

Sports performance
– segmental sequencing in overarm throwing
 運動表現 – 過臂投擲的“連續分段旋轉”順序

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 THE UNIVERSITY OF SYDNEY
 Croucher Sports Biomechanics Course

1

Evaluation technical skills for sports performance
 運動表現評估技術技能



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Movement pattern運動模式

General series of anatomical movements that have
common elements of spatial configuration空間配置的共同要素



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Movement skills動作技能

Adapted within the constraints of an activity or sport
 在活動或運動的限制範圍內進行調整

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Constraints for “throwing skills”

Training/ Skill levels



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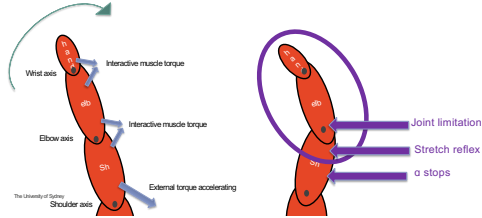
Sports performance perspective

Why segmental sequencing rotation can achieve high end-point velocity?
 為什麼“連續分段旋轉”可以達到高終點速度？

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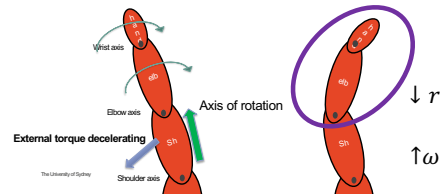
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Open Kinetic Link Model 開放式動力學連結模型



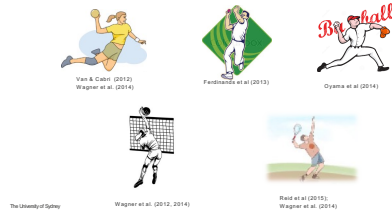
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Open Kinetic Link Model 開放式動力學連結模型

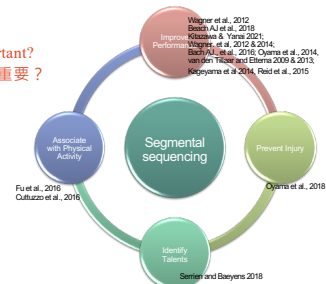


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Application to enhance sports performance 提升運動表現的應用



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Why is it important?
為什麼它如此重要？

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Research application 研究應用

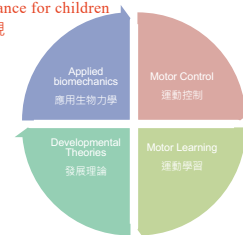
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MEDICINE & SCIENCE IN SPORTS

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Segmental sequencing of the upper body segments in unconstrained maximum overarm throws: An implication for coaching

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Throwing performance for children
兒童投擲運動表現

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Rationale - Fair understanding of the upper body/ limb sequence



13

Rationale - Fair understanding of the upper body sequence

- Less shoulder joint movement in non-throwing arm of skilled pitchers
- A characteristics of max ball release throw (Murata, A. 2001)
- Sig decrease in elbow extension at the time of ball release
- pelvis achieved max ω earlier (Ishida, K., & Hirano, Y., 2004)

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Research/ Knowledge Gap 研究/知識差距

The BASIC form !!

- No study on unconstrained conditions 無約束條件 (fundamental movement skill)
- No research on the segmental sequence of the upper body and both upper extremities
- No investigation of age-appropriate skills: early adolescents
- What are the critical features?
- Segmental sequencing => in the expected sequence? => Is it true?

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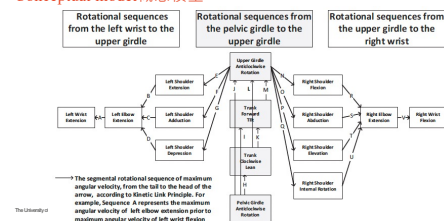


Identify age-appropriate & evidence-based movement skill criteria by investigating the segmental sequencing features
 確定適合年齡的&基於證據的運動技能標準
 透過研究連續分段旋轉

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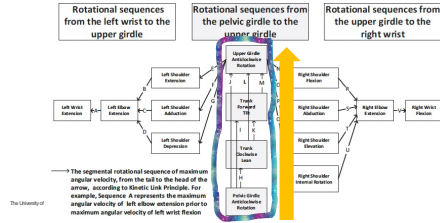
Conceptual model 概念模型



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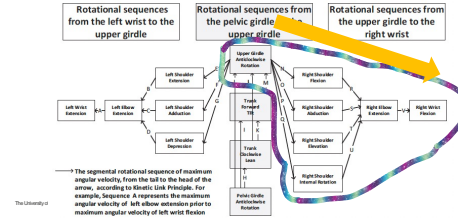
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Conceptual model概念模型



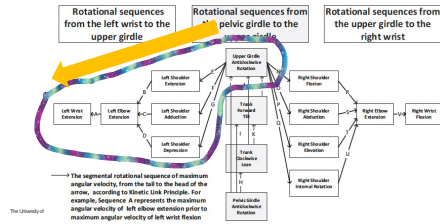
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Conceptual model概念模型



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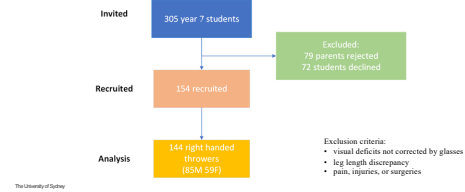
Conceptual model概念模型



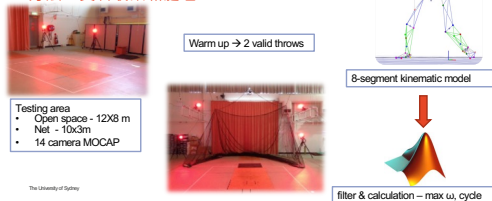
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Methodology – participants

方法 - 參與者

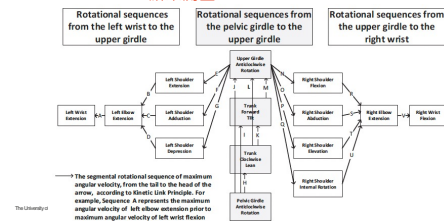


23

Methodology – Data Collection and Processing
方法—資料收集和處理

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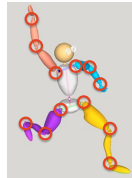
Variables of interest結果測量



25

Variables of interest結果測量

- Movement patterns



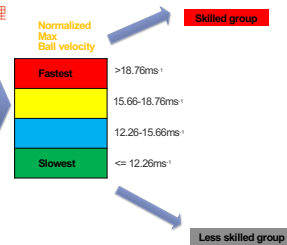
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Data processing資料處理

Total 144
right-handed
throwers

Divide



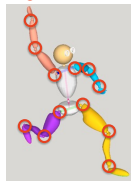
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27

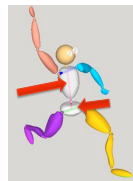
28

Data processing資料處理

Joint and Segment Rotational Kinematics



Joint rotations



Segment rotations

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Statistical analysis統計分析

- Normality check: Shapiro-Wilk
- Age, height, weight, and BMI between groups : independent t-test
- Gender: χ² test
- Movement Patterns: 95% CI curve

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Statistical analysis統計分析– Timing and Sequencing

- Characteristic segmental sequencing of each group
 - Defined: the sequence with significant within-group differences in successive events
 - pair t-test
 - α level set as **0.001**
- Critical segmental sequencing
 - Defined: the sequence with significant within-and-between-group differences
 - pair t-test and independent t-test
 - α level set as **0.001**



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Discussion 1 - Demographics
討論 1 - 人口統計

- Age, height, weight, and BMI between groups:
no significant differences ($p > 0.05$).
- The number of boys > girls:
no significant difference ($\chi^2 = 16.37$, $p < 0.001$).

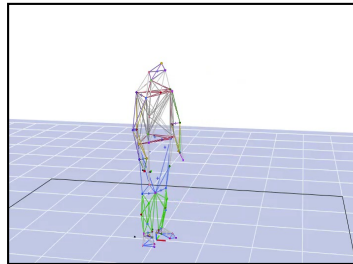
Not a-priori factor X
movement pattern deviation

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31

Discussion 2
討論 2

Typical 'Less Skilled'

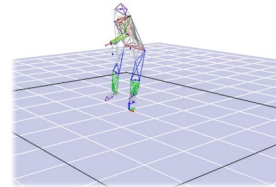


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32

Discussion 2
討論 2

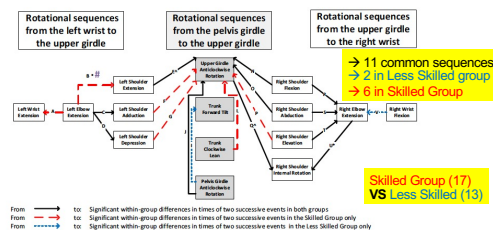
Typical 'Skilled'



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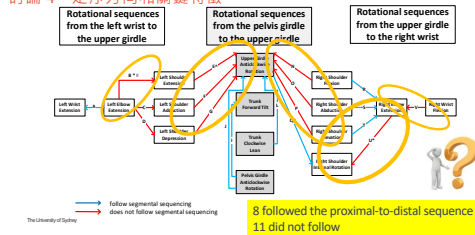
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Discussion 3 – No. of segmental sequences @ group
討論 3 – 組別中連續分段旋轉的數量



34

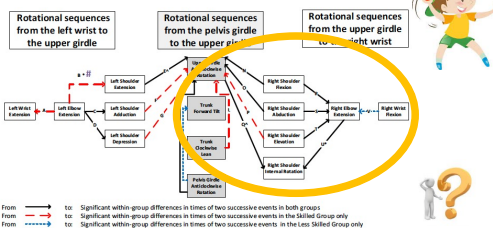
Discussion 4 – Direction of sequencing & Critical feature
討論 4 – 定序方向和關鍵特徵



35

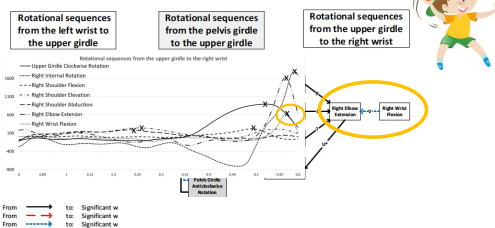
Discussion 5 – The throwing arm
討論 5 – 投擲手臂

~50% not in PD



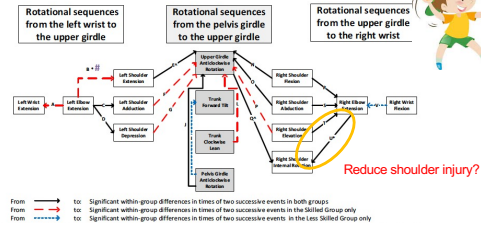
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Discussion 5 – The throwing arm
討論 5 – 投擲手臂



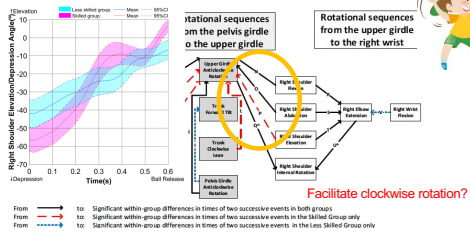
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Discussion 5 – The throwing arm 討論 5 – 投擲手臂



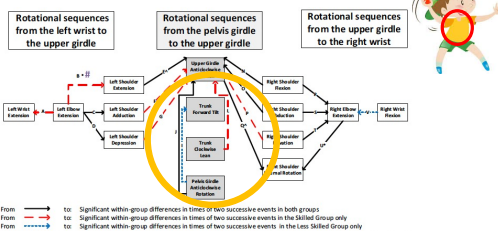
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Discussion 5 – The throwing arm 討論 5 – 投擲手臂



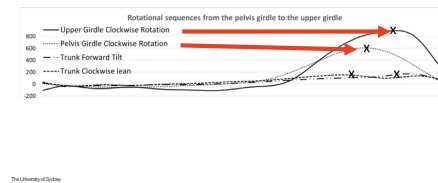
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Discussion 6 – Trunk 討論 6 – 軀幹



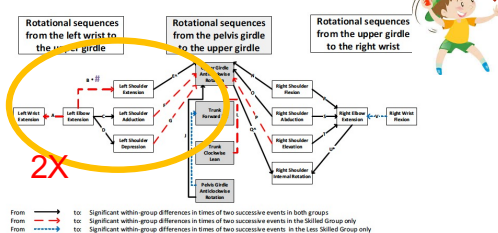
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Discussion 6 – Trunk 討論 6 – 軀幹



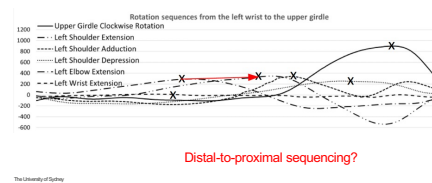
41

Discussion 7 – Non-throwing arm 討論 7 – 非投擲手臂



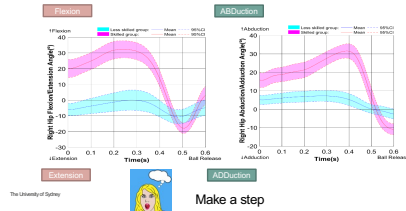
42

Discussion 7 – Non-throwing arm 討論 7 – 非投擲手臂



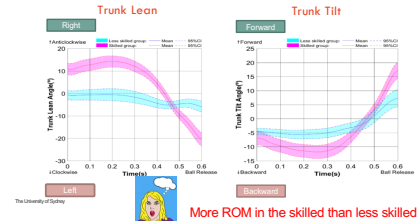
43

Discussion 8– Movement pattern (Right Hip)
討論 8 – 運動模式 (右髖)



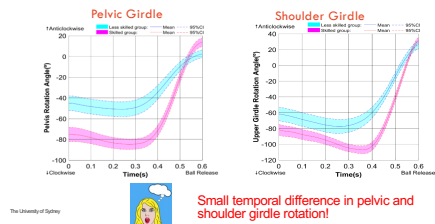
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Discussion 8– Movement pattern (Trunk Lean and Tilt)
討論 8 – 運動模式 (軀幹傾斜)



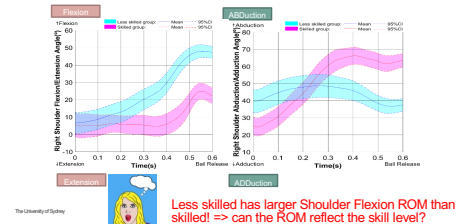
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Discussion 8– Movement pattern (Pelvis & Shoulder Girdles)
討論 8 – 運動模式 (骨盆和肩帶)



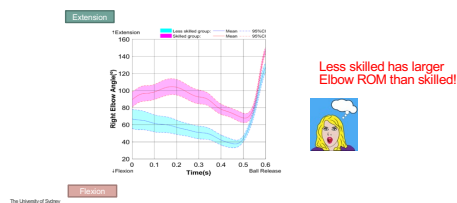
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Discussion 8– Movement pattern (Right Shoulder)
討論 8 – 運動模式 (右肩)



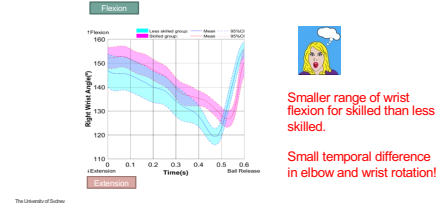
47

Discussion 8– Movement pattern (Right Elbow)
討論 8 – 運動模式 (右手肘)



48

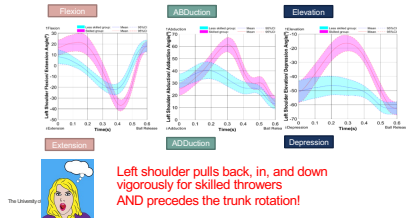
Discussion 8– Movement pattern (Right Wrist)
討論 8 – 運動模式 (右手腕)



49

Discussion 8 – Movement pattern (Left Shoulder)

討論 8 – 運動模式 (左肩)



50

Discussion 9 – How do the findings differ from teaching practice?

討論 9 – 研究結果與教學實踐有何不同？



Original skill instruction	Amended or new skill instruction in plain language
No prior mention	Extend the elbow of the non-throwing arm and then draw the shoulder downwards, backwards and toward the trunk
No prior mention	Elevate the throwing arm while abducting and flexing
No prior mention	Move the upper arm forward before rotating the upper girdle toward the non-throwing side
Hips then shoulders rotate forward	Pelvis rotation leads the upper trunk rotation toward the non-throwing side using a side-on approach
No prior mention	Flex the throwing wrist while the elbow is extending

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51

Do you remember the developmental theories?

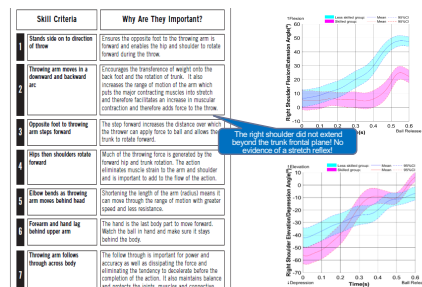
你還記得發展理論嗎？

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52

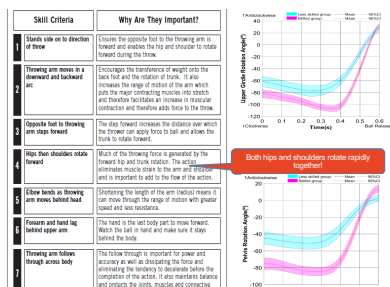
Step	Backswing	Trunk	Forearm
11 No Step—The child moves from the initial stationary foot position.	B1 No Backswing—The ball in the hand moves directly forward to release from the arm's original position.	T1 No Trunk Action or Forward Backward Movement—Only the arm is active in force production. If trunk action occurs, it accompanies the forward thrust of the arm by being forward at the hips. Sometimes there is trunk extension prior to hip flexion.	F1 No Forearm Lag—The forearm and ball move quickly forward to ball release.
12 Unilateral Step—The child steps with the foot on the same side as the throwing hand.	B2 Elbow and Forearm Flexion—The ball moves away from the extended line of flight to a position behind or straight up the hand.	T2 Upper Trunk Rotation or "Wind" Rotation—The spine and pelvis both rotate away from the intended line of flight and then immediately "snap" forward rotation, setting a solid or "back."	F2 Forearm Lag—The forearm and ball appear to "lag" slightly forward to ball release.
13 Circular Step—The child steps with the foot on the opposite side of the throwing hand.	B3 Circular Upward Backswing—The ball moves away from the extended line of flight to a position behind the head in a circular down-and-back motion, which carries the hand below the waist.	T3 Pelvis Rotation or "Wind" Rotation—The spine and pelvis both rotate away from the intended line of flight and then immediately "snap" forward rotation, setting a solid or "back."	F3 Forearm Lag—The forearm and ball appear to "lag" slightly forward to ball release.
14 Circular Step—The child steps with the foot on the opposite side of the throwing hand.	B4 Circular Upward Backswing—The ball moves away from the extended line of flight to a position behind the head in a circular down-and-back motion, which carries the hand below the waist.	T4 Pelvis Rotation or "Wind" Rotation—The spine and pelvis both rotate away from the intended line of flight and then immediately "snap" forward rotation, setting a solid or "back."	F4 Forearm Lag—The forearm and ball appear to "lag" slightly forward to ball release.

2024



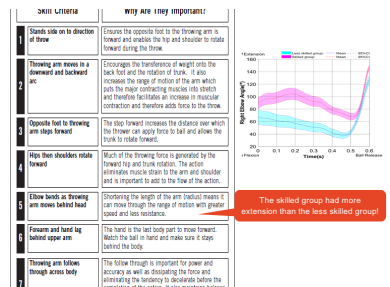
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2024



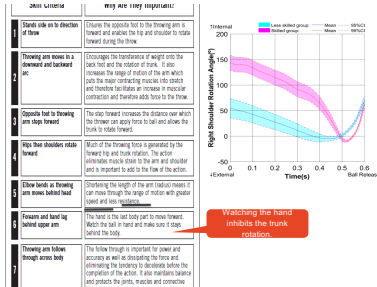
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2024



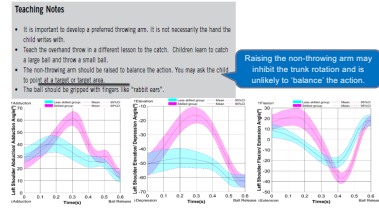
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2024



56

2024



57

2024



- PD or DP sequencing depends on the tasks and other constraints
- Help us to understand the critical movement features
- Help us to improve performance +/- injury prevention

58

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59