COACHING BIOMECHANICS INTERFACE: COMPETITION AND TRAINING

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INTRODUCTION:

Coaching-biomechanics interface

Bridging the gap between the underlying biomechanical parameters that determine successful gymnastics performance, and the provision of meaningful information for coaches has been the challenge for sports biomechanists for decades. Conceptualising this fundamental relationship through the coaching-biomechanics interface draws on the cognitive processes of learning and understanding, combined with grounded scientific concepts, which help explain and increase understanding of gymnastic performance. As such the coaching-biomechanics interface begins with an examination of coaches' implicit knowledge highlighted through the conceptual models of skill learning and development (Irwin et al., 2005). Central to this model is the development of a mind set, a conceptual understanding of how a skill works. Coaches develop an understanding of how the skill works then aim to replicate the spatial and temporal characteristics of the final skill in the physical preparations, progressions and preparatory skills used in training.

Gymnasts are currently training close to their biophysical limits and with the evolving Code of Points (FIG, 2009) and desire to continually strive for more complex and innovative moments it is desirable to enhance training by using objective criterion against which skill development pathways can be measured. The ultimate aim of the coaching-biomechanics interface is to make training more effective, efficient and safe, incorporating the needs of the elite performer in parallel with considering the well being of the individual. The following two examples provide research-based evidence of the coaching-biomechanics interface employing biomechanical studies based on the fundamental principles of training to help understand the development of a key gymnastic movement (high bar longswing) and explain techniques of release and regrasp skills on uneven bars (Tkachev). Previous research in the area of high bar and gymnastics has been dominated by groups from Loughborough (Hiley et al., 2007; Yeadon and Hiley, 2000) and Cologne (Arampatzis and Brüggemann

Skill Development

A series of studies have been conducted which have resulted in novel biomechanically driven scores, based on the principle of specificity, and incorporating movement variability and difference which aimed to assess the effectiveness of progressions.

The biomechanical scores were applied in three ways; firstly examining the single joint orientation of the hips and shoulders (Irwin and Kerwin, 2005); secondly from a more holistic perspective examining the interaction of the hips and shoulders using measures of inter joint coordination, namely continuous relative phase (Irwin and Kerwin 2007a); and finally employing an inverse dynamics approach, scores were applied to the musculoskeletal

demands placed on the performer (Irwin and Kerwin, 2007b). When considering kinematics and kinetics similarity it was suggested that progressions, which cause gymnasts to use similar levels of energy to the longswing, are placing a stress on the musculoskeletal system in a specific manner. Although the energy level, in a progression, may be similar, this does not always correspond to similarities in the movement pattern. As a consequence the physiological adaptations which occur through training may not be effective or desirable. Different classifications of progressions therefore exist with those that replicate the movement pattern (kinematics) and those that replicate the physical demand (work done/ energy expenditure). These studies have generated further questions for example, how is skill development effected by the choice of progression?

Understanding technique

Official changes to the rules governing the bar spacing on uneven bars in the late 1990's have enabled female gymnasts to perform different versions of the complex but common release and regrasp skill, the Tkachev. Historically the Tkachev has been performed with the gymnast facing outwards and travelling towards the low bar whilst clearing the high bar. Increased bar spacing has enabled females to longswing the opposite way, facing inwards and travelling away from the low bar when performing the Tkachev.

This change in direction highlights two issues; firstly relating to the scoring system (should both versions be valued with the same difficulty) and secondly, are these skills, which appear similar, placing the gymnast under the same physical and technical demands. The responses to these questions could have implications for the most effective physical preparations for a gymnast. As such a biomechanical investigation was carried out with the specific aim of quantifying the differences in musculoskeletal work between the outward and inward Tkachevs, and to examine whether these skills are equally demanding on gymnasts (Kerwin and Irwin, 2010). Based on the premise that gymnastics coaches visualise all skills as a series of shape changes and movement patterns (Irwin et al., 2005), the current study observed kinematic similarities in the two variants of the straddle Tkachev which masked differences highlighted by the subsequent kinetic analyses. In particular, the musculoskeletal work at the shoulders was found to be predominantly positive in the outward and negative in the inward variant of the skill. These differences underpin variations in rate of change in angular momentum with the inward variant being superior for generating improved release conditions and greater reversal of angular momentum. There are two implications of these findings. The first is that the inward version of the Tkachev provides the gymnast with the opportunity to produce more complex versions of the skill through alterations in body shape in flight (e.g. piked or straight body). Secondly, from a classic training principles perspective, in order to develop the inward Tkachev, gymnasts need to change the preparatory activities to elicit the specific musculoskeletal adaptations which correlate more closely with those required in the inward variant of the skill. This study has highlighted that apparent similarities in the kinematics mask fundamental differences in the kinetics and expands the ideas promoted by Irwin and Kerwin (2007b) when ranking progressions for skill development based on musculoskeletal demands.

SUMMARY

This paper has highlighted the coaching biomechanics interface as an integrated concept within the coaching process. The aim is to bridge the gap between the underlying biomechanical parameters that determine successful performance and the communication of

this information in a meaningful way to coaches. We have considered how progressions can be organised based on biomechanical principles and also how techniques can be developed through enhanced understanding of key components of selected skills. This approach aims to make training more effective, efficient and safe at all levels of performance.

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