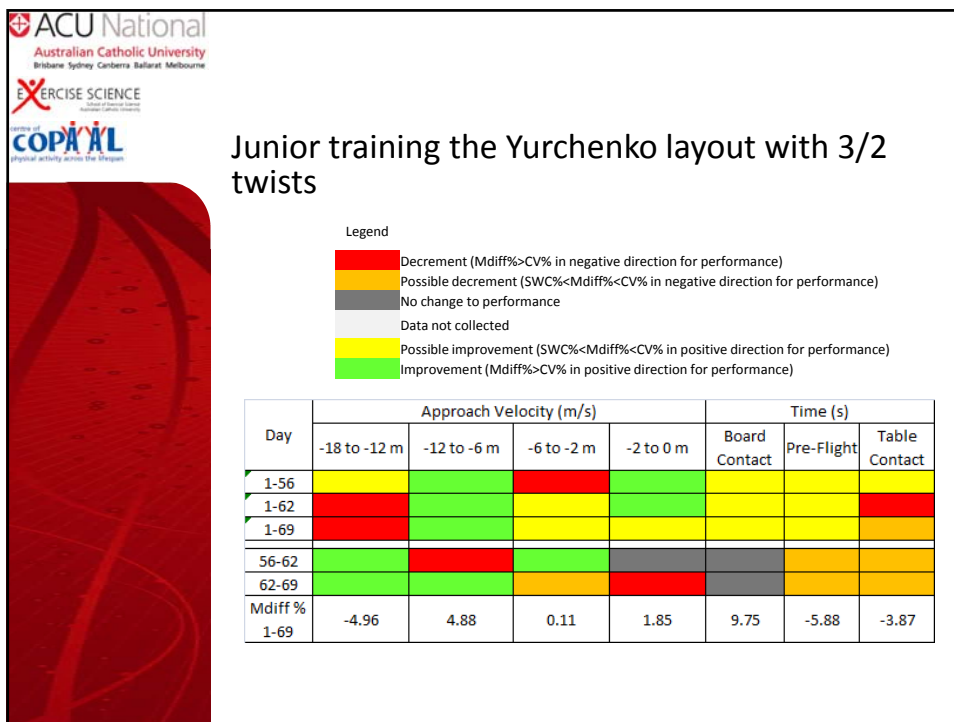
- Objective monitoring of training not common

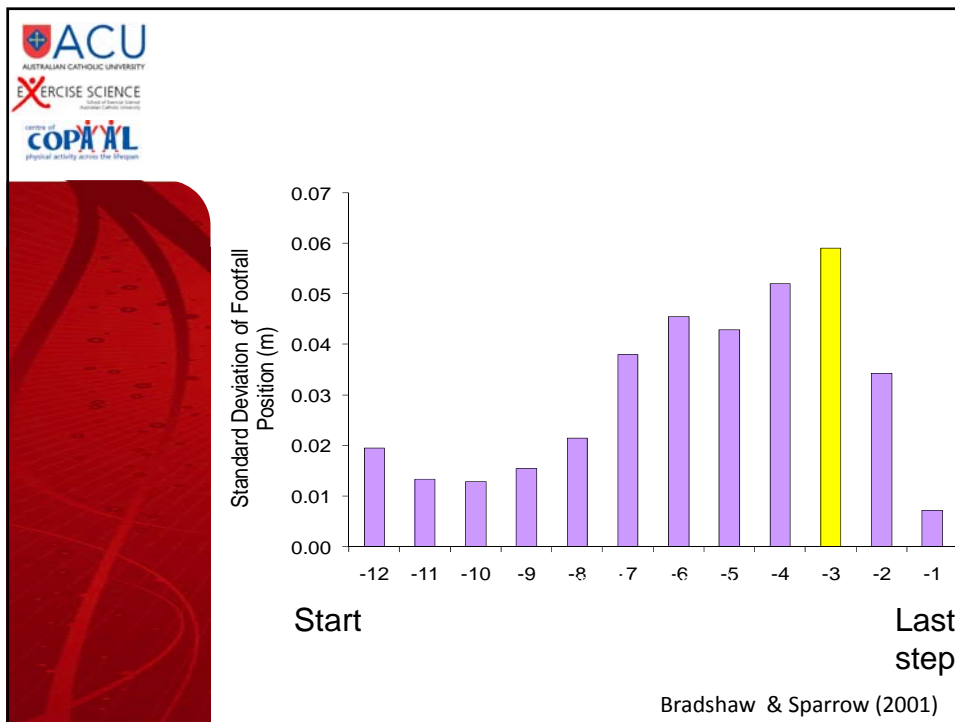
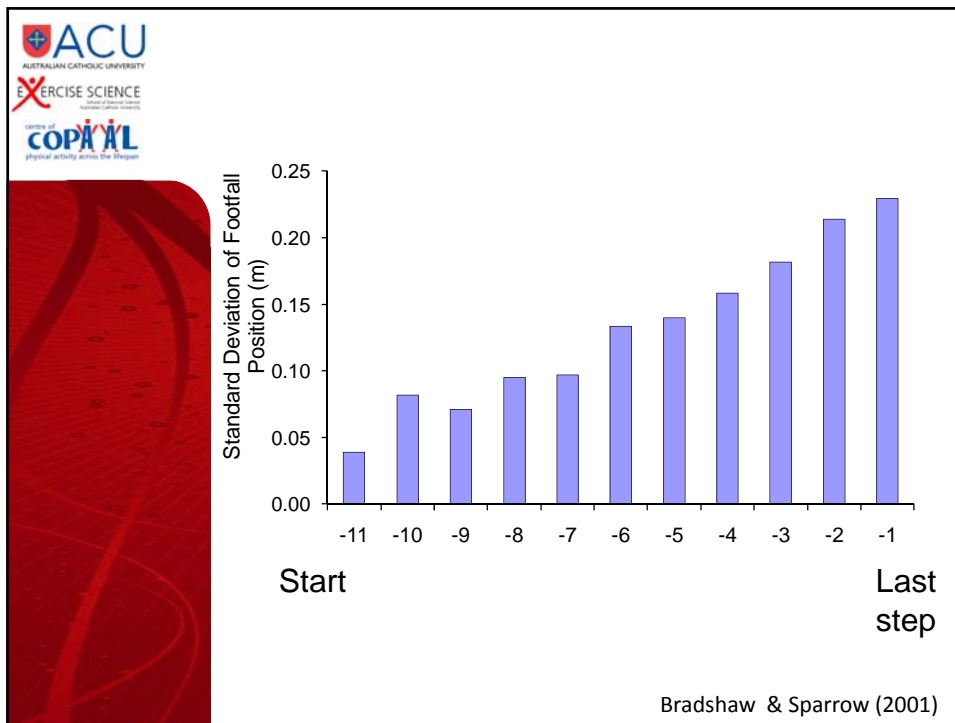
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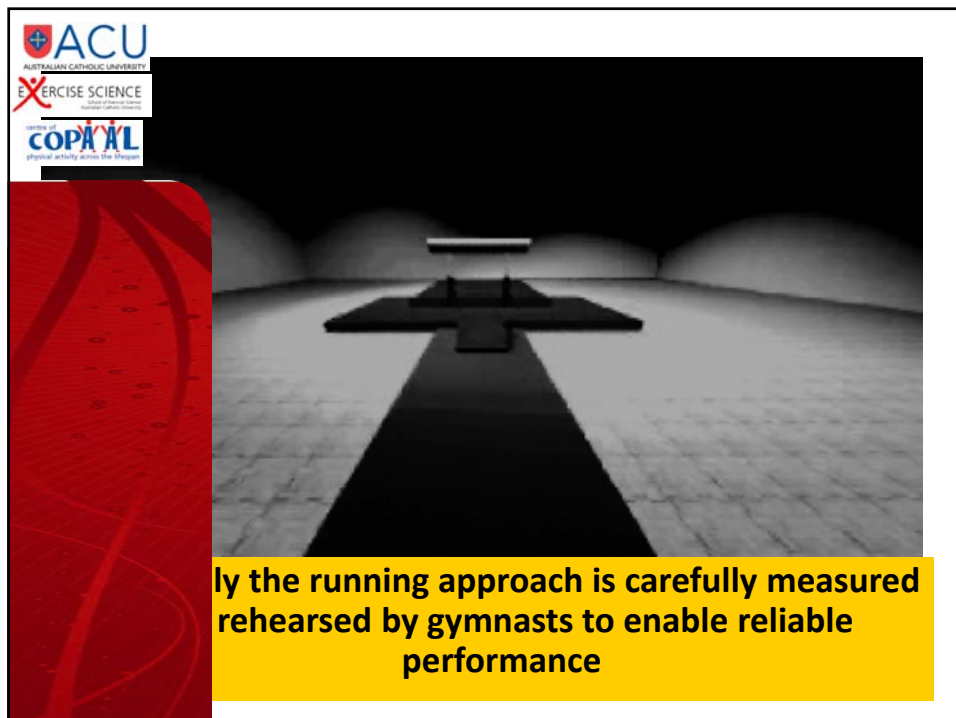
BRADSHAW ET AL (2010)

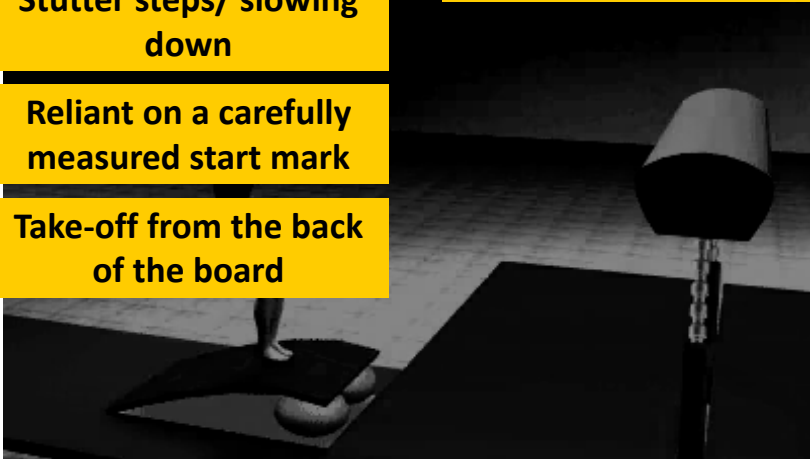








		
	Gymnast 1	Gymnast 2
	Yurchenko Layout 720⁰	Yurchenko Open Tuck
	Scores: 9.325 - 9.425	Scores: 8.025 – 8.225
	Targeting: 7 steps before hurdle (17.20 m)	Targeting: From the hurdle (3.08 m)
Take-off velocity: 6.45 m/s	Take-off velocity: 5.92 m/s	




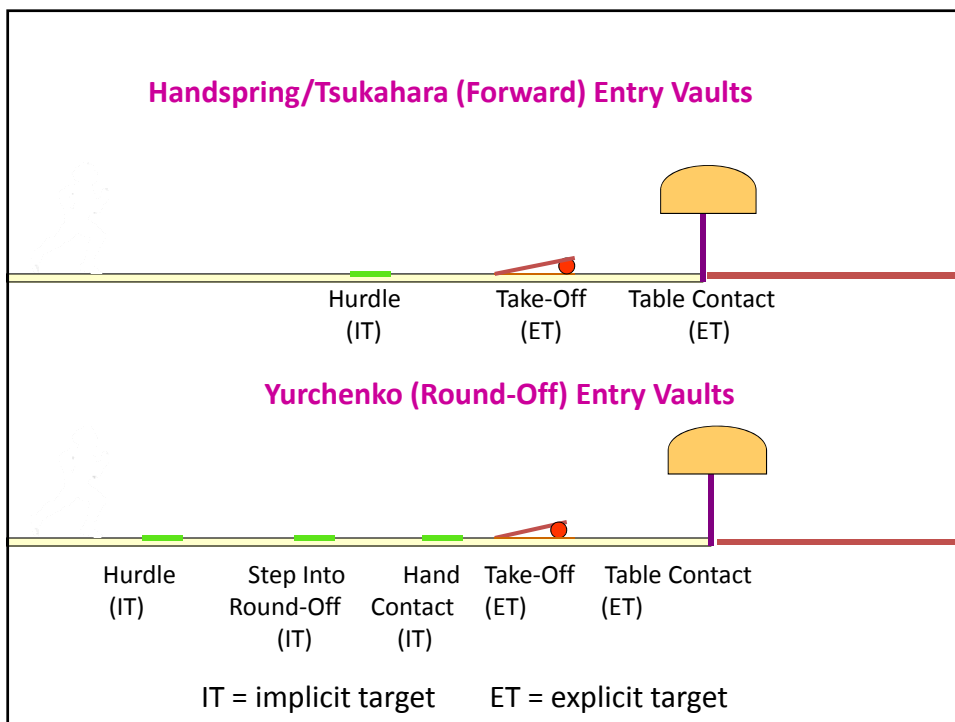
Training	Competition
Baulking during the run-up	Run-up not working on competition podium 
Stutter steps/ slowing down	
Reliant on a carefully measured start mark	
Take-off from the back of the board	

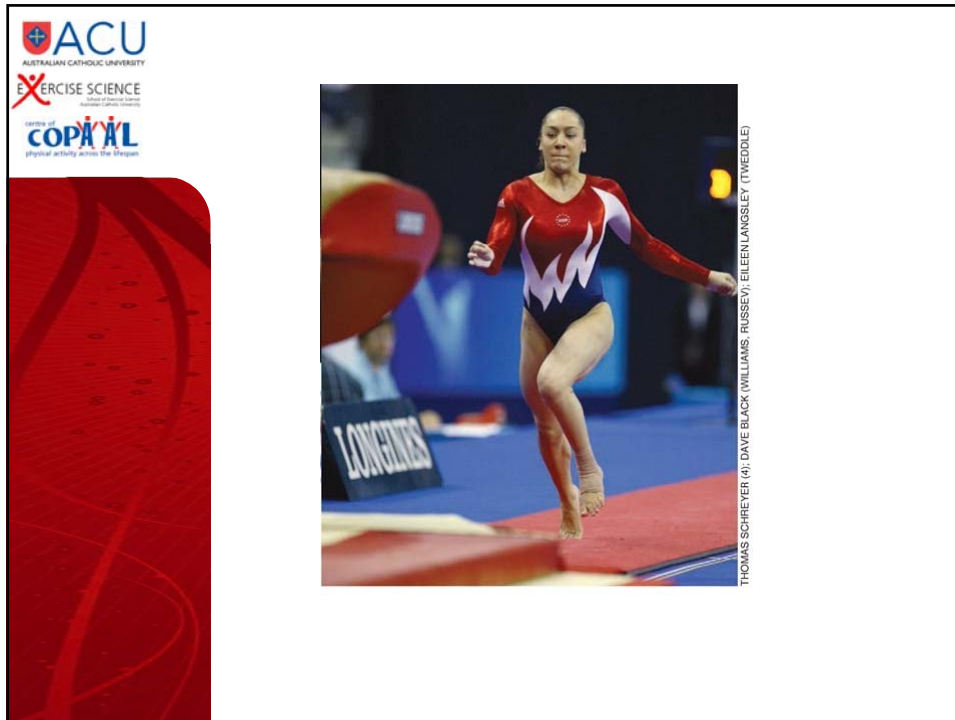
<u>Intrinsic Factors</u>		<u>Extrinsic Factors</u>
Growth Muscle Soreness Fatigue Form Training Improvements		Running Surface Temperature Event



Small and systematic stride adjustments to accommodate the obstacles (e.g. take-off board) into the approach run without large sacrifices to speed

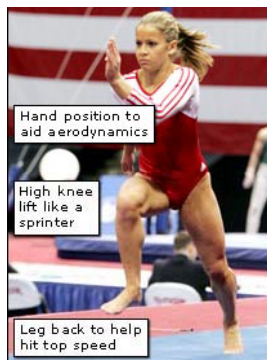
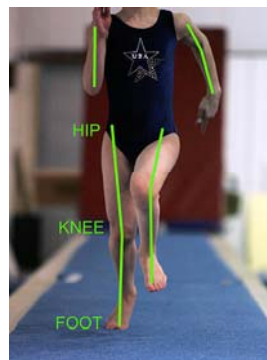






General Points

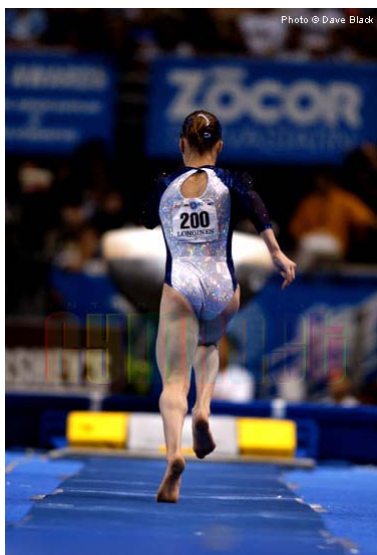
Train good running technique that starts with the first step





Train the shortest run-up distance possible to produce the highest possible speed that the gymnast can control

Ensure that the run-up has good structure and rhythm



Avoid a hop &/or skip to start → Start tall with one step back to initiate. Allows the knees to drive up.

3-4 steps for acceleration → Start targeting → Change gear to increase cadence for final 6 steps into hurdle

Targeting



Vary approach distances by
0.5 - 2 m

Variety of surfaces




Variety of targets & obstacles

Intention (tech. vs speed)



Influences on Training: Review

- Biomechanics not yet having a large impact on training like in other sports e.g. swimming, athletics
- Forward modelling by Yeadon (2009) in aerial skiing is starting to show great promise and would be of great interest to coaches in gymnastics

Biomechanical Perspectives

- Governance and Rules
- Positive and Negative Effects of Impact
- Impact on Training





Photo © Randy Chow





Concluding Remarks

- There has been much focus on elite gymnastics
 - descriptions of specific skills
 - reports on injury rates
 - impact on growth
- More research is required on fundamental issues that can be broadly applied during training




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- Injury prevention research needs to:
 - focus more on the elementary years of gymnastics when the fundamental motor skills are being formed
 - where there is the bulk of participants




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FLY HIGH
LIVE LIGHT

FLY HIGH
LIVE LIGHT

Thank-you



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