

Optimization of Human Performance

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The papers in this issue of *Kinesiology Review* collectively constitute the bulk of the Proceedings of the National Academy of Kinesiology (NAK) and are expansions on a series of presentations given at the 89th annual meeting held in Bellevue, WA, September 12–14, 2019. The theme of the conference was the “Optimization of Human Performance,” and 13 scholars who are internationally recognized leaders in kinesiology and beyond presented their views on this topic from multiple perspectives spanning the historical and philosophical to the biophysical and sports-medicine dimensions. We now present full papers from 10 of those presentations in this issue.

The highest levels of human performance are inspiring and captured by the Olympic motto *Citius, altius, fortius* (Faster, higher, stronger), which characterizes the beauty of the moving body at its limits or capacity. Remarkably, the highest-level performance of an athlete is sometimes associated with an apparent ease of exertion in such exceptional performers as Wilma Rudolph, who won gold as a sprinter in 100-m, 200-m, and 4 × 100-m events at the 1960 Rome Olympics and was affectionately referred to by European press as the Black Gazelle, while Red Grange, the outstanding football halfback nicknamed the Galloping Ghost, who played at the University of Illinois in the 1920s and went on to star with the Chicago Bears, also moved with apparent ease. Grange’s movements during game performance, similar to those ascribed to Rudolph, were also described as beautiful, fluid, and graceful and akin to that of nimble deer in the woods by his college coach Bob Zuppke. As such, human performance can embody both beauty and functionality. In this vein a subtheme of the conference was, in fact, that of efficiency or economy of motion for optimization, and it certainly applies, beyond the speedsters, to the endurance athletes and all who must sustain their efforts on the job, as well as on the field of play, since economy of movement preserves the energy substrates that fuel the human machine. Although these examples capture the movements of superior athletes, the arena of human performance also includes the actions of first responders and soldiers in highly stressful environments and extends to the movements of those who are challenged by age, infirmity, and disease who are doing their best to execute their activities of daily living and achieve the goals that are meaningful to them (e.g., rising from a chair and walking to the washroom in an attempt to maintain independence).

A phrase that is often used to describe the content of kinesiology is that of health and human performance, and the health dimension is essentially intertwined with performance in that cognitive-motor skill is the fundamental requisite for engaging in physical activity. Thus, there is need for skill to move and accrue

the many health benefits of activity—both physical and mental. It is noteworthy that the U.S. federal government (Health and Human Services) is about to or has just released *Healthy People 2030, the Physical Activity Guidelines*, and a National Youth Sport Initiative, and it takes both skill and performance to participate while the performances involved with such participation lead to health-promoting outcomes.

The intent of the NAK meeting was to understand the essential nature and expression of skillful human performance and how it is achieved. The emphasis of the speakers at the meeting leaned toward superior performers, but the principles apply to all. It takes all subdisciplines working in concert to approach such understanding, and that was the approach taken here. As such, the approach was that of including *multiple perspectives* (historical to biophysical to neural, pedagogical, big data, and sports medicine)—it takes the landscape of kinesiology and all its subdisciplines considered in harmony to capture the phenomenon (see Figure 1). Of course, there is great specificity to the expression of optimal performance, so one formula does not apply across the board, but there are fundamental issues related to pedagogy, learning, physiology, and injury prevention (sports-medicine topics were covered broadly in the scope of the meeting, and the importance lies in keeping the performer, whether an athlete or not, “in the game” since those pushing their limits, whatever they may be, are always flirting with injury and overtraining) that generalize to all, and that is what was covered to the extent that the format and duration of the meeting could accommodate! The following passages overview the content and flow of the optimization of human performance.

The Rainer and Julie Martens Keynote Lecture

To provide an overall context, the opening presentation—the Human Kinetics Lecture—was provided by Dr. Adam Russell, who has served as a program officer in the Defense Advanced Research Projects Agency (DARPA) and shared his perspective on the importance of clear and compelling research on human performance and the kinds of futuristic developments in science that can instill confidence in the results of our investigations and would well serve those who must depend on the veracity of the research enterprise. Russell summarized his presentation as follows:

As Carl Sagan said, at the heart of science is a balance between remaining open to novel, surprising insights about the world without sacrificing a ruthless skeptical scrutiny of all ideas, old and new. Being able to determine whether a particular finding reflects what Sagan calls a “deep truth” or “deep nonsense”—in part by establishing the replicability and reproducibility of a finding—is one of the hallmarks of a true science. This ruthless skepticism seems more appropriate than ever as there is a growing awareness across a number of research disciplines

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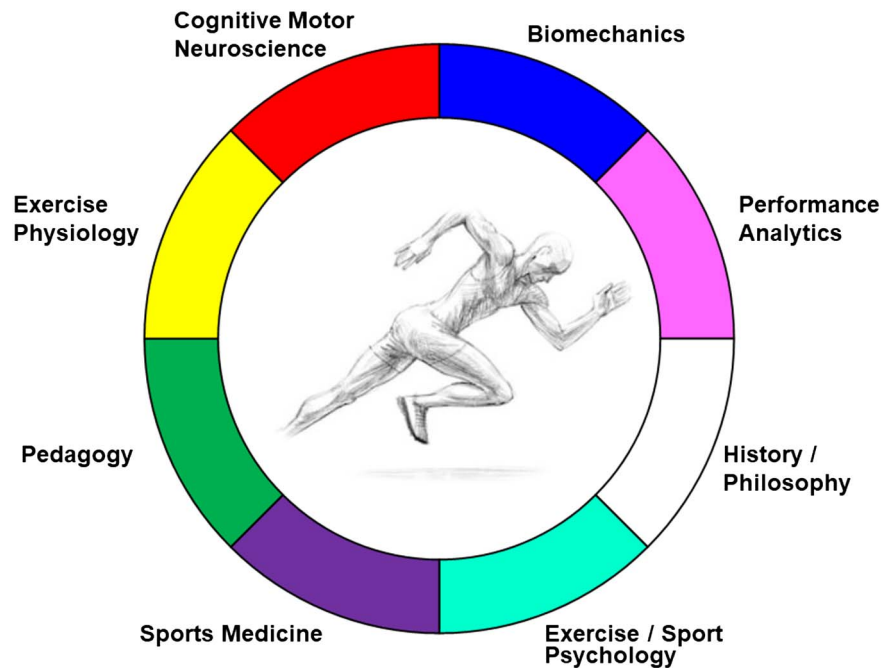


Figure 1 — Employment of multiple convergent perspectives to understand human performance.

(including exercise and sports science) that many published results are failing to replicate and cannot be reproduced, leading to what has been referred to as a replicability “crisis.”

While the term “crisis” may be disputed, this talk presented some of the evidence giving rise to concerns about the widespread and potentially negative impacts of questionable research practices that stem from poorly aligned professional incentives, which often prioritize being published over being right. While noting the enormous challenge of changing professional incentive structures, the talk discussed some of the more promising approaches toward enabling research communities to tackle the current crisis (such as preregistration, Registered Reports, adversarial collaboration, quantifying a study’s computational reproducibility, etc.), ultimately hoping that these and future “metascience” innovations will increasingly enable researchers to be rewarded for getting it right, not just getting it published.

Multiple Perspectives

The Historical and Philosophical Subtheme

Dr. Mark Dyreson of the Pennsylvania State University shared his ideas on the preparation of elite athletes from a historical perspective. He described the origins of *Homo sapiens* 300,000 years ago, from a macrohistorical perspective of the hunter-forager cultures and the improvement of endurance capabilities and weapons skills, leading to the agricultural revolution that began about 10,000 years ago, the enhancement of elite warriors to protect others, and then to the modern revolution that began 500 years ago with a reliance on technology more than on human locomotion. Beyond these general developments, he describes the amazing endurance capabilities of the Tarahumara peoples of Mexico, who were products of their unique culture in the modern world. Dyreson extended the call for strong team science to the notion of team scholarship to understand

human performance beyond science to include the arts and humanities. Dr. Cesar Torres of the College at Brockport (State University of New York) inspired the audience with a presentation on the role of values in human performance and challenged us to understand the value of pursuing optimal athletic performance. He introduced and explained six kinds of values that drive the pursuit of excellence. Such phenomenological constructs as *living well* and *loving one’s life* may provide a strong explanation for the drive to excel.

Biophysical Dimension of Human Performance

Dr. Ron Zernicke of the University of Michigan described the role of biomechanical efficiency in the optimization of human movement and discussed efficient movement as essential to the human experience and one’s quality of life. Efficient movement is conducive to participation in a physically active lifestyle with attendant health benefits. He also described the role of efficiency in elite athletic performance and the lessons learned from the study of elite performers that apply to all from the adaptations that accrue from extreme efforts (e.g., increased bone mineral density in the arms of baseball pitchers). Richard Kreider (Texas A&M University) discussed the role of sport science in performance enhancement, specifically, that of strength and nutrition, and described the history and incredible developments that have occurred in the area and how they play an important role in preparing athletes to perform to the best of their ability. It is now commonplace in college and professional sport teams to have sport dietitians and/or nutrition consultants as part of the performance-enhancement team, and academic and professional preparation of such professionals is becoming increasingly common in kinesiology programs. Mary Jane DeSouza of the Pennsylvania State University triad described the female athlete triad, which comprises menstrual dysfunction, low energy availability (with or without an eating disorder), and decreased bone mineral density and has become increasingly common in women pushing their

bodies under the pressure of intense training. She described a similar condition in male athletes in which they exhibit a combination of symptoms parallel to the female athlete triad under the challenge of heavy work.

Neural and Psychological Dimensions of Human Performance

Rachael Seidler, University of Florida, described the unique aspects of learning motor skills under unusual conditions such as those of visual distortion of feedback in the laboratory and noted that such studies may help us understand human performance in new and challenging environments such as those during space flight and interplanetary travel. Gabrielle Wulf of the University of Nevada Las Vegas described her work in the motivational basis of human performance via the OPTIMAL model—optimizing performance through intrinsic motivation and attention for learning theory—which has been used to explain how practice effects such as attention and autonomy support and influence motor performance and learning. Beyond the psychological level of analysis, Tsung-Min Hung of the National Taiwan Normal University provided the C. Lynn Vendien International Lecture, in which he described understanding and control of cerebral cortical activities for superior motor performance. In essence, he described the evidence in support of the brain states associated with expertise and learning. His presentation complemented that of Zernicke's on biomechanical efficiency, as superior performers are also characterized by neural efficiency.

Contextual Dimension of Human Performance

Peter Hastie of Auburn University spoke of regulators of skill development in school physical education. His paper identifies several factors that affect the quality of instruction that students can potentially receive, which in turn has implications for the extent to which they can engage in appropriate practice and skill development. These factors are “contextual,” such as time, class size, and teaching resources; “curricular,” relating to the content and pedagogy of physical education; and “instructional,” such as teacher effectiveness and content knowledge. Stefan Szymanski, an economist in sport management at the University of Michigan, described the emerging field of sport analytics wherein patterns are captured from large data sets, or the use of Big Data forecasting. This is an emerging area of human performance and is growing with the advent of wearable technologies. Szymanski states that sport analytics promises to use Big Data and sophisticated statistical methods to identify effective strategies in sports—“the Moneyball moment.” However, much like alchemy, sport analytics is characterized by opacity and secrecy!

Sports-Medicine Dimension of Human Performance

The sports-medicine area of knowledge is critical to keeping human performers “in the game.” Doug Casa of the University of

Connecticut and the Kory Stringer Institute described the maximization of performance and safety during intense exertion in the heat, as well as the roles of obesity, climate change, drugs, and physical fitness in heat stress. Notably, Casa stated exertional heat stroke is 100% survivable and that health care professionals have a critical role in recognizing predisposing factors that lead to its susceptibility. Sandra Shultz, from the University of North Carolina, Greensboro, described recent advances in primary and secondary anterior cruciate ligament (ACL) injury prevention and the future of research on this devastating injury. She described considerable advances in risk identification and prevention over the past 20 years and posed many questions regarding the most effective training and rehabilitation approaches to ACL-injury prevention, engaging the various subdisciplines of kinesiology. Kevin Guskiewicz of the University of North Carolina at Chapel Hill described the changing landscape of sport concussion. He discussed how many individuals have recently referred to “concussion” as a “hidden injury.” There is, indeed, much to learn, but we are better informed today than ever. Of great importance, blood and neuroimaging biomarkers are now available to investigate innovative treatment. One point of discussion at the end of the meeting relevant to Guskiewicz's talk was the Dartmouth College model of football pedagogy, in which risk of traumatic brain injury has been reduced by Coach Buddy Teevens and his staff, teaming with engineers to develop smart tackling dummies/robots and thus reducing dangerous helmet-to-helmet contact during practice. In addition, the Big 10 Academic Alliance and the Ivy League have recently partnered to advance research in this critical area.

Conclusion

One unique feature of the Bellevue conference was a 45-minute question-and-answer session at the end of the meeting that included all speakers and allowed for an integrated discussion of the various elements that compose expert/optimal performance. This synergistic perspective included psychological, biomechanical, physiological, pedagogical, medical, historical-philosophical, and organizational factors that facilitate optimal performance. Many factors beyond those discussed in the meeting bear great relevance to the topic, including accelerated learning, virtual-immersion practice settings, neurofeedback, resilience to stress, sport management organizations that promote athlete development, team dynamics, trust, cognitive load, and assistive robotics and human-machine interfacing, as well as rehabilitation optimization.

We covered a rich landscape and have much to consider in the future, particularly as new technologies emerge to measure the mind and body moving through space and time. A debt of gratitude is owed to the planning committee consisting of NAK Fellows David Wiggins, Ron Zernicke, Rick Kreider, Mary Jane De Souza, Peter Hastie, and Dave Perrin. A special thank you to Kim Scott for her tireless work to organize the meeting and to Dave Wiggins in his role as Editor-in-Chief of *Kinesiology Review*.