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Functional Variability In Elite Driving Performance

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Purpose:

The golf swing is a technical movement which requires interaction across many body segments. This interaction and timing of the movement is vital for success in both ball velocity generation and shot dispersion. Due to this complexity, many coaching models have been developed that constrain the degrees of freedom within the system to aid swing to swing consistency (Hardy &, Andrisani, 2005; Haney & Huggan 2011; Leadbetter & Kaspriske, 2015). Traditionally, variability has been viewed as noise and undesirable. Ecological motor control specialists however consider variability functional, giving the performer the ability to adapt to the environment (Bartlett *et al.*, 2007). The ability to freeze and unfreeze the degrees of freedom may aid an elite performer's ability to satisfy the task contrasts, whereas a less skilled performer needs to try and make the movement system as rigid as possible (Newell *et al.*, 2006). Functional Movement variability (swing to swing) may allow adaptation within the movement which facilitates the same delivery and shot outcomes (Langdown *et al*, 2012).The aim of this study was to investigate whether movement variability trends are observable in elite driving performance.

Methods:

Seven professional and 3 elite amateur (hcp = 0±2) male golfers volunteered for the study (age = 29 ± 10 yrs, height = 1.8 ± 0.1 m, mass=81 ± 6 kg). The study was granted ethical approval by the Cardiff Metropolitan University ethics committee and written informed consent was gained prior to participation.

Kinematic data of 20 golf drives per participant were collected at 250 Hz with 11 Vicon MX cameras (Vicon, Oxford Metrics, Oxford, UK). Trajectories were tracked and gap filled using Vicon Nexus V1.8 (Vicon Motion Analysis, Oxford, UK) and data were filtered using a 4^{th} order Butterworth filter with a cut-off of 6 Hz. Position and orientation of the pelvis and thorax were expressed via a right-handed local coordinate system. Segment angular displacements were defined relative to the global coordinate system and described by an XYZ Cardan sequence. Data were time normalised to 101 points; 0% indicating takeaway and 100% mid follow through and expressed as continuous mean profiles with the standard deviation used to show biological variability. Initial ball launch and flight data were obtained independently using a GC2 Launch monitor (Foresight Sports, San Diego, USA, CA) and used to assess player outcome performance.

Results:

Figure 1 gives an example of the data collected from the 20 drives performed. The standard deviation was greater in the early parts of the movements and reduced into ball contact. This trend in variability was apparent across all participants. However, the velocity profiles did not show the same standard deviation trends witnessed in the positioning of the segments. The group average carry distance was 265 m ±10 with a lateral dispersion of 20 m ± 14. There was no evidence that participant ball carry and dispersion away from the stated group means was a product of the amount of standard deviation within the body segments.

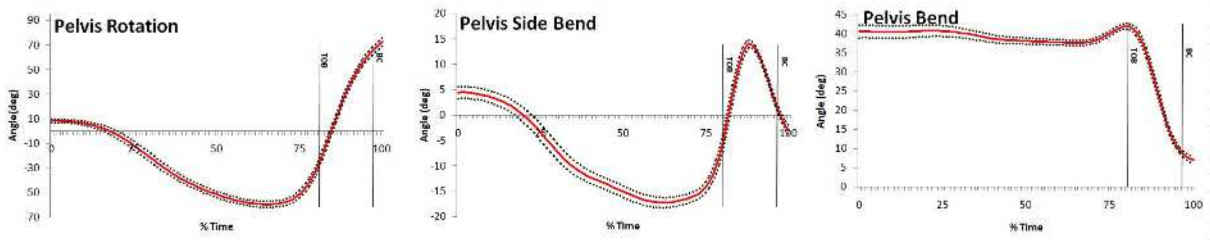

Figure 1: Example of Mean (Black line) ± SD (Red line) Pelvis Rotation, side bend and bend for participant 4.

Discussion:

Variability was higher in the backswing and reduced moving through transition and into ball contact.The variability in the segment movement was not mirrored in the velocity profiles. Kugler *et al.* (1980) stated that the functionally of the variability is to preserve function rather than preserving body parts that are involved in the movement; the variability within the segment positioning at the beginning of the swing may be a mechanism to allow the overall velocities and sequencing being generated to be more stable. The higher variability witnessed at the beginning is supported by Davids *et al.* (2003) who stated variability in parts of the movement of elite performers can have higher reflecting compensatory measures. With all ten participants demonstrating velocities and ball data that are reflective of elite performers in previous literature (Myres *et al.*, 2007; Cheetham et al., 2008; Chu *et al.,* 2010*)* and had the same pattern of variability through the movement of the pelvis and thorax, there is no support that the witnessed variability is having detrimental effects.

Practical Application:

The role of variability needs consideration when prescribing coaching interventions. Swing models that aid a novice may not be the best solution for an elite performer as the presence of functional movement variability can facilitate elite level golf driving performance.

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