TRACKING MOTOR LEARNING IN CIRCUS ATHLETES USING EXTERNAL VIDEO DATA

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Introduction

- Studying motor learning in circus disciplines such as Rola Bola is challenging because athletes have limited training time and cannot have their practice disrupted with extensive setup or wearable sensors.
- External video provides a minimally invasive, time-efficient method for documenting technique changes throughout training.
- However, the accuracy and overall effectiveness of video-based analysis for this purpose remain unclear.
- This study investigates how dual-angle video data, paired with Kinovea motion-analysis software, can capture motor-learning indicators such as joint stabilization, center-of-gravity control, balance loss, and overcorrection patterns.
- By identifying both the strengths and limitations of this approach, we aim to determine how effectively video data alone can model motor-learning progression in a Rola Bola skill.

Methodology

- Our study tracked a circus athlete during active Rola Bola training, capturing repeated attempts as their skill developed over time.
- Two stationary cameras recorded each attempt simultaneously, positioned to capture anterior and sagittal views.
- Video files were imported into Kinovea and aligned for frame-by-frame analysis.
- Using Kinovea's digital measurement tools, we extracted quantitative and observational indicators of motor-learning progress, including:
  - Joint angles at key lower-body joints (ankle, knee, hip)
  - Center-of-gravity indicators, based on segment alignment
  - Body positioning relative to the board and roller
  - Purposeful joint stabilization during balance maintenance
  - Points of control or balance loss, identified by displacement patterns
  - Overcorrection behaviors, such as excessive counter
  - shifts or reactive motions
- Measurements were compared across attempts to identify changes in technique and corrective strategy throughout training.
- Particular attention was given to the consistency and precision of data captured from each camera view; reliability decreased when the athlete rotated out of true anterior or sagittal alignment.

Fig. 1- First Studied Skill: Arabesque

Fig. 2- Second Studied Skill: Juggling

Fig. 3- Third/ Fourth Studied Skill: Single Jump rope/ Double Jump rope

Fig. 4- Fifth Studied Skill: Press to Handstand

Fig. 5- Sixth Studied Skill: Triple Stack Ring Weave

*Figure Key: Left= Anterior view, Right= Sagittal view

Results

Based on our methods, we predict the results will highlight these main points:

- Measurable Joint and Balance Changes: Joint angles and center-of-gravity indicators are expected to become more consistent across attempts.
- Recognizable Stabilization Strategies: Athletes may show more deliberate joint stabilization as they gain skill.
- Identifiable Points of Balance Loss: Common patterns before a fall.
- Overcorrection Patterns: Larger, reactive corrections vs. smaller corrections.
- Camera Alignment Limitations: measurement accuracy will likely drop when the athlete rotates and moves out of ideal camera alignment.
- Overall Feasibility: Findings are expected to support video data as a simple, nonintrusive, and effective method for studying basic motor learning concepts.

Current Status & Next Steps

- Video data collection for this project is ongoing, with new training footage continuing to be added as the athlete progresses.
- As videos are received, the next step is to segment each recording into single-skill-attempt clips, allowing us to track the progression of each individual attempt across time.
- Once segmented, one of the first metrics we will analyze in Kinovea is the tilt angle of the Rola Bola board, assessing how far the board deviates from horizontal on each attempt.
- Tracking the board's excursion over time may reveal whether board-tilt variability decreases with training, offering an early indicator of improved balance control and developing motor stability.
- This process will lay the foundation for analyzing additional motor-learning indicators and evaluating how effectively video-based methods can capture subtle changes in skill acquisition.

Resources

- Kinovea. (2023). Kinovea (Version 0.9.5) [Computer software]. https://www.kinovea.org
- Riemann, Bryan L, and Scott M Lephart. "The Sensorimotor System, Part II: The Role of Proprioception in Motor Control and Functional Joint Stability." Journal of athletic training 37.1 (2002): 80–84. Print.