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COMMENTARY

Central and Peripheral Limits to Exercise...and Exercise Science: A Young Investigator's Perspective

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If you are familiar with the illustrious career of Dr. Roy Shephard, or if you have simply read the other commentaries in this tribute, you likely understand that Dr. Shephard is a giant in our field. Throughout his career, he has worked on groundbreaking new research across numerous sub-disciplines of exercise science; and just as importantly, he has had a tremendous impact by creating links and integrations of evidence, which bring cross-disciplinary theories together. I have recently had the opportunity to sit down with Dr. Shephard to discuss his review of the central governor mechanism (CGM) that examines differing perspectives and theories as to the limits of human performance considering both central and peripheral factors (Shephard, 2009). Dr. Shephard's critical review of the CGM is a perfect example of how having the command of a great depth and breadth of knowledge allows examination of a novel theory from a critical and encompassing viewpoint.

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As a young investigator, connecting with good mentors and role models is crucial to successfully planning and starting down one's own career path. The remarkable accomplishments of Dr. Shephard demonstrate the extensive research possibilities in exercise science and set an example that all researchers (new and established) can look up to and strive for. In this article, I reflect on some of the lessons I have been fortunate to learn from Dr. Shephard's research and personal advice, and I attempt to highlight the examples to be followed from a young investigator's perspective.

For almost 15 years, a group of researchers led largely by Dr. Timothy Noakes, has argued that exercise is not limited by traditionally accepted cardiovascular regulatory factors, but rather a specific brain centre, whose role is to maintain homeostasis and protect the body from overexertion related injury. Since the introduction of the CGM, Noakes and his colleagues have suggested numerous hypotheses for the development and effectiveness of this theory. For the average peripheral observer to this debate, the proposed hypotheses of the CGM advocates are of varying persuasiveness, with some theories being of at least superficial plausibility.

Dr. Shephard's critical review of the CGM effectively argues against the existence of evidence to support these proposed theories. The paper is particularly compelling because Dr. Shephard draws on examples from a breadth of sources to present, in a convincing manner, concrete evidence contrary to the factors purported to drive each major hypothesis of CGM proponents. As an example of Dr. Shephard's broad expertise, he addresses convincingly the CGM debate in the areas of: evolutionary selection, exercise-related ischemic and thermal injury, cardiac function and cardiac output, maximal aerobic power, and neuromuscular drive in reference to the electromyogram. Although it is beyond the scope of this commentary to review Dr. Shephard's extensive experience and background in each of these areas (among others), laudatory papers within this series offer an in-depth account of these experiences and research collaborations.

As a graduate student or a new investigator initiating his or her own research program, what career lessons can be gleaned from an overview of Dr. Shephard's career and consideration of this particular review? I have formulated a list which I believe captures some of the qualities Dr. Shephard exemplifies, and which young investigators would benefit from emulating.

1. *Success comes through hard work.*

It is a fact that Dr. Shephard has had a great many experiences on which he surely draws when considering complex questions, theories, and proposals. Given his wealth of experience, it is also possible (though perhaps unlikely given his photographic memory) that Dr. Shephard could easily forget more about exercise physiology than some will ever

know. This experience in conducting, reading, writing, and editing research has accumulated through years of dedicated hard work. In the words of Dr. Shephard, "I have always believed that if working 14 hours a day is good, then working 16 hours in a day is even better."

2. *Think of the big picture.*

Admittedly, some of Dr. Shephard's research has been very focused on specific processes, organs, or systems within the body. From both a basic and applied perspective, these studies have been important. However, it is the ability to consider the evidence as a whole, or to "see the forest for the trees" which has allowed Dr. Shephard to frame ideas in a way that others could not. As Dr. Shephard puts it, ultimately "...in human research, you must be able to consider the whole body as a system."

3. *Be open to opportunity.*

Breadth of experience and an understanding of areas peripheral to your current focus come from capitalizing on opportunities that present themselves at unexpected times. Be ready to act when opportunities arise (see Dr. Shephard's article: "Groundwork for my first sixty-three years as an Applied Physiologist" (Shephard, 2011)). Collaborate with others in your department and elsewhere. Seek to understand the research focus of those who work around you, especially if the focus is different from your own.

4. *Stay focused.*

By his own disclosure, one of the reasons Dr. Shephard has such a prolific research career has been his ability to avoid distractions (political, administrative, or otherwise) that pull him away from front-line research. Although Dr. Shephard agrees that

community service is important (as is clearly evidenced by his extensive contributions to community service highlighted in Drs. Gledhill and Jamnik's (2011) article), he also believes that recognizing your strengths and focusing your effort in these areas will allow for the greatest overall impact. One of Dr. Shephard's strengths is clearly his ability to conduct and report high quality research. Maintaining focus is also important in the research itself, from asking the right questions to designing the best experiments and correctly interpreting the results. Be clear of your goal and work to achieve it.

5. Be a lifelong student and continue to learn.

When asked how he compiles evidence to write a paper such as the comprehensive review of the CGM, Dr. Shephard told me that most of his opinions and arguments begin informally as a simple by-product of his staying abreast of current research. Furthermore, it is specifically the critical appraisal of manuscripts during the review process that leaves a lasting impression, compared to the more superficial contemplation one might give an article when browsing abstracts. Even in retirement, Dr. Shephard reviews 3-4 manuscripts a week and is involved on the editorial board of more than 20 leading journals. Doctor Shephard embodies the spirit of a life-long student in his willingness to change and adapt his methods and use of technology. As an example, when Dr. Shephard first started publishing his research, manuscripts were hand written (before being typed on typewriters) and references, which he often committed to memory for later use, were only found in hardcopy in the dusty stacks of privileged libraries. Doctor

Gledhill recounted to me an experience with Dr. Shephard in the early 1970s; they were both travelling on the subway to downtown Toronto and while carrying on a conversation, Dr. Shephard was finishing a hand-written article in which he proceeded to insert all of the complete detailed references entirely from memory. In preparing his arguments for the current manuscript, Dr. Shephard accumulated his articles online by searching the University of Toronto's library system from across the country, inserting references automatically while he wrote using reference software, and storing "pdf" copies of each article on his new 300 GB external hard drive (which he described with a smile).

6. Find your passion.

Even though he has been retired for a number of years, Dr. Shephard maintains a publication productivity which is equal to or greater than that which many researchers achieve in the prime of their careers. Great theories and arguments come through hard work and hours of contemplation. Doctor Shephard admitted to me that many of his great ideas are formulated during his regular 5 km morning walk from thoughts he had been working on the night before. Why would someone dedicate so much time and effort to a scientific pursuit even after retirement? The only explanation I can come up with is because it is something that he is truly passionate about.

In his article "Is it time to retire the 'Central Governor'?" Dr. Shephard convincingly argues that there is no evidence to support a feed forward CGM limiting exercise. I believe that the example Dr. Shephard has set for researchers around the world also demonstrates compellingly that there is no evidence for a limit in health-related

DR. ROY SHEPHARD AND THE CENTRAL GOVERNOR

science, or what dedicated, passionate researchers in exercise science are capable of accomplishing.

Qualifications

The author's qualifications are as follows: Jamie Burr, Ph.D., CSEP-CEP.



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Picture (from left to right): Art Salmon, Barry McPherson, John Sutton, Norm Gledhill, Claude Bouchard, Roy Shephard, Tom Stevens

