The importance of movement variability for performance and prevention of injury.

There continues to be a great deal of interest in the role of movement variability for skilled performance and prevention of injury in the field of human movement science. Rather than considering variability in a motor task as unwanted noise or a problem that must be corrected, variability in movement patterns is now seen as a functional and indeed an important part of the adaptability of coordination and movement efficiency required in producing optimal outcomes in dynamic performance\textsuperscript{1}. For physiotherapists, the importance of including variability in exercise techniques and programs is becoming more and more apparent.

**Movement variability and movement tasks**

Movement variability can be described as the normal variations that occur in motor performance across multiple repetitions of a task\textsuperscript{2}. That is, when a person repeats a movement task, no two repetitions will be identical, rather each repetition will involve unique, non-neural and motor patterns or as described by Bernstein\textsuperscript{3} – “repetition without repetition”. However, for many years (some) health practitioners interested in movement have continued to focus on reducing variability, or purported “error”, during performance of movement tasks. For example, patients presenting with pain or movement dysfunction are told to “correct” their pattern of movement; are asked to perform repetition after repetition of a task-specific movement with the aim of achieving ‘consistency’ or a ‘normal pattern’. While there are obvious advantages of asking patients to repeat movements, it could also be argued that encouraging people to focus on trying to produce the same movement patterns may simply encourage rigid, inflexible motor behaviours that subsequently limit the patient’s ability to adapt to different tasks or changing environmental demands\textsuperscript{2,4}.

**Movement variability and pain/injury**

Much research has been devoted to identifying movement patterns that predispose both athletes and non-athletes to injury. However, more recently, more attention has been directed towards analysing actual patterns of movement during functional tasks instead of discrete kinematic measurements in order to gain a greater understanding of the interactions that occur in the motor system that may result in pain or injury\textsuperscript{1}. From this type of research, there is evidence to suggest that a loss of movement variability in fundamental movement variables leads to injury and pain\textsuperscript{5-7}. Hamill et al\textsuperscript{5} argue that absolute coordination with its low variability causes forces to be distributed across small surface areas, possibly resulting in overuse injuries. In contrast, the variations present during relative coordination allow joint or tissue forces to be distributed, thereby possibly minimizing the chance for overuse injuries. Supporting this argument was the study by Seay and colleagues\textsuperscript{7} that demonstrated that runners with low back pain had the lowest coordinative variability between their trunk and pelvis compared to those runners without low back pain or those runners who had recovered from low back pain. There is also evidence to suggest that patients with spinal pain adopt more rigid postural control strategies\textsuperscript{4,8} and less flexibility in strategies during more complex tasks\textsuperscript{9}. Patients with anterior cruciate deficient knees have been found to have less divergence in flexion-extension movement during gait indicating a more rigid type of motor behaviour\textsuperscript{10}. This increased behavioural rigidity may be a mechanism contributing to the eventual development of osteoarthritis in the ACL deficient knee\textsuperscript{2}. While there is evidence to suggest that different coordinative patterns during other sports related activities predict injury\textsuperscript{11}, more prospective studies are needed to determine the role of movement variability in risk for injury.
Movement variability and skilled performance

In multi-joint tasks that require precision of an “end-point effector”, the variability of individual segment trajectories may be substantially greater than the variability of the end-point trajectory. This feature was perhaps best illustrated in the classic study of Bernstein, where the movement of professional blacksmiths were described when repeatedly hitting a chisel. Considerable variability was observed for individual joints of the upper body, yet the trajectory of the hammer tip was consistent with each strike, particularly at the point of impact. Similar features have now been found during the golf swing and the basketball free throw where different coordinative patterns exist for the more proximal segments but at the point of impact in the case of the golf swing for example, segmental variability is low. Many constraints interact to shape postural behaviours during sporting endeavours, including body properties, support surfaces and tasks, but highly skilled performers are able to adapt to these constraints and perturbations, resulting in the necessary flexibility and adaptability to operate proficiently in a variety of performance development and learning contexts.

Implications for health professionals

Rather than focussing on asking patients to perform repetitive movement tasks with the goal of simply trying to replicate the exact same kinematics, health professionals should consider encouraging their patients to adopt flexibility in motor patterns and also take into account the patient’s individual co-ordination strategies and recognise that these strategies are a function of the interaction between a number of constraints. When prescribing exercises, the importance of movement variability for skilled performance and its relationship to injury should be considered and health professionals should consider whether or not they are in fact limiting their patient’s coordinative strategies by simply asking them to repeat ‘correct’ movement patterns during specific tasks. There is still a long way to go in understanding the complexity of movement. However, a consideration of the neurophysiological benefits of encouraging movement variability is certainly warranted.

The role of the FreeForm Board

Like many physiotherapists, I have been asked to endorse a number of products over the 20 years I have been practising. The FreeForm Board is the first that I have agreed to support. My interest in devising exercise programs that enhance movement efficiency and encourage flexibility in motor patterns was the first reason I began to experiment with the FreeForm board. The board allows patients to perform numerous exercises that range from very simple range of movement exercises to highly complex, multi-segmental tasks requiring coordinated patterns of segmental movement and control. I like exercises that are fun, creative, and simple to administer. Patients that have been using the board report significant improvements in balance, control and movement awareness and it is these factors that we have begun to research. That is, we have commenced a number of studies to investigate muscle activation patterns during exercises on the board and its ability to improve functional outcomes for a number of patient populations – watch this space!


---

**Dr. Kerrie Evans has no financial interest nor receives any commission from the sale or supply of the Freeform board and her endorsement complies with the APA Code of Conduct, March 2014.**