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The BASES Expert Statement on the Importance of Fundamental Movement Skills for Children's Physical Activity and Health

Prof Michael Duncan FBASES,
Prof Gareth Stratton FBASES,
Dr Lawrence Foweather,
Helen Collins and
Prof David Stodden

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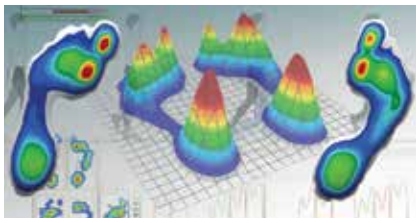

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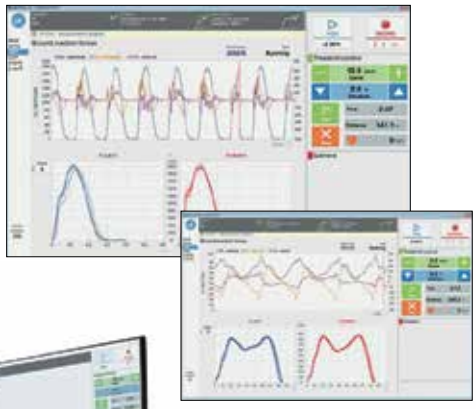

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News

BASES 2019-2020 Annual Report

The Board has pleasure in presenting the BASES Annual Report 2019-2020 (covering the period 1 September 2019-31 August 2020) and the financial statements for the year ended 31 March 2020. The full PDF document can be found at: https://bit.ly/3knsAcd

BASES Division Chairs

Three BASES Division Chairs finished their current terms after the November 2020 Board meeting. Following open recruitment, the following appointments were made: Dr Andrew Mitchell, Chair of the Division of Biomechanics and Motor Behaviour; Dr Adam Gledhill FBASES, Chair of the Division of Psychology; and Dr Ibrahim Akubat, Chair of the Division of Sport and Performance.

BASES Position stand

Drs Andy Smith MBE FBASES, Rita de Oliveira, Mark Faghy, Mark Ross and Neil Maxwell prepared a position stand on the 'reopening' of Sport and Exercise Science departments in Higher Education after lockdown, which was approved by the BASES Board and published 13 August 2020. BASES members can view the full document at: https://bit.ly/30qMrjJ

Careers Guide

At the end of August 2020, BASES launched the new BASES Career Guide: A Guide to Careers in Sport and Exercise Science. This updated Career Guide includes a wealth of guidance and information about choosing courses at school, college and university (undergraduate and postgraduate courses), career opportunities and how to get ahead, and how to pursue popular career paths and occupations. Online, BASES members can view the full unrestricted version of the BASES Career Guide by logging into the Members' Area of the BASES website: http://bit.ly/2GkkEqN.

BASES commitment to Equity, Diversity and Inclusion (EDI)

At its meeting in July 2020, the BASES Board appointed Satvinder (Vinny) Leach as the first Board Diversity Champion. The newly created EDI Committee first met in July 2020 and again in September 2020 to advance the new EDI Action Plan. The first BASES Diversity Monitoring Survey was launched in September 2020 and was open for a month. Members of the EDI Committee shared their stories of what inclusion means to them, as part of National Inclusion Week in September 2020. The articles and other resources can be found here at: https://bit.ly/2Ry47V8

BASES Fellowships

BASES Fellowship recognises esteemed professional achievement, skills, knowledge and service to BASES and the sport and exercise science community made by BASES members. Nine fellowships have been awarded in 2020: Dr Lindsay Bottoms, University of Hertfordshire, Dr Neil Clarke, Coventry University, Prof John Dickinson, University of Kent, Dr Sarah Gilchrist, Gilchrist Performance, Dr Adam Grainger, Hockey Ireland, Dr John Iga, Huddersfield Town Football Club, Dr Simon Nichols, Sheffield Hallam University, Dr Alan Ruddock, Sheffield Hallam University and Dr Christopher Spray, Loughborough University.

Abstract submission now open for BASES Student Conference 2021

Solent University will host BASES Student Conference 2021 taking place on Wednesday 7-Thursday 8 April 2021. The theme for this year's conference is Equality, Diversity and Overcoming Adversity in Sport and Exercise Science. Abstract submission is now open to all BASES student members - guidelines for preparing abstracts and information about how to register and submit your abstract can be found on the BASES website at: http://bit.ly/2SQeHpj. The deadline for submitting an abstract is Friday 26 February 2021.

Committee Appointments

Equity, Diversity and Inclusion Committee
Lucinda Abell, Dr Richard Buscombe, Dr Sharon Dixon, Dr John Fernandes, Dr Kotryna Fraser, Helen Matthews, Dr Izzy Moore, Dr Emma Ross FBASES, Dr Tori Sprung, Savannah Sturridge, Ian Wilson and Shameema Yousuf.

Psychology Division
Richard Simpson, Co-opted member.

Sport and Performance Division
Laura Needham, Co-opted member.

BASES Re-Accreditation and Accreditation

Re-Accreditation

Jack Ade, Liverpool FC, Dr Jo Batey, University of Winchester, Matthew Birnie, Chelsea FC, Dr Howie Carson, University of Edinburgh, Prof Stewart Cotterill FBASES, AECC University College, Dr Melissa Day, University of Chichester, Prof Andrew Edwards FBASES, Canterbury Christ Church University, Dr Matthew Haines, University of Huddersfield, Prof Glyn Howatson FBASES, Northumbria University, Dr Carl James, Physiology Support, Dr Paul Jones, University of Salford, Dr Lyndsy Kass, University of Hertfordshire, Jennie Killilea, Manchester City FC, Prof Zoe Knowles FBASES, Liverpool John Moores University, Dr Kiara Lewis FBASES, University of Huddersfield, Jane Lomax, University of Chichester, Jim Lowther, University of Ulster, Dr Philippa McGregor, Thrive2Perform Ltd, Oliver Morgan, Celtic FC, Dr Mark Noon, Coventry University, Dr Joanna Richards, University of Bedfordshire, Helen Ryan-Stewart, University of Winchester, Dr Jonathan Smith, AdaptiveMind Consultancy, Perry Stewart, Arsenal FC, Alex Taylor, University of Birmingham, Richard Taylor, Coventry University, Dr Mark Uphill, Canterbury Christ Church University, Dr Carl Wells, Sheffield United FC, Dr Matthew Weston FBASES, Professional Referee Organisation, Craig Winstanley, University Academy '92, Dr Stacy Winter, St Mary's University.

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High Performance Sport Re-Accreditation (HPSA)

Dr Joy Bringer, Sport Wales, Prof Dave Collins FBASES, Grey Matters UK, Dr Neil Gibson, Blacktown City Council.

BASES Certified Exercise Practitioner

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Letters

RE: The Psychological impact of Covid-19 on elite athletes

Rossato et al. provide interesting insights into the mental health impact of Covid-19 on athletes, a topic which appears to have been overlooked throughout the pandemic. Clearly, significant disruption to athletes' training and competitions has been caused throughout the world. The article mentions an important point regarding an athlete's interpretation of an adverse event, i.e. their cognitive appraisal; whether or not the athlete perceives a stressful event as a threat to their progress or merely a challenge that can be used to move forward in other ways. There has never been a better time to take advantage of coping strategies - learning other skills, diet, meditation, maintaining contact with friends and family etc. Coaches should regularly reassure their athletes that there are a multitude of methods to maintain mental health and well-being. Further research of the impact of Covid-19 on psychological parameters such as self-efficacy, locus of control and anxiety is necessary. It would also be beneficial to observe the long-term consequences on athlete performance and well-being for future events, e.g. Olympics. The interrelationship amongst other lifestyle factors and how they can influence subsequent athletic performance remains an additional area of intrigue.

ADNAN HAQ, MOULTON COLLEGE/UNIVERSITY OF NORTHAMPTON

The BASES Expert Statement on the Importance of Fundamental Movement Skills for Children's Physical Activity and Health

Produced on behalf of the British Association of Sport and Exercise Sciences by Prof Michael Duncan FBASES, Prof Gareth Stratton FBASES, Dr Lawrence Foweather, Helen Collins and Prof David Stodden.

Introduction

Promotion of physical activity (PA) in youth continues to be a challenge, with limited success in increasing the proportion of children who attain 60 min/day of moderate-to-vigorous physical activity (MVPA) (Chief Medical Officers, 2019). The development of fundamental movement skills (FMS) provides a foundation for more advanced, complex movements needed to successfully participate in sports and activities across the lifespan (Gallahue *et al.*, 2012). Developing proficiency in FMS domains of locomotor (e.g. running, jumping), object control (e.g. throwing, catching) and stability (e.g. balancing, twisting) skills require appropriate learning opportunities to promote a foundation of skill during childhood and adolescence. It is concerning, therefore, that low levels of FMS competence have been widely reported in children and adolescents and that this is associated with low PA (Robinson *et al.*, 2015). These reports are particularly relevant as skill competence tracks from childhood into adolescence (Robinson, *et al.*, 2015; Logan, *et al.*, 2015). Consequently, developing proficiency in a range of FMS has become a prominent focus in school curricula and sport programmes worldwide, including the National Curriculum for Physical Education (PE) in England.

Since 2000 there has been a considerable increase in evidence highlighting the positive role that development of FMS during childhood plays in children's current and future PA and health (Robinson *et al.*, 2015). Moreover, the latest Chief Medical Officers' guidelines for PA emphasise the importance of movement quality as well as quantity, including the development of FMS for the first time (Chief Medical Officers, 2019). This expert statement summarises what is known about the importance of FMS for children's PA and health, and provides recommendations for research and practice.

Background and evidence

Stodden's conceptual model (2008; see Figure 1) illustrates a developmental perspective (i.e. different antecedent/consequent pathways across age) for the influence of FMS on long-term trajectories of PA, fitness and obesity. PA opportunities drive acquisition of FMS and musculoskeletal fitness in early childhood and vice versa. During middle to late childhood acquiring competency in FMS is a critical antecedent for PA, fitness and healthy weight status. The development of self-concept, specifically perceived competence, also plays a critical role in the model. All factors in the model interact, promoting either positive or negative developmental cascades with the strength of associations between variables hypothesised to increase across time. Evidence to support this model continues to emerge, including multiple recent reviews and meta-analyses (Robinson *et al.*, 2015; Logan *et al.*, 2015; Utesch *et al.*, 2019).

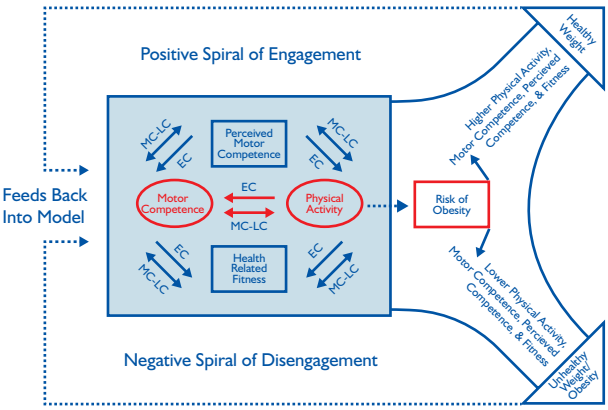

Figure 1. The developmental model (Stodden *et al.*, 2008) hypothesising developmental relationships between motor competence, health-related physical fitness, perceived motor competence, physical activity and risk of obesity. EC=early childhood, MC=middle childhood, LC=late childhood.

Research indicates that FMS competence is positively associated with health-related fitness, perceived competence and MVPA (i.e. better FMS is associated with higher levels of PA) and inversely related to weight status (i.e. better FMS is associated with healthier weight; see Logan *et al.* (2015); Robinson *et al.* (2015); Utesch *et al.* (2019). Longitudinal data suggest that increasing motor competence is associated with healthier weight and higher PA in children and forms the foundation of a positive developmental trajectory for PA (Lima *et al.*, 2017). However, there are limited longitudinal studies and a lack of experimental studies preventing demonstration of cause-effect. Future research using these types of design would enable a better understanding of the causal mechanisms at play, if they exist. Most recently, Tyler *et al.* (2020) demonstrated that FMS successfully integrate into the youth PA promotion model and are related to clear outcomes for health enhancing behaviour demonstrating a clear path for FMS as a mechanism for enhancing children's PA.

Methods of FMS assessment

Although the published literature includes a plethora of tools to assess FMS, there is, as yet, no consensus on a gold standard method. Broadly, assessment methods for FMS comprise process measures, reflecting the quality of movement, or product measures, reflecting the outcome of movement. The Tests of Gross Motor Development (TGMD) is the most widely used measure of process-oriented FMS, offering a low cost, valid and reliable means to assess children. Process-oriented measures, such as the TGMD described above, provide an evaluation of movement quality/technique but do not examine the outcome of the movement. A number of other studies provided quantitative, product measures of FMS and gross motor coordination tasks such as the KörperKoördinationsTest für Kinder (KTK), Bruininks-Oseretsky Test of Motor Proficiency, Movement ABC or other measures that address overall physical fitness, but incorporate FMS skills (e.g. Eurofit, standing long jump, shuttle run for agility). The literature relating to product measures suggest that these are economical, objective, reliable and valid means to assess FMS. Very few assessments examine both process and product measures together, although recent research has suggested validity of combined measures within the same tool (Dragon Challenge, Tyler *et al.*, 2018). The use of wearable sensors also offers potential for more precise quantification of movement quantity and quality.

FMS based interventions

Low FMS competence levels and the evidence for the importance of FMS on health and development highlight the need for effective interventions. As yet, such interventions have not been forthcoming. In particular, younger children, overweight/obese groups, girls, children from low socio-economic status backgrounds and children with disabilities require targeted FMS interventions. A number of systematic reviews and meta-analyses demonstrate that interventions aimed at enhancing FMS are efficacious (see Logan *et al.*, 2015) and show promise in improving various health-related parameters, particularly weight status and PA (Robinson *et al.*, 2015). However, most intervention studies are conducted over relatively short periods with little or no follow up data collected.

The school setting and PE in particular appear to be a favoured site for any intervention to enhance FMS with limited examples from other settings. Studies based within schools emphasise "high quality PE" yet there is currently insufficient fidelity data to establish best practice for interventions, when they are delivered by individuals without specialist training in the sport and exercise sciences. Employing process evaluations and using an intention-to-treat protocol for analysis remain key gaps in study designs and translating FMS into wider practice. There is also limited data available to establish a dose-response for FMS "training" and there is a relatively high risk of bias in the intervention studies published to date.

Conclusions and recommendations

- The development of FMS across childhood and adolescence plays an important role in promoting health-enhancing PA.
- Children's levels of FMS competency are low and there is a need for interventions to encourage positive health trajectories during childhood.
- There are valid and reliable means to assess FMS, but no gold standard tool to effectively assess both processes and products of movement competence.
- While FMS is important, enabling factors such as physical activity, fitness, participation and accessible facilities are key correlates and determination of cause and effect relationships needs to be explored.
- Interventions can enhance children's FMS with subsequent beneficial effects on PA and health. However, the sustainability of programmes is limited and remains a key challenge to address in future research.
- Interventions should include both structured and non-structured programmes including activities specifically aimed at developing a broad range of FMS, delivered at least twice per week by appropriately trained individuals (e.g. teachers, parents, coaches).
- Although cross-sectional and longitudinal evidence suggests FMS is important for health and development, research is needed to understand the causal mechanisms relating to how changes in movement competency influences key outcomes such as PA behaviours, fitness and obesity. ■

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Helen Collins

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Prof David Stodden

David is a Professor in Motor Behaviour and Director of the Human Performance & Development Lab in the Department of Physical Education at the University of South Carolina.

References:

Chief Medical Officers. (2019). UK Chief Medical Officers' Physical Activity Guidelines. London: Department for Health.

Gallahue, D.L., Ozmun, J.C. & Goodway, J.D. (2012). Understanding motor development: Infants, children, adolescents, adults. 7th ed. New York, NY: McGraw-Hill.

Lima, R.A. *et al.* (2017). Motor competence and cardiorespiratory fitness have greater influence on body fatness than physical activity across time. Scandinavian Journal of Medicine and Science in Sport, 27, 1638-1647.

Logan, S.W. *et al.* (2015). Relationship between fundamental motor skill competence and physical activity during childhood and adolescence: a systematic review. Kinesiology Review, 4, 416-426.

Robinson, L.E. *et al.* (2015). Motor competence and its effect on positive developmental trajectories of health. Sports Medicine, 45, 1273-1284.

Stodden, D.F. *et al.* (2008). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. Quest, 60, 290-306.

Tyler, R. *et al.* (2018). A Dynamic Assessment of Children's Physical Competence: The Dragon Challenge. Medicine & Science in Sports & Exercise, 50, 2474-2487.

Tyler, R. *et al.* (2020). Youth Motor Competence Promotion Model: A Quantitative Investigation into Modifiable Factors. Journal of Science and Medicine in Sport. E-pub ahead of print.

Utesch, T. *et al.* (2019). The relationship between motor competence and physical fitness from early childhood to early adulthood: a meta-analysis. Sports Medicine, 49, 541-551.

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Screen time's ironic reprieve: a life-line for *exercise as medicine?*

Prof John Saxton FBASES is the physical activity for health columnist for The Sport and Exercise Scientist.

In August we were reminded of the health hazards of too much screen time via the publication of an observational study from the UK biobank cohort (Foster *et al.*, 2020). The study, involving around half a million adults, showed that the lowest risk of all-cause and cardiovascular mortality is associated with <2 hours of daily TV viewing. This comes as screen time is on the rise due to the Covid-19 pandemic. Data published by OfCom showed that nearly 6 and a half hours per day were spent watching TV and on-line video content during lockdown (mainly subscription streaming services), an increase of 31% since last year (OfCom, 2020a). It seems somewhat ironic then, that practitioners and scientists within our professional community have been looking to screen-based technologies (i.e. video conferencing) as a means of helping vulnerable sectors of the population with long-term conditions to remain active.

The adoption of screen-based technologies such as Zoom, Teams and Skype received an *injection of pace* during lockdown, including diffusion into sectors of the population with most resistance, as families and friends wrestled with the challenge of keeping in touch. For example, video calling (at least weekly) increased from 22% in February 2020 to 61% in April/May 2020 amongst adults aged 65 years and older who are most likely to be living with long-term health conditions (Ofcom, 2020b). At the same time, telehealth/telemedicine increasingly came to the fore as a means of providing safe ongoing medical care and rehabilitation services. This includes the provision of remote exercise support for individuals undergoing cardiac and pulmonary rehabilitation, and a wide range of other chronic conditions for which hospital and community-based exercise programmes now form part of standard care. Although the pros and cons of telemedicine are still being debated (e.g. Greenhalgh *et al.*, 2020), the need to provide continued access to healthcare (including exercise support) for such individuals is far less contentious. Aside from the physical health benefits, this communication *life-line* could prove to be invaluable for attenuating the adverse mental health impacts of social isolation for individuals who are shielding or fearful of returning to socially distanced exercise rehabilitation services because of concerns about virus transmission (Brooks *et al.*, 2020).

Video conferencing enables the delivery of *real-time* (synchronous) exercise support for patients in the comfort and safety of their own home. Additionally, by simultaneously providing "a window" for visual and audible interaction with expert practitioners and their peer-group, it has to be the closest approximation to facility-based supervised support. In theory, this approach can be used to ensure that exercise is being performed safely and effectively, monitor engagement and provide some level of social support - widely acknowledged as being an important motivational factor for continued engagement (adherence). It could also help to address commonly reported barriers to facility-based exercise programmes (lack of time, travel difficulties, feeling self-conscious in front of others, etc.) and offers the advantages of greater reach (particularly for rural populations), increased scalability and cost efficiencies for rehabilitation services. Foster *et al.* (2020) showed that substituting screen time with walking and moderate to vigorous physical activity reduces the risk of range of future disease and mortality outcomes - but they probably didn't envisage this particular genre of screen time becoming a credible post-pandemic threat to the old enemy!

Cardiac rehabilitation services are taking this seriously, with innovative approaches to delivering cardiac rehabilitation in the Covid-19 and post-pandemic era being a major theme of the October 2020 British Association for Cardiovascular Prevention and Rehabilitation (BACPR) Online Conference (BACPR, 2020).

However, empirical evidence for the physical and mental health benefits of remote exercise support via video conferencing technologies is scant - and the extent to which this *tech* competes with "touch" on patient experience and social support is still to be determined. In addition, the challenge of comprehensively assessing physical capabilities and an inability to provide in-person assistance with movement technique or closely monitor individual physiological responses, perhaps limits the scope of support to simple (non-technical) floor or chair-based exercises. For these reasons, video conferencing support seems much better suited to patients with stable chronic conditions and may preclude those with complex needs. Furthermore, low technology literacy and/or lack of access to equipment (or an appropriate exercise space) remain important threats to engagement amongst older adults, individuals with low socioeconomic status and rural populations with a poor internet connection, which means it has the potential to exacerbate health inequalities.

Covid-19 may have changed the way exercise rehabilitation programmes are delivered for ever, as patients with long-term conditions recalibrate their perceptions of safe distance and we live with the threat of second waves of Covid-19 and the emergence of other viruses (Michaelis *et al.*, 2020). The robust evaluation of such programmes using qualitative as well as quantitative methods, accompanied by the sharing of "best practice" knowledge and experience, is vital for addressing unanswered questions. A more established evidence-base will help determine whether video conferencing becomes a means of providing minimum standards of care for individuals unable or unwilling to travel to exercise facilities or an enduring mainstay component of clinical exercise support long after this pandemic has passed. ■

Prof John Saxton FBASES

John has been researching the important role that physical activity plays in the prevention and management of chronic non-communicable diseases for two decades. He is a BASES accredited sport and exercise scientist.

References:

BACPR. (2020). British Association for Cardiovascular Prevention and Rehabilitation Online Conference, 2 October, 2020. Available: https://eu.eventscloud.com/website/2769/agenda/

Brooks, S.K. *et al.* (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet, 395(10227), 912-920.

Foster, H.M.E. *et al.* (2020). Understanding how much TV is too much: a nonlinear analysis of the association between television viewing time and adverse health outcomes. Mayo Clinic Proceedings, S0025-6196(20)30480-8.

Greenhalgh, T. *et al.* (2020). Video consultations for covid-19. BMJ, 368:m998.

Michaelis, M. *et al.* (2020). The pandemic is an opportunity to change our health behaviour for good. The Conversation. Available: https://theconversation.com/the-pandemic-is-an-opportunity-to-change-our-health-behaviour-for-good-144023

Ofcom. (2020a). Media Nations 2020 UK Report (published 5 August 2020, page 4). Available: https://www.ofcom.org.uk/__data/assets/pdf_file/0010/200503/media-nations-2020-uk-report.pdf

Ofcom. (2020b). Online Nation 2020 Report (published 24 June 2020, page 149). Available: https://www.ofcom.org.uk/__data/assets/pdf_file/0027/196407/online-nation-2020-report.pdf

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Reviews - books and podcasts

App Name: **Polar Beat**
App Developer: **Polar**
App Cost: **Free**
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Polar Beat's features and functions are largely as advertised. The functionality exceeded my requirements and expectations. The app is incredibly easy to use. The initial setting up of personal data and pairing with my Polar H7 heart rate sensor was straightforward. When beginning an exercise session, it was simple to select from the extensive 100+ choices available. The app tracks exercise heart rate and provides a summary of each workout. Recent additions to the app include targeted training, indicators of energy contribution, a running index and a fitness test facility. There may be alternative products available on the market but Polar has done a good job of integrating all these functions into one easy to use application. I would like to see an information section that explains how calories are calculated and the results of the fitness test generated. You can locate this information online but it would be useful to have it all in one place. The app does not connect to third party devices. It is designed to work with Polar products (which it does very well!) but there is no functionality to connect to a laptop to export workouts, etc. This would be a handy function to have.
CHRIS KITE, ASTON UNIVERSITY
Rating 8/10

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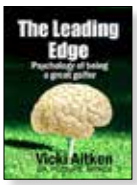
I couldn't wait to read Dr Steve Ingham's second book, *The First Hurdle: A Guide to Searching, Applying and Interviewing for Jobs in Sports Performance*. Steve has done it again! The book did not disappoint at all. It is a real page turner and very much lives up to the title. A book about achieving your dream job sounds as dull as ditch water. However, the invaluable advice and wisdom Steve openly shares, from his years of working and recruiting in high performance sport, are articulated in such an enthusiastic, humorous and grounded way that it is never a boring read. At the start of each chapter I liked the "guiding philosophy" that sets the tone for the information to come. The chapters are presented logically, from CV writing to the interview itself. In addition to the traditional panel interview, tips for group interviews, practical tests, video pitching and online interviews are discussed. Within the appendix, pertinent information on unpaid internships and the different professional routes within sport is provided. Overall, this is an excellent and invaluable self-help guide for those seeking employment in sports performance. This is a must read for every student studying a sports science-related degree.
GAVIN THOMAS, UNIVERSITY OF WORCESTER
Rating 10/10



The Leading Edge: Psychology of Being a Great Golfer
Aitken, V. (2020)
Self-published
Kindle £7.74
from www.amazon.co.uk

As a keen golfer in my younger days, prone to throwing the odd club in a fit of pique, I was eager to get my hands on *The Leading Edge*. The author has a wealth of knowledge and experience in golf as a player, coach and researcher. This self-published book is written as an extension and elaboration of Bob Rotella's seminal work. It is aimed at golfers of all levels, providing them with a self-help guide to enhancing their psychological skills. The main content areas are preparation, play and course management from a psychological perspective. *The Advanced Toolbox* chapter is particularly pragmatic, demonstrating how to integrate mental skills training techniques ("the canon") into pre-shot routines and practice drills. I also enjoyed the discussion around different formats of the game, stroke play versus match play. The chapter on course management also taps into the wisdom of experienced tour caddies (see Aitken's previous book, *Caddy-Talk*). I found the language, at times, slipped towards the academic, which may be a turn off for some. Nevertheless, this book should provide tangible benefits to every golfer out there. For the price of a couple of golf balls, this is well worth a read.
RICHARD SILLE, LIVERPOOL JOHN MOORES UNIVERSITY
Rating 7/10

Perception & Action Podcast

Having recently celebrated its fifth anniversary, the *Perception & Action Podcast* is a must-listen for those who want to delve deeper into the Constraints-Led Approach. Hosted by Dr Rob Gray, an Associate Professor in Human Systems Engineering at Arizona State University (USA), the show covers a wide range of topics related to skill acquisition like periodisation, technology and talent identification. Dr Gray often welcomes renowned guests like Anders Ericsson, Keith Davids and Joe Baker. Episodes 87 to 89 provide a great introduction to the Constraints-Led Approach for those still looking to familiarise themselves with its philosophical underpinning and the meaning of some key concepts. Furthermore, Dr Gray has also produced special series dedicated to the legacies of key figures in the Constraints-Led Approach like James Gibson and Nikolai Bernstein. The podcast's show notes are true gems, including links to the papers discussed and other multimedia resources. There is also a video version for those who prefer to watch the discussions. The sound is usually good, depending on the quality of remote calls, but the combination of meaningful themes, consistency and enthusiasm of its host make the *Perception & Action Podcast* a model for those who aspire to create a podcast.
FRANCISCO DE SA FARDILHA, UNIVERSITY OF STIRLING
Rating 10/10

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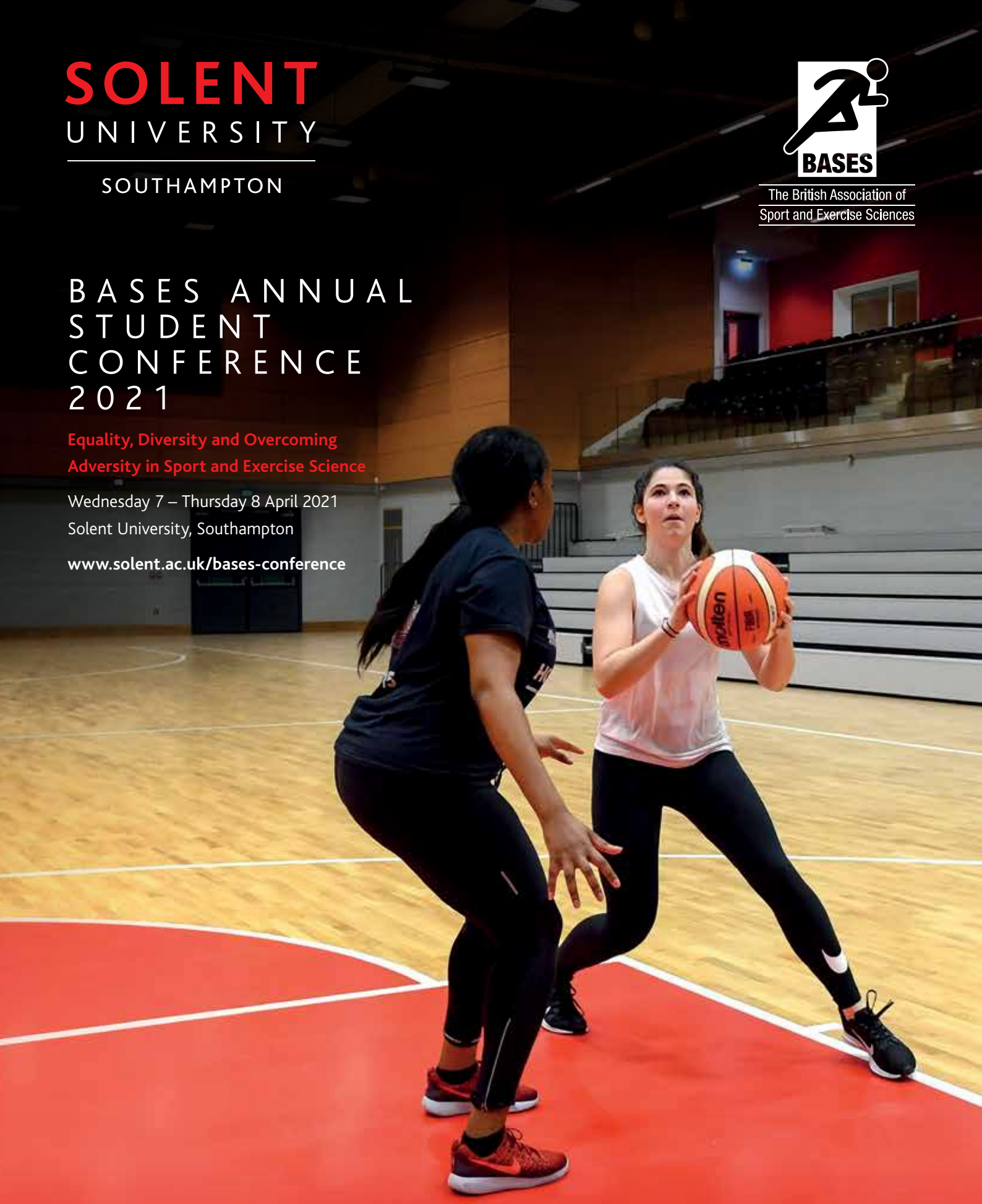

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#ProjectThrive: the enabling of better persons and performers

Dr David Fletcher shares his work on supporting high achievers' well-being alongside their performance.

Introduction

Occasionally in life something stops you dead in your tracks. This happened to me last year when I settled down to read a newspaper and came across an article about an American student-athlete named Kelly Catlin. Kelly was a postgraduate student at Stanford University studying computational and mathematical engineering, and an elite cyclist having won three world championship titles and a silver medal at the 2016 Olympic Games. As a performance psychologist, I was immediately drawn to Kelly's story because not only was she achieving at the highest level, she was doing so in two intensely demanding arenas. As I eagerly read further, however, I was stunned to learn that Kelly had died by suicide 2 days earlier. She was 23 years old.

Kelly was a paragon of performance excellence and, it would appear, had everything to live for. In addition to having a realistic chance of winning a gold medal at the Tokyo Olympic Games and the prospect of a career in Silicon Valley, she played classical violin, was fluent in Chinese, and was loved by family, friends and her peers - how could Kelly find no reason to keep living? In the weeks following her death, however, some accounts of Kelly's state of mind emerged.

In the months before her death, Kelly had been writing a blog in which she stated that managing her graduate studies alongside her cycling career was like "juggling with knives" and "I really am dropping a lot of them," and in an e-mail to her parents, a coach and a friend that her thoughts were "never-ending spinning, spinning, spinning" as if they were "never at rest, never at peace." Her father, Mark, a pathologist, subsequently wrote a memo putting her death down to a combination of factors, including various personality traits and environmental stresses.

Thriving or surviving?

Over the past couple of decades, I've researched and consulted with high achievers from a variety of performance domains, including Olympic and world champions from a range of sports, special forces and military personnel, and senior leaders and their teams in FTSE 100 and Fortune 500 companies. Although being very successful at what they do, I have observed that for some (if not for many) their accomplishments have come at a heavy cost. Their extreme drive to succeed, sometimes characterised by obsessional, perfectionistic, ruthless and/or selfish tendencies, combined with them constantly seeking out challenging situations, was taking a toll on their health and well-being. These high achievers were not displaying the *complete* physical, mental and social well-being considered essential for human health.

This was no more apparent to me than during the build-up to the London 2012 Olympic Games. Many of the athletes I was supporting and observing were performing better than ever, and so it proved as Team GB won more medals than at any other Games in living memory. But, behind the scenes, some of the athletes were exhibiting worrying symptoms of mental ill health such that their psychological functioning in daily life was impaired. Put another way, although outwardly they were excelling as performers, inwardly some were merely surviving as persons.

As much as I respect and want to support high achievers in their quest for success, I was increasingly questioning the price some of them were willing to pay in their endeavors. I undertook further professional development in mental health first aid and treating clinical psychiatric disorders but, after a chance encounter with Gretchen Rubin (2009) and hearing about her *Happiness Project* to discover what proactively leads to true contentment, I realised that to more effectively support this unique group of individuals, I needed an approach that *enabled* high achievers' well-being *alongside* their performance. The concept that I felt best represented this objective was thriving.

The evolution of #ProjectThrive

Following the London 2012 Olympic Games, I began what has evolved into an ongoing project to better understand and support human thriving. My mission was simple: to enable people, teams and communities to be better persons and performers. To underpin this project, I developed a line of research investigating thriving in high achievers (Brown *et al.*, 2017b; Sarkar & Fletcher, 2014) with the aim of advancing knowledge of the joint experience of development and success (Brown *et al.*, 2017a; Fletcher, 2019). At the same time, I spoke with high achievers from multiple performance domains and established three guiding principles and values for the project.

#ProjectThrive: guiding principles and values

1. Ethically grounded: decision-making guided by the fundamental principles of respect, competence, responsibility and integrity.

2. Evidence based: practice underpinned by the best available research that attests to the robustness of constructs and the effectiveness of support.
3. Psychosocially informed: knowledge gleaned from principles and reflections from a range of psychological- and social-related scientific disciplines.

As the research was disseminated, it became apparent that there is an appetite across different walks of life to better understand how to better support high achievers. Professionals and organisations were hungry to distill the main findings of the project to provide insight and direction to their own work. I have found that using a model (see Figure 1) has been particularly helpful in facilitating understanding of human thriving and initiating conversations about how to most effectively provide support in this area.

To be described as thriving, an individual must display evidence of development and success at that time in his or her life (Brown *et al.*, 2017a; Fletcher, 2019). The development aspect of thriving involves progressive improvement that may be physical, psychological or social in nature; for high achievers, this could respectively be refining a technical skill, developing mental strategies or integrating into a team. The success aspect of thriving involves personal achievement that may be mastery focused or self-referenced, or

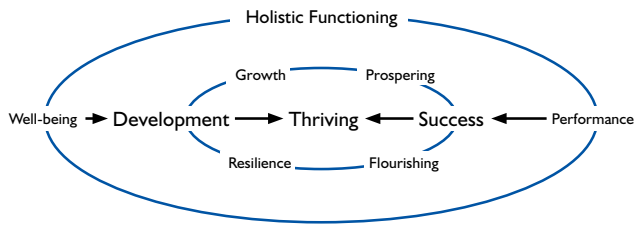

Figure 1. #ProjectThrive: a basic model of human thriving.

comparative or normatively focused in nature; for an athlete, this could respectively be posting a personal best time or winning a race. With these components in mind, thriving encapsulates other related concepts associated with human development and success, such as growth, prospering, resilience and flourishing.

To realise development and success, high achievers need to be functioning fully and effectively at a holistic level, typically indicated by high levels of well-being (e.g. physical, emotional, psychological, social) and performance (e.g. artistic, cognitive, motor, work) (Brown *et al.*, 2017a; Fletcher, 2019). High levels of well-being are important for thriving because of its association with the personal and social functioning necessary for development to occur. High levels of performance are important for thriving because of its association with the efficient and effective functioning necessary for success to occur. If high levels of well-being and performance are perceived across a series of situations, then the likely continual development and success will lead to sustained thriving (Brown *et al.*, 2017a; Fletcher, 2019).

A significant message of the model is that indications of both high levels of well-being and performance are required for thriving (Brown *et al.*, 2017a). If either is lacking then, although someone might appear to be thriving (e.g. successful in their performance domain), he or she should not/cannot be described as thriving as a human being (e.g. due to a lack of personal development and well-being). This is particularly relevant for high achievers who may seem to be accomplished individuals but, in reality, may be deficient in some important areas of life. This is not only a superficial form of functioning because these individuals may be struggling behind the scenes, it is also a fragile form of functioning because if the basis of their achievements is compromised for any reason, they will be left very psychologically vulnerable.

In applying the model to support high achievers, I have made a number of observations. First, the notion of thriving typically changes over time at different ages and across the lifespan. What "works" for a high achiever at one point in time might not be effective at another, so support should continually adapt and evolve accordingly. Second, thriving is contextual and experienced differently across areas of life and/or in specific scenarios. Just because an individual is high achieving in one domain doesn't mean that he or she will be thriving in another. Third, high achievers are, by definition, social outliers with unique characteristics and needs that should be recognised. This means that support should, as far as practically possible, be individualised and "fit" the specific requirements of a high achiever and his or her surroundings. Fourth, the environment and those operating within it should cultivate caring and compassionate relationships. Although high achievers desire constructive challenge to raise their performance levels, a nurturing culture is fundamental for supporting their aspirations and well-being. Fifth, accountability for thriving does not lie with an individual person but rather with everyone who directly or indirectly influences them and/or others. There should be a shared responsibility for high achievers' thriving whereby it is everybody's business.

Psychologists' role

At Kelly's burial, her sister, Christine, slipped a handwritten note into her coffin before it was closed, that included these words, "Kelly, if I could trade my life for yours, I would. I love you without all your accomplishments." No-one should go through what Kelly and her family suffered. There needs to be a greater awareness of the psychology of thriving on the part of high achievers themselves, those who support them, and their family and friends. Particularly noteworthy is how aspects of high achievers' psyche and environment can, sometimes, enhance performance whilst compromising well-being or vice versa. It is essential that high achievers have access to expert and trusted professionals who are able to collectively provide holistic support across lifestyle, rest, recovery, health and other related areas. Psychologists have an important role to play not only in supporting high achievers from all walks of life, but also in advising governments and organisations on creating environments that enable well-being alongside performance. ■

If you, or someone you know, have been affected by any of the issues addressed in this article, please refer to the following:

- www.nhs.uk/conditions/stress-anxiety-depression
- www.nhs.uk/using-the-nhs/nhs-services/mental-health-services/where-to-get-urgent-help-for-mental-health
- www.nhs.uk/conditions/suicide

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References:

Brown, D.J. *et al.* (2017a). Human thriving: A conceptual debate and literature review. European Psychologist, 22, 167-179.

Brown, D.J. *et al.* (2017b). Thriving on pressure: A factor mixture analysis of sport performers' responses to competitive sporting encounters. Journal of Sport and Exercise Psychology, 39, 423-437.

Fletcher, D. (2019). Thriving. In D. Hackfort, R.J. Schinke & B. Strauss (Eds.), Dictionary of sport psychology: sport, exercise, and performing arts (p.303). London: Academic Press.

Rubin, G. (2009). The happiness project. New York City, NY: HarperCollins.

Sarkar, M. & Fletcher, D. (2014). Ordinary magic, extraordinary performance: Psychological resilience and thriving in high achievers. Sport, Exercise and Performance Psychology, 3, 46-60.

The BASES Expert Statement on Human Performance and Health in Cold Environments

Produced on behalf of the British Association of Sport and Exercise Sciences by Profs Greg Whyte OBE, FBASES and Mike Tipton MBE.

Background and evidence

Environmental conditions can have a profound impact on human performance and health. Excessive cooling can impair performance and cold is one of the largest killers of sports people in the UK (Whyte *et al.*, 2014). Accordingly, management of the cold is important. This expert statement examines the impact of cold environments on performance and health, and ways of mitigating these problems.

Performance

Performance in the cold can be impaired by cooling of nerves, muscles and deep body temperature. Below a local tissue temperature of 20°C the firing rate, conduction velocity, amplitude and repolarisation of action potentials is slowed. Nerve block can occur at local temperature of 5-15°C for 1-15 minutes and maximum power output falls by 3% per °C fall in muscle temperature, with physical incapacitation occurring at a temperature of about 27°C (Castellani & Tipton, 2015). The rate of force application is particularly affected with an increased motor unit recruitment to maintain force production (left shift in EMG power frequency). Muscle spindle activity, twitch force and stretch reflexes are decreased. Enzymatic activity, rate of ATP utilisation, acetylcholine and calcium release and uptake, and muscle tendon elasticity are all reduced. Reductions in muscle blood flow result in an earlier contribution from anaerobic metabolism, higher plasma lactate concentrations and a shorter time to exhaustion (Whyte *et al.*, 2014).

With a reduced deep body temperature, the superimposition of shivering on low intensity exercise metabolism increases the oxygen consumption and cardiac output for any given submaximal workload; thereby decreasing exercise economy, increasing carbohydrate oxidation rates and hastening glycogen depletion and fatigue (Castellani & Tipton, 2015). A decrease in deep body temperature of 0.5°C-1.5°C results in a reduction of 10-40% in the capacity to supply oxygen to working muscles due to a left-shift in the O_2 dissociation curve. With more profound muscle cooling, anaerobic energy production is impaired. Maximum oxygen consumption ($\dot{V}O_2max$) is reduced by 10-30% following a 0.5-2°C fall in deep body temperature. Stride frequency increases and stride length decreases, concomitant with an increase in slips, trips and falls (Whyte *et al.*, 2014).

Dehydration is common in cold environments because thirst is blunted, water is not always easily available (frozen) and respiratory water loss can be high in cold dry environments. Cold exposure can also result in a cold-induced diuresis due to vasoconstriction and raised central venous pressure; although this can be prevented by moderate intensity exercise (Whyte *et al.*, 2014). In addition to a performance decrement, the combination of exhaustion (cessation of exercise), hypoglycaemia, dehydration and hypothermia can represent a significant health threat during exposure to the cold (Golden & Tipton, 2002).

Health

Threats to health in cold air environments include: frostbite, non-freezing cold injury and hypothermia. Additional threats in cold water resulting from its greater cooling capacity include: cold shock leading to drowning and cardiac issues (Whyte *et al.*, 2014). A number of pre-existing conditions (e.g. asthma, Raynaud's disease, hypertension) can be exacerbated by exposure to cold environments. Prolonged working in the cold can result in hypertension, mild respiratory impairment (airflow limitations, bronchial hyper-responsiveness) and increased incidence of musculo-skeletal complaints (Tipton, 2019).

Frostbite and non-freezing cold injury

Skin cooling is accentuated by peripheral vasoconstriction. The extremities that are most affected due to their high surface area to mass ratio, and the fact that their major source of heat, blood flow, has been restricted. The incidence of cold injury begins to increase when air temperatures fall below -12°C and wind speed exceeds 4.5 $m.s^{-1}$ (see Table 1.). These thresholds are reduced at altitude due to augmented vasoconstriction caused by hypoxia. Females and individuals of African descent are more at risk of cold injury due to differences in the thermal sensitivity of their peripheral circulation (Whyte *et al.*, 2014).

Frostbite. Human tissue freezes at -0.53°C. With rapid cooling, intracellular freezing occurs and ice crystals cause direct mechanical disruption of the tissues. Slow cooling causes predominantly extracellular water crystallisation. Osmotic outflow then leads to intracellular dehydration, damage to capillary walls and cell death. Local hypoxia and the release of inflammatory mediators result in increased blood viscosity, capillary sludging, endothelial injury, platelet aggregation, vessel thrombosis and gangrene (Francis & Oakley, 1996).

Non-freezing cold injury. The pathogenesis and pathology of non-freezing cold injury is less understood. Prolonged exposure to cold and cold/wet condition can result in life-long cold sensitivity, hyperhidrosis, intractable pain, bone/joint damage and gait changes. These symptoms probably result from small fibre neuropathy (due to direct cooling) and local vascular endothelium damage (due to cold-induced ischemia) (Whyte *et al.*, 2014).

Hypothermia

Defined as a fall in deep body temperature below 35°C, the clinical features of hypothermia include:

- Mild (35-32°C) - shivering, mild incoordination, cold axilla, tachycardia, tachypnea, diuresis, amnesia.
- Moderate (31-28°C) - apathy, clumsiness, slurred speech, weakness, semi-consciousness, fatigue, dehydration.
- Severe (<28°C) - bradycardia, cardiac arrhythmia, ventricular fibrillation, hypotension, pulmonary oedema, muscle rigidity, fixed dilated pupils, and possible fatality (Francis & Oakley, 1996).

There are many risk factors for hypothermia, including: climatic conditions, age, body stature/morphology, sex, fitness, nutritional status, fatigue, injury, intoxication and clothing (Whyte *et al.*, 2014).

Water immersion

On initial immersion rapid cooling of the skin initiates "cold shock" that includes: a "gasp" response, hyperventilation, hypertension and increased cardiac workload. These can be precursors to drowning and cardiovascular problems. In situations where the face is also immersed, co-activation of sympathetic and parasympathetic inputs to the heart can produce "autonomic conflict," resulting in potentially fatal arrhythmias in a variety of sporting situations (i.e. open water swimming, triathlon). Approximately 60% of cold water immersion deaths generally occur within the first minutes of immersion, long before hypothermia occurs (Tipton, 2013).

Mitigating the threats of cold environments

Limiting exposure. Indices (e.g. Table 1 - wind chill) help identify the risk of cold injury. Limiting exposure time and appropriate clothing, hydration, nutrition strategies can reduce the deleterious impact of the cold. International governing bodies of sport have set temperature limits for competition to reduce the risk of injury.

Clothing. In air, the heat produced by exercise is usually sufficient to offset that lost to a cold environment, particularly when combined with the careful use of clothing. Clothing should:

- Prevent flushing of cold air/water beneath the garment
- Trap air close to the skin
- Enable adjustments in insulation (e.g. layers) to cater for changes in heat production
- Be windproof
- Wick moisture away from the body
- Be vapour permeable.

Table 1. Wind chill (effect of wind speed on cooling)

	Ambient Temperature (°C)									
	4	-1	-7	-12	-18	-23	-29	-34	-40	-46
Wind Speed (mph)	**Wind Chill (Equivalent) Temperature (°C)**									
5	2	-4	-12	-15	-21	-26	-32	-37	-43	-48
10	-1	-9	-15	-23	-29	-37	-34	-51	-57	-62
15	-4	-12	-21	-29	-34	-43	-51	-57	-65	-73
20	-7	-15	-23	-32	-37	-46	-54	-62	-71	-79
25	-9	-18	-26	-34	-43	-51	-59	-68	-76	-84
30	-12	-18	-29	-34	-46	-54	-62	-71	-79	-87
35	-12	-21	-29	-37	-46	-54	-62	-73	-82	-90
40	-12	-21	-29	-37	-48	-57	-65	-73	-82	-90
	Less Danger			**Increasing Danger. Flesh may freeze within a minute**			**Great Danger. Flesh may freeze within 30 seconds**			

*Equivalent temperature = environmental temperature that would have the same effect on bare skin in the absence of any wind (equivalent cooling power).

Adaptation and acclimatisation to cold

In water, the cold shock response subsides after 1-2 minutes. It is best to do as little as possible during this period ("float first") to avoid aspirating the small volume of water necessary (1.5 L salt water) to start the drowning process (Golden & Tipton, 2002).

The most frequently reported acclimatisation is characterised by a reduced shivering response (habituation), faster fall in deep body temperature ("hypothermic adaptation") and increased thermal comfort. The acclimation is specific to the deep body temperatures experienced during acclimatisation. The hazardous initial responses to cold water immersion can be reduced by as much as 50% by as few as five 2-minute immersions in cold water. This habituation appears to last for several months (Tipton, 2013).

Out of hospital treatment

Mild hypothermia: warm drink, external active re-warming.
Moderate and severe hypothermia: critically ill, handle carefully, passive slow (0.75-1 °C.h^{-1}) rewarming - insulate and evacuate.
Frostbite: evacuate, rewarm only if re-exposure and further trauma are unlikely and follow-up treatment available. Do not rub injured area. Immerse in whirlpool bath with antiseptic added (38 °C) until red/purple colour and tissue is pliable.
Non-freezing cold injury: remove outer clothing (i.e. boots and socks), slightly elevate limb. Insulate area (do not rewarm rapidly), expose to warm air. Encourage movement of affected tissue (i.e. toes and ankles).

Above: The impact of cold environments
Courtesy Prof Greg Whyte OBE, FBASES

Drowning: basic life support compressions and ventilations (2 rescue breaths then cardiopulmonary resuscitation at 30:2 ratio). Provide high inspired oxygen as soon as possible.

Summary

Cold can decrease performance and threaten health. Limiting exposure, appropriate clothing/protective equipment, hydration and nutrition, and acclimatisation can help mitigate these problems. ■

Prof Greg Whyte OBE, FBASES

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Prof Mike Tipton MBE

Mike is Professor of Human & Applied Physiology at the Extreme Environments Laboratory, School of Sport, Health & Exercise Science, University of Portsmouth, UK.

References:

Castellani, J.W. & Tipton, M.J. (2015). Cold stress effects on exposure tolerance and exercise performance. Comprehensive Physiology, American Physiological Society Section 14. Handbook of Physiology, Environmental Physiology.

Golden, F. & Tipton, M.J. (2002). Essentials of sea survival. Champaign, Illinois: Human Kinetics.

Saycell, J. *et al.* (2018). Scientific rationale for changing lower water temperature limits for triathlon racing to 12 °C with wetsuits and 16 °C without. British Journal of Sports Medicine. 0, 1-8. doi:10.1136/bjsports-2017-098914

Tipton, M.J. (2013). Sudden cardiac death during open water swimming. British Journal of Sports Medicine, 10.1136/bjsports-2012-092021

Tipton, M.J. (2019). Cold. In P. Brukner & K. Khan (Eds.), Brukner & Khan's clinical sports medicine (5th edition), Volume 2 (Exercise Medicine). AU: McGraw-Hill Education.

Whyte, G., Loosemore, M. & Williams, C. (2014). ABC of Sports & Exercise Medicine (4th edition). London: BMJ Books.

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Winter's principles of sport and exercise science

Dr Alan Ruddock FBASES and Profs Rob Copeland, David Broom FBASES and Jon Wheat provide insights into the lessons learned from Prof Edward Winter FBASES.

Introduction

Edward Winter was Professor of the Physiology of Exercise at Sheffield Hallam University for more than 20 years, a founder member of BASES and made a sustained and substantial contribution to the Association for more than 35 years; he sadly passed away on 18 July 2020. In this article we share some of the lessons Edward taught us, as an inspirational teacher, nurturing colleague and mentor, co-author, supportive friend and bastion of science.

Edward's approach to teaching

"Science appears to us with a very different aspect after we have found that it is not in lecture rooms only, but that we may find illustrations of the highest doctrines of science in games and gymnastics, in travelling by land and water, in storms of the air and of the sea, and wherever there is matter in motion." - James Clerk Maxwell (1831-1879) - Introductory lecture on elementary physics (Cambridge, 1871).

Edward would start each academic year with the above quote, which exemplifies his approach to teaching. Traditional lectures and laboratory practicals were a mainstay, but he supplemented theory with seemingly innumerable examples of the applications of science to occupation, combat and aviation, which underpinned the first principle.

Edward's principles

1. Science is simply a way of working, consisting of: 1) observations; 2) research questions; 3) hypotheses; 4) experimentation; 5) analyses; 6) outcomes; and 7) broadcasting (not dissemination as only males can do this, from Latin dis-semen). The term "bad science" is, therefore, a misnomer, because if principles and practices of science are relinquished, work is not science. This simple seven-step process provides a framework for conducting science and importantly evaluating what is, and is not, science - which in the information age, is a handy tool (Winter, 2010).

Sport and exercise science is, therefore,…

2. The scientific study of factors that influence the ability to perform exercise.

Exercise defined as "planned, structured and repetitive bodily movement" on the surface appears to be an innocuous term, often used interchangeably with physical activity. However, the lesson here is in taking care to identify key terms; here, movement.

There are many examples in sports where movement is disadvantageous, such as in a crucifix, not discounting the benefits of fixator and stabilising muscles in dynamic activities such as running, cycling and swimming. Winter and Fowler (2009a) proposed a new definition of exercise that accounted for dynamic and static activity:

3. Exercise is "a potential disruption to homeostasis by muscle activity that is either exclusively or in combination, concentric, isometric or eccentric" (Winter & Fowler, 2009a; Winter *et al.*, 2016).

Definitions are important because they enable common understanding, form an essential basis for science, and are at the heart of critical thinking. It is tempting to accept popular terms and nomenclature as scientific. However,…

4. Scientists are bound by the principles of the Système International d'unités (SI). They should pay due diligence to the mechanical constructs of force, work, power, energy, velocity, impulse, momentum, efficiency, economy, effectiveness, mass and weight and use correct terms and nomenclature (Winter & Fowler, 2009a; Winter & Knudson, 2011; Winter *et al.*, 2016).

We should take care to understand the mechanical origins of metrics. For example, power, denoted as the eponymous Watt, has a specific definition and there are many activities, such as jumping, where the calculation of power alone cannot fully explain the outcome of movement.

The importance of understanding mechanical constructs and origins is exemplified in principle 5.

5. The function of muscle is "to exert force, and it does so by attempting to shorten" (Winter & Fowler, 2009a; Winter *et al.*, 2016).

Galen (c. 150 AD) proposed that muscle expands, consistent with the acute increase in girth that accompanies muscle activity. In 1663, Swammerdam isolated and suspended muscle in a sealed glass tube, with a single water droplet in a capillary to the top. The muscle was stimulated and twitched, but the water droplet did not move as would have been the case in Galen's function-by-expansion theory. Importantly, this simple experiment also demonstrated that muscle does not contract. Despite this finding almost 400 years ago, the use of the term "contraction" to describe muscle activity perpetuates. Indeed, misuse of "contraction" is not alone in sport and exercise science.

6. Terms such as "workload" and "work rate" (which are mechanically imprecise and colloquial) should be abandoned and the terms "intensity of exercise" and "domains of exercise" should be adopted because of their clarity and universal applicability (Winter & Fowler, 2009a; Winter *et al.*, 2016).

Similarly, because of their clarity and universal applicability…

7. Scalar quantities such as time (s), distance (m) and speed ($m \cdot s^{-1}$) might be all that is needed, and preferable over, for example, power, to assess performance (Winter & Fowler, 2009a; Winter *et al.*, 2016).

Above: Prof Edward Winter FBASES

Indeed, "power" and derivatives of metrics in principle 7 should only be used if they adhere to strict definitions that enable scientists to describe and explain outcomes better than first principles. If they do not, work risks becoming the antithesis of principle 8.

8. Use a writing style that upholds the scientific requirements for precision, clarity and conciseness (Winter, 2005).

As section editor for the *Journal of Sports Sciences*, Edward often observed misapplied vernacular, tautology and superfluity. Common examples included:

- "This study looked at." Studies do not look; they "investigate, examine or explore."
- There are many different types." "Different" is not required.
- "In order" used as a prefix but its omission makes no difference to the meaning of a sentence.

This principle also extends to the presentation and interpretation of findings.

9. Do not confuse significance with precision of measurement. Consider whether "a significant finding" refers to "significance" in a statistical or practical sense. Relating to the latter, "is the finding meaningful?" (Winter, 2008a).

On meaningfulness, which is arguably more important than statistical significance…

10. Does the intervention work? If yes, how well? Does it exceed the minimum important difference? How precise is the estimate of how well the intervention works? Is the intervention cost-effective? (Winter *et al.*, 2014).

Authors can *a priori* state an important difference, use confidence intervals to assess precision of estimates, and importantly appraise the time and financial costs of an intervention to judge practical application. The latter is important because if sport and exercise science is to have a continued positive impact, it must be accessible in some form to all corners of society.

In this manner…

11. Outcomes from research should be stated clearly, simply and unequivocally and answer the "so-what?" question (Winter & Nevill, 2014).

Dr Ruddock remembers a conversation with Edward. "I asked him for advice on reviewing a manuscript. Edward asked me to recall the practical application of the study, then repeatedly asked, 'So what?' until I found the real importance of the work. It took five 'So what?' questions to find this base. I passed the findings of Edward's interrogation, along with principle 12, to the authors who were grateful for the insights."

12. Two simple questions define good work: First, does the work advance knowledge and understanding. Second, will the work change practice? (Winter & Nevill, 2014; Winter *et al.*, 2014).

Principle 12 was always at the heart of PhD programmes, doctoral training workshops he provided for students in the faculty and vivas. However, ostentatious statements associated with novel findings were tempered by historical references.

13. Just how new is new? Consider the works of Hippocrates and Galen who attended to the surgical and medical needs of gladiators, the formalisation of science in the Renaissance, notably Santorio and Galilei (1600s), and the formulation of the laws of Thermodynamics forged by the industrial revolution (1700s) (Winter, 2008b).

Important lessons can and should be learned from history. Some might consider aspects of the above semantics. However, principle 14 should be unequivocally and universally accepted by all scientists.

14. Humans are *participants* in research, not *subjects*. The latter is associated with crimes against humanity during the Second World War (Winter & Maughan, 2009). Freezing, infection and treatment of typhus, transplantation of limbs and making seawater drinkable were just some of the appalling ways humans were *subjected* to experiments, in which death was considered a necessary outcome to improve the chances of Nazi survival in war (Winter, 2008c). Participants provide informed consent, volunteer for, and can withdraw from studies at any time per the Declaration of Helsinki, the internationally recognised ethical standard.

Remember…

15. "Everything's already been said before, but since nobody was listening, we have to start again." (Andre Gide (1869-1951) (Winter *et al.*, 2016).

We encourage all readers to apply Winter's principles of sport and exercise science. They are a distillation perhaps, but certainly a continuation of Edward's attempts to uphold science in sport and exercise. ■

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Prof Jon Wheat

Jon is Associate Dean, Research and Innovation in the College of Health and Wellbeing at Sheffield Hallam University. He remembers Edward for his insight, grace and integrity.

References:

Winter, E.M. (2005). Writing: Bartlett revisited. Journal of Sports Sciences, 23(8), 773-773. https://doi.org/10.1080/02640410500217156

Winter, E.M. (2008a). Use and misuse of the term "significant". Journal of Sports Sciences, 26(5), 429-430. https://doi.org/10.1080/02640410701786827

Winter, E.M. (2008b). Sport and exercise science: Just how new is new? Journal of Sports Sciences, 26(12), 1247-1248. https://doi.org/10.1080/02640410802321367

Winter, E.M. (2008c). Experiments: Why "participants" rather than "subjects"? The Sport and Exercise Scientist, 11, 12-13.

Winter, E.M. (2010). BASES-Present. The Sport and Exercise Scientist, 24, 8-9.

Winter, E.M., Abt, G.A. & Nevill, A.M. (2014). Metrics of meaningfulness as opposed to sleights of significance. Journal of Sports Sciences, 32(10), 901-902. https://doi.org/10.1080/02640414.2014.895118

Winter, E.M. *et al.* (2016). Misuse of 'Power' and Other Mechanical Terms in Sport and Exercise Science Research. Journal of Strength and Conditioning Research, 30(1), 292-300. https://doi.org/10.1519/JSC.0000000000001101

Winter, E.M. & Fowler, N. (2009a). Exercise defined and quantified according to the Système International d'Unités. Journal of Sports Sciences, 27(5), 447-460. https://doi.org/10.1080/02640410802658461

Winter, E.M. & Knudson, D.V. (2011). Terms and nomenclature. Journal of Sports Sciences, 29(10), 999-1000. https://doi.org/10.1080/02640414.2011.588821

Winter, E.M. & Maughan, R.J. (2009). Requirements for ethics approvals. Journal of Sports Sciences, 27(10), 985-985. https://doi.org/10.1080/02640410903178344

Winter, E.M. & Nevill, A. (2014). You've told me what you have found, but you haven't told me the so-what. Journal of Sports Sciences, 32(1), 1. https://doi.org/10.1080/02640414.2013.870698

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How can we become more inclusive researchers? A department's journey so far

Dr Emily Oliver shares the learnings of The Department of Sport and Exercise Sciences at Durham University about inequalities in the research process

Introduction

Increasing awareness of long-standing inequalities is currently driving global debate, reflection and overdue social change. Sport and exercise contexts have featured strongly in terms of inequalities in opportunities to be active during the Covid-19 pandemic, welfare in elite sport, and the increasing visibility of athletes as activists.

While as a sector we research issues relating to equality, diversity and inclusion, arguably our practices have not always fully embraced these ideals. To consider where this might be the case, for several years as a Department we have been working with our partners (including members of the public, professionals, charities and campaigning groups) to think creatively and critically about our *how* we research. Following the recent call from BASES to action, launching their Equality, Diversity and Inclusion Committee, we felt it was timely to share some of our learnings so far. Let us stress at the outset that we do not claim to have the final word or all the answers. We are still learning.

What follows is a summary of some of the questions that we, as a department, have grappled with. We wanted to move beyond initiatives that consider equality, diversity and inclusion in our own working environment (e.g. Athena Swan), although acknowledging that these have both a place and their critiques (e.g. Rosser *et al.*, 2019). Instead, we focused on the practices of "doing" sport and exercise science research.

We wanted to move beyond initiatives that consider equality, diversity and inclusion in our own working environment (e.g. Athena Swan), although acknowledging that these have both a place and their critiques (e.g. Rosser *et al.*, 2019). Instead, we focused on the practices of "doing" sport and exercise science research.

What do and don't we research?

As researchers, an attraction towards familiar issues, theories or methods shapes the questions we pose and the projects we pursue. Our knowledge base is further constrained by predominantly drawing from researchers and theorists who write in English. In the Department of Sport and Exercise Sciences (DSES) we have created opportunities as a team to reflect on and discuss our cognitive biases and we are working with a wider range of individuals to identify and generate priority research topics. We are addressing biases we have observed (e.g. towards male-only samples in physiological research) and sharing important translated papers.

Such biases can be exacerbated by research funding systems and panel compositions. For example, work exploring the lower rate of funding of African-American/Black scientists by the US National Institute of Health identified topic choice as a key factor (controlling for variables including track record). Approaches and topics more likely to be proposed by black applicants, including community interventions and health disparities, received less competitive scores from reviewers (Hoppe *et al.*, 2019). Discrepancies in the ability to allocate research and development funding within industry and also in elite sports can also narrow the fields in which we research.

What can sport and exercise scientists do?

- Work with a wide range of individuals and stakeholders to identify and fund priority research areas.
- Promote a diversity of reviewers on funding panels (internally and externally), including non-academic stakeholders.
- Work to remove policies and practices that perpetuate inequalities (e.g. inflexible contracts or funding systems) so that the sport and exercise science research community diversifies.

Who do we work with and how?

In the DSES we have challenged ourselves to think about how the same factors that influence engagement in other forms of public life (e.g. affluence, race, ethnicity and educational experience) are reflected across those we research with. Often the most vulnerable voices are missed. We recognised the need for us to work more with varied publics at all stages of the research process.

One positive experience within the department has been working with The McPin Foundation, who specialise in the recruitment, training and support of peer researchers with lived experience of mental health difficulties. Collaborating from grant application stage ensured necessary resourcing and developmental support for our peer researchers during the project. Wider good practices we have identified includes "going out" to communities rather than relying on them to contact us, and thinking creatively and flexibly about how opportunities to contribute are offered.

What can sport and exercise scientists do?

- Engage with the range of useful guidance on promoting inclusive engagement of non-academic stakeholders in research (e.g. UK Standards for Public Involvement in Research).
- Adopt and scrutinise (e.g. via ethics committees) policy and practices against standards for public involvement.

Who do we recruit and how?

When it comes to recruiting participants, in the DSES we recognised that standard practices are not inclusive. For example, the UK Government's *Skills for Life* survey identified that 1 in 7 adults in England have literacy levels at or below that expected of a 9 to 11-year old. How are many of our questionnaires, or perhaps more importantly information sheets and consent forms, accessible to those with poor literacy skills? Are we recruiting predominantly on-line, or through social media, like many of our physical activity surveys during Covid-19 pandemic? Lack of access to the internet may mean that the voices of those facing complex barriers to sport and physical activity are excluded. Recently, in the DSES some useful ways of widening recruitment have included working with

partners and local user-groups, for example Disability Rights UK, to develop an accessible survey, and using print media and community newsletters to reach older football fans.

What can sport and exercise scientists do?

- Use non-academic reviewers and automated "readability" checkers to increase the accessibility of information, including making language or visual images more inclusive.
- Develop and validate inclusive versions of common tools or protocols.
- Ensure that materials and opportunities are available in a range of formats and shared in ways beyond just the internet.
- Work with charities, representative organisations and community groups to improve the reach of recruitment.

What data do we capture, analyse, report and share?

Too often it is unclear that a group is excluded or if a characteristic is important because it is not recorded. From our own work on inequalities in outdoor walking groups (Rigby *et al.*, 2020), we realised that even when demographic data is collected, it is rarely used to inform analyses in a theoretically-considered or intersectional way. A more thorough (and reflexive) approach to analysing participant data is required; ethics boards can usefully take a stronger stance in challenging unjustified inclusion or exclusion criteria (e.g. by age, gender, etc.).

In turn, in the DSES we are considering how we can foster more inclusive impact opportunities, through public facing resources, sharing open data and for co-constructed learning to be developed, rather than presenting prescriptive recommendations. Participatory workshops have been useful for considering the relevance of findings to participants' contexts.

What can sport and exercise scientists do?

- Routinely collect, or justify the exclusion of, a wider range of demographic variables. For example, all protected characteristics in UK law (cf. Equality Act, 2010), or the PROGRESS-Plus characteristics that stratify health outcomes and opportunities (O'Neill *et al.*, 2014).
- Promote and share de-identified open data through reliable platforms - enabling more organisations and individuals to interrogate our data in ways meaningful for them.

What next?

The above provides a flavour of our learning within the department and the challenges we all face when seeking to reduce inequalities within our research processes. We hope that both the general questions and more specific insights are useful; these are neither final nor complete. We are keen to stimulate wider discussion in our sector about how to engage in more inclusive research in the future. ■

Dr Emily Oliver

Emily is a Chartered Psychologist and an Associate Professor in the Department of Sport and Exercise Sciences, Durham University. The Department's work focuses on reducing inequalities and promoting social justice.

References:

Rigby, B.P., Dodd-Reynolds, C.J. & Oliver, E.J. (2020). Inequities and inequalities in outdoor walking groups: a scoping review. Public Health Reviews, 41, 4.

Hoppe, T.A. *et al.* (2019). Topic choice contributes to the lower rate of NIH awards to African American/black scientists. Science Advances, 5 (10), eaaw7238.

O'Neill, J. *et al.* (2014). Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. Journal of Clinical Epidemiology, 67 (1), 56-64.

Rosser, S.V. *et al.* (2019). Athena SWAN and ADVANCE: effectiveness and lessons learned. The Lancet, 393(10171), 604-608.

Performance data: less is more?

Dr Andy Renfree presents a case that practitioners may be best served by focusing on overall subjective perceptions of the athlete as opposed to isolated physiological or performance variables.

Introduction

Sport and exercise scientists, as well as athletes and coaches, routinely collect a wide range of physiological and performance data to assist the decision-making process informing the design and monitoring of physical training programmes. Although a vast array of affordable laboratory-based and wearable technology is now available to collect this data, ultimately users must still interpret its meaning and decide how to act upon it. Given the complexity of the factors determining human performance, this is clearly no simple task. In this short opinion piece, I argue that in many circumstances, the decision-making process may be best served by focusing on overall "gestalt" sensations (a phenomenon whereby the mind integrates multiple sources of perceptual information to produce an overall summary), rather than being concerned with isolated variables. Through use of such an approach, it is acknowledged that in complex systems the characteristics of the whole system are often greater than the sum of its parts.

What could we measure?

So, assuming we want to collect data on something during training, what should be collected? The obvious answer to this is the various markers of "external load." So, things such as how far or long (volume), how fast or heavy (intensity), and details of interval sessions, etc. These are very simple to calculate and provide an accurate picture of what work has actually been done. However, in isolation these metrics clearly do not provide the full picture - the goal of training is not to go as far or fast as possible, but to provoke an adaptive response. This depends not on the external load as much as on the degree of physiological stress imposed by the session, or the "internal load." It is easy to see how the two can become disassociated. A 16 km run completed by a well-trained athlete in 60 minutes with a howling tail wind would be expected to produce a lower degree of physiological stress than doing the same run in 70 minutes in the opposite direction.

To give us some indication of the more important internal load, we need some way of measuring the degree of physiological stress experienced, and also the acute response to this exercise stress. There are now lots of relatively cheap ways of doing this, and commonly used methods include assessment of heart rate, heart rate variability, blood lactate, blood glucose and more. Elite level athletes may have access to more sophisticated technology allowing monitoring of endocrine and inflammatory markers amongst other things. However, despite the availability of this technology, my suggestions as to the most useful data to collect would relate to more subjective measures of internal load and its associated responses, such as ratings of perceived exertion (RPE), muscle soreness and psychological state (e.g. mood and motivation); data requiring no more than a pencil and paper to collect. Why?

The problem of complexity

You, I and everything else in biology are complex systems and we operate within various environments, each of which also represents a complex system. Essentially, a complex system is one that displays properties that cannot be predicted based on knowledge of its components. These properties are generated by the interactions between the various components of the system, meaning that examination of the various components in isolation cannot explain the behaviour of the system as a whole, which is therefore considered an "emergent" phenomenon (I have previously written about athletic races being best considered as complex systems with pacing behaviour being an emergent phenomenon - Renfree & Casado, 2018).

It is the issue of these interactions that presents a problem when trying to decide what to monitor relating to internal load and physiological strain. Consider what happens if you try to predict the path of the balls on a billiard table if someone was to strike them hard with a cue ball:

"If you know a set of basic parameters concerning the ball at rest, you can compute the resistance of the table (quite elementary), and can gauge the strength of the impact, then it is rather easy to predict what would happen at the first hit. The second impact becomes more complicated, but possible; you need to be more

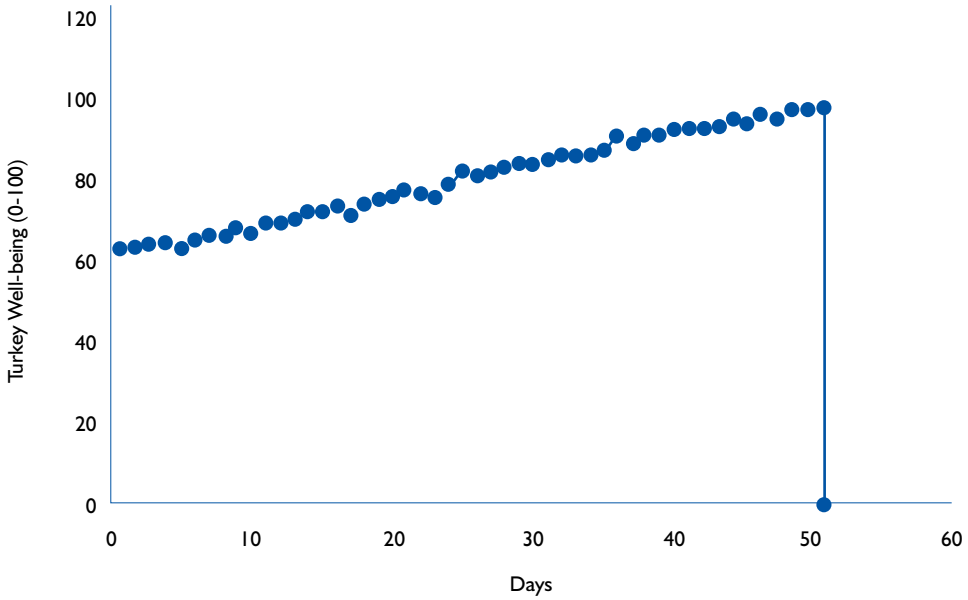

Figure 1. Well-being of a turkey over the 51 days after hatching. If you only collected data for the first 50 days of life, you may draw the (incorrect) conclusion that well-being increases with age.

This applied feature aims to address issues and areas that are often common in the real world, but are seldom covered by the usual learning mediums (university courses, journals, books, etc.). Please contact the editor if you have any ideas for future issues: **editor@bases.org.uk**

careful about your knowledge of the initial states, and more precision is called for. The problem is that to correctly compute the ninth impact, you need to take into account the gravitational pull of someone standing next to the table. And to compute the fifty-sixth impact, every single elementary particle of the universe needs to be present in your assumptions!" (Taleb, 2007, p. 178).

So, considering the difficulty in predicting the behaviour of balls hitting each other, consider how much more difficult it is to predict the behaviour of an individual consisting of billions of interacting cells. What this means is that if you want to be confident you are monitoring the relevant data you have to monitor everything. Of course, this is impossible, and we must also consider the possibility that there are crucial variables we have not yet discovered or appreciated the importance of. This is before we even get to the issue of understanding how the numerous components interact with each other. To paraphrase Donald Rumsfeld speaking at a 2002 news briefing - there are the known knowns, the known unknowns, but most importantly of all are the unknown unknowns.

In summary so far then, prediction in complex systems is exceptionally difficult, or even impossible, because of availability of incomplete information, large numbers of interacting variables combined with inability to measure them and likely measurement error. Even small errors in measurement of some variable may have dramatic impacts on predictions for the system as a whole. All of this means that measurement of only a handful of biological or performance markers is unlikely to give us the full picture with regards to how an individual is responding or is likely to respond to any training intervention.

Don't be a turkey

At this point somebody might say, "But by recording lots of data I can track progress and identify how things looked when things were going well," an argument that basically says you can see trends in the data. Imagine that you monitor any variable you can measure (variable x) and you notice over a period of a few weeks or months that as x decreases your ability to run a given distance quickly also improves. The obvious conclusion is that x is correlated with performance and is therefore worth measuring. However, you may also have fallen foul of the "Turkey Problem" (see Figure 1). Taleb (2007) talks of a turkey who for the first 50 days of his life associates the arrival of humans with the delivery of food, and therefore draws the conclusion that the humans have his well-being at heart. On day 51 though the turkey gets a nasty surprise!

Substitute "well-being" and "days" with for example, "performance" and "training volume" and you can see how similar errors may be made in interpreting training data. The other issue you have is that by collecting data over a relatively short timeframe you may miss out on the true pattern generating process - what looks linear may in reality only represent a small part of an oscillating pattern over the longer term.

Rules of thumb

If, as I argue, you cannot rationally decide what best to do based on measurement of isolated physiological variables, what can you do? In any situation where you have incomplete knowledge of options and likely outcomes (or a "large world" environment) then you need to rely on heuristics (Renfree *et al.*, 2014). Heuristics are a method of decision-making that ignore much of the available data and allow humans to solve problems without relying on complex statistical analysis. Crucially, heuristics have been shown to allow individuals to make better quality decisions in complex environments. At the most basic level, heuristics are little more than "rules of thumb."

What rules of thumb should be used then? In my opinion, if the athlete isn't motivated to train on a particular day, then this tells me something isn't quite right "under the bonnet." I don't necessarily need to know exactly what but I can fall back on the old adage of "if in doubt, don't." Similarly, if an athlete has delayed onset of muscle soreness (DOMS), I do not need to know the exact

Above: Don't be a turkey

levels of Creatine Kinase in the blood to know they are not yet recovered from previous training. My preference then is to focus on the overall experience of the athlete, admittedly based on the assumption that this is reflective of physiological status. Surely this is preferable to making training decisions based on incomplete and not fully understood data?

Be careful

I argue that use of athletes' overall gestalt sensations may be superior to more complex data pertaining to isolated physiological or performance variables in informing future training or conditioning decisions. However, it is acknowledged that there are potential limitations to this approach, and that the suggestion is not to simply do whatever you feel like. What an athlete "feels like" is not necessarily what they "need." Additionally, there are potential negative emotional outcomes if a highly motivated athlete feels guilty about failure to adhere to a prescribed programme. However, just as an engine warning light on a car dashboard indicates a problem without identifying the specific nature of that problem, changes in an athlete's sensations of well-being or motivation can act in them same way and indicate when the time has come to collect more specific data that may help explain the "malfunction."

Summary

This article has argued that the monitoring of athletes' overall perceptual sensations is likely to be at least as effective as, if not better than, complex physiological or performance data in informing future conditioning decisions. Rather than being overly simplistic, such an approach may provide a more accurate overall summary of condition than information relating to isolated variables. ■

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References:

Renfree, A. et *al.* (2014). Application of decision-making theory to the regulation of muscular work rate during self-paced competitive endurance activity. Sports Medicine, 44(2), 147-158.

Renfree, A. & Casado, A. (2018). Athletic races represent complex systems, and pacing behavior should be viewed as an emergent phenomenon. Frontiers in Physiology, 9, 1432.

Taleb, N.N. (2007). The black swan: The impact of the highly improbable (Vol. 2). New York, Random House.

Re-thinking sport and exercise science post-pandemic?

Dr Andy Smith MBE, FBASES and Prof Helen Dawes add to the debate about post-pandemic professional practice, research and curriculum development.

Introduction

This article adds to the debate about the future of sport and exercise science. We draw on information that members of the Association's Covid-19 Special Interest Group (SIG) have posted on their webpage and on contributions from members. This "many minds" approach that embraces shared data and open access is itself part of the rethink of science that began before the pandemic but has been accelerated by recent events. The context in which sport and exercise science operates is going to change radically over the coming months. This new context will be determined by the pandemic but also by climate change and Brexit. For those working in Higher Education the review of the National Student Survey and the agenda around freedom of speech are also going to reshape the landscape. At this moment of opportunity and challenge this article addresses three questions related to professional practice, research and curriculum development.

1. How might professional practice change?

Based on the contributions from Ash Wilmott (Anglia Ruskin University), Andrew Lane (University of Wolverhampton) and Mark Ross (Edinburgh Napier University), Figure 1 presents a starting point for thinking about how professional practice might change.

"Back to better" may involve engaging with the opportunities and challenges presented by multimorbidity, technology and interdisciplinary practice. Increasingly multimorbidity is a feature of the communities with whom sport and exercise science works. As an estimate around a third of adults have at least one long-term health condition (Kings Fund, 2013). People with multimorbidity have an increased risk of further illness and disease (e.g. Covid-19). Arguably exercise prescription in both health care and sports injury settings has focused on the condition (e.g. stroke) or the injury (e.g. fracture). Going forward we need to recognise that just because a group of people have the same condition does not stop them being individuals with different motivations, values and attitudes. As Dawes has argued this call for a shift to *condition informed exercise prescription* rather than prescription for diseases *per se* (see Busse & Ramdharry, 2020). When designing exercise programmes we should focus on the individual as well as the condition.

The pandemic has fast tracked the delivery of sport and exercise science using existing technology. As the fourth industrial revolution develops this trend is likely to accelerate. This will demand the profession to rethink how it blends face-to-face with remote delivery and how the next generation is trained.

We believe that the complexity of exercise prescription during the pandemic has highlighted the need for more multi- and interdisciplinary practice. For example, Health Professionals may have greater expertise and knowledge of pathology and disease-exercise interactions whilst Exercise Scientists' knowledge may be greater in exercise prescription. Bringing these professionals more closely together (as seen in Australia) is worth rethinking. The article by Dr Andrew Scott and Prof David Broom FBASES in this issue regarding a proposal for accredited clinical exercise physiologist status in the UK is a helpful step forward.

Going forward, the challenge is to train sport and exercise scientists to support people presenting with multimorbidity and to train them in the safe, effective and appropriate use of technology. We need to rethink how we train Professionals to give them the skills to problem solve and to adapt their practice safely and effectively in rapidly changing and complex situations.

2. What research questions should be prioritised in relation to sport and exercise science and Covid-19?

This question is addressed in three ways:

1. The research needed to underpin the potential changes in professional practice discussed above.
2. From an exercise immunological perspective.
3. In terms of the actual research that is being conducted across the UK.

Professional practice. Given that professional practice will increasingly be shaped by technology the following priorities are suggested:

- Exploring the extent to which digital technology and Artificial Intelligence can improve engagement, adherence and goal achievement.
- Determining whether technological innovation can improve exercise enjoyment thereby promoting active lifestyles.
- Investigating how technology can be used to support people to achieve a physically active lifestyle as they transition between wellness and illness and through life stages.
- Creating effective models of combined physical and virtual exercise delivery for people living in different contexts and environments.

Exercise immunology. Contributing to this article, Helen Hanstock (Mid Sweden University) suggested two general research strands.

1. The effect of having had Covid-19 on individuals' ability to exercise. How long before athletes should return to training after having been ill with Covid-19? For those who have been mildly and severely ill, are there any repercussions with regard to their ability to train and perform weeks, months and even years after recovery?
2. The effects of lockdowns and other restrictions on, for example, physical activity patterns, fitness and mental well-being.

Specifically, on exercise immunology, Helen wrote, "As an exercise immunologist I am also interested in susceptibility to Covid-19. Clinical risk factors were highlighted relatively quickly, but are there other predictors of susceptibility that may be important to understand, for athletes (e.g. training-related) or for the general population? Some of this research is almost certainly ongoing already, and will typically be observational in nature, but I believe there is an opportunity here with a new disease where prior exposure is less of a confounder. Another approach for more controlled studies could come in once a vaccine becomes available, for example by examining factors that affect the vaccine response."

Actual research. Table 1 summarises some of the research being conducted across the UK by members of the Covid-19 SIG. More details on these and other projects can be found at https://members.basport and exercise science.org.uk/spage-special_interest_groups-basport and exercise science_covid_19_.html

Table 1. Examples of research being conducted by members of the Covid-19 SIG

Member	Research title or summary
Dan Gordon (Anglia Ruskin University, Cambridge) and colleagues from the University of Northumbria. Contact - Dan.Gordon@anglia.ac.uk	Investigation into the impact of lockdown on physical activity and health in the blind and visually impaired in the UK.
Lindsay Bottoms and colleagues from University of Hertfordshire. Contact - l.bottoms@herts.ac.uk	• Physical activity habit formation during Covid-19 stay-at-home restrictions. • Working with Leon Paul a fencing equipment provider to help explore the concentration of gases being breathed in whilst exercising at fencing intensity (~83% heart rate max), wearing either a face mask or a face guard under a fencing mask.
Szekeres, de Oliveira, Zaidell and Mileva (London South Bank University). Contact - r.oliveira@lsbu.ac.uk	Understanding the barriers and motivation to exercise in older adults before and after the Covid-19 lockdown.
Mark Ross (Napier University). Contact - M.Ross@napier.ac.uk	Working with a group of cardiovascular researchers from the UK and Australia on determining the impact of Covid-19 on the cardiovascular system.
Nicola Buckland and colleagues from Sheffield Hallam University. Contact - n.buckland@sheffield.ac.uk.	Exploring changes in adults' physical activity during the Covid-19 lockdown.
Lindsy Kass (University of Hertfordshire) Contact - l.s.kass@herts.ac.uk	Effect of home confinement and flexible working patterns on physical activity and lifestyle behaviour during the Covid-19 outbreak.
Neil Maxwell (University of Brighton), Ana Bonell and Karen Forrest (London School of Hygiene and Tropical Medicine) and Behzad Nadjm (Medical Research Council, The Gambia) Contact - n.maxwell@brighton.ac.uk.	A project evaluating heat alleviation strategies in healthcare workers wearing personal protective equipment in The Gambia.
Melitta McNarry and Kelly Mackintosh (Swansea University) Contact - k.mackintosh@swansea.ac.uk	In collaboration with Sport Wales and all Welsh higher education institutes, the recently inaugurated Welsh Institute of PA, Health and Sport (WIPAHS), have appointed a 6-month Research Assistant (Dr James Shelley), to coordinate research activity across Wales related to Covid-19 and sport and exercise sciences.
James Faulkner (University of Winchester), along with 11 academics from 6 institutes, including Melitta McNarry and Kelly Mackintosh (Swansea University). Contact - James.Faulkner@winchester.ac.uk	A survey across numerous countries, including the home four nations, investigating the impact of lockdown on PA and mental health.
Melitta McNarry, Kelly Mackintosh and and colleagues from Swansea University. Contact - m.mcnarry@swansea.ac.uk	Sêr Cymru funded project to assess the effectiveness of inspiratory muscle training to address the persistent respiratory muscle weakness widely reported following infection with Covid-19.
Helen Dawes (Oxford Brookes University) and colleagues and partners from Oxford Health Biomedical Research Centre, Sheffield Hallam University and the University of Sheffield. Contact - hdawes@brookes.ac.uk	Symptom Tracking, Activity and Recovery (STAR-Long Covid).
Helen Dawes (OBU) is working with colleagues and partners at OBU and including the Safer at Home Network, Good Boost, University of Oxford, Oxford Health BRC, University of Sheffield, Sheffield Hallam University and 500More on a range of projects. Contact - hdawes@brookes.ac.uk	• Physical activity as a vital sign. • PAIDEIA: Using digital health to improve and protect mental wellbeing in university students and NHS clinical staff during the Covid-19 pandemic: a pilot study for an international randomised controlled trial (University of Oxford Medical Sciences Division). • Assessment of mobility and Gait and recovery using a smart phone in Covid (Innovate). • Remote AI-Exercise App for MSK (SBRI/Innovate).

3. What might a module entitled *Exercise and Covid-19* for Masters' students contain?

Ash Wilmott, Andrew Lane and Mark Ross have worked on a starting point for thinking about what a module might look like. Such a module could use a biopsychosocial approach to educate sport and exercise science to think of prescription across systems and disciplines, informed by pathology and disease alongside individual, family, community and population level contexts. It might include: what is Covid-19?; impact on the individual; past, current and future impact on society; case studies; impact of lockdown; and exercise immunology.

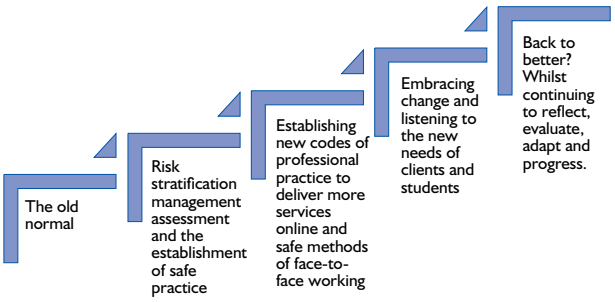

Figure 1. Steps toward a new professional practice.

Conclusion

How many of us saw the pandemic coming? Part of our rethink might be to ask, "What next?" A scenario that we should plan for is the impact of the economic downturn on sport and exercise science. Harris (2019) states that, "A phenomenon that is not predicted by the constituent parts and is more complex than the sum of its parts, is referred to as an emergent phenomenon." Arguably this is the best way to understand how the pandemic is reshaping sport and exercise science and, given the complexity of emergent phenomenon, why we need to think carefully about how our discipline is changing and how we want it to develop. Throughout the pandemic Andrew Lane has made a powerful contribution to the debate pointing out that, "A lesson learned from Covid is that a lot of what we do is to help others (wearing a mask being one)..." Perhaps it is this focus on helping others that should guide our thinking about the future of sport and exercise science. ■

Dr Andy Smith MBE, FBASES

Andy is a "retired" professor and Convenor of the BASES SIG on Covid-19. He is a co-author of the BASES Expert Statement on exercise and COVID-19 and the Position Stand on the "reopening" of Sport and Exercise Science departments in HE after lockdown.

Prof Helen Dawes

Helen is Professor of Movement Science and is supported by the Elizabeth Casson Trust and the NIHR Oxford Health Biomedical Research Centre. She co-designed a rehabilitation programme for Covid-19 patients for wide use in Hubei Province.

References:

Busse, M. & Ramdharry, G. (2020). Targeting sedentary behaviour in neurological disease. Practical Neurology, 20, 187-188.

Harris, A. (2019). Conscious. Harper Collins, New York.

Kings Fund. (2013). Time to Think Differently. Available: www.kingsfund.org.uk/projects/time-think-differently/trends-disease-and-disability-long-term-conditions-multi-morbidity

Keeping up with the clinical Joneses: a proposal for the Accredited Clinical Exercise Physiologist status for the UK

Dr Andrew Scott and Profs David Broom FBASES and Helen Jones present the need and blueprint for an accredited clinical exercise physiologist pathway in the UK.

Introduction

Non-communicable diseases and disorders are prevalent in western society and cause an increasing health care burden, for both nationalised and private health care providers. Morbidity and impaired mobility appearing earlier in life also increases the burden on adult social care services and family carers. Increasingly prevalent and heterogenous long-term conditions, such as cancer, will have an incidence of 1 in 2 people in our lifetime, with cancer and the deleterious effects of its treatment often leading to sedentary and inactive lifestyles, social isolation and future secondary long-term conditions. Being physically active is associated with improved health outcomes and response to treatment. This article outlines how a standardised training, experience and accreditation in clinical exercise physiology could and should be developed in the UK.

Exercise professionals in healthcare

In the UK, some professions currently take responsibility for physical activity advice and provision in the NHS, such as physiotherapists, nurses and occupational therapists, but this is neither their primary role nor is there sufficient time or standardised training for them to be systematically fulfilling the role of a clinical exercise physiologist. Likewise, the provision in typical sport and exercise science undergraduate and postgraduate degrees do not contain standardised clinical competencies of their health care equivalents.

To support health care services and standard allied health professionals, Australia, Canada and the US have established accreditation pathways for clinical exercise physiologists to be trained according to specific standards demanding study beginning at BSc and progressing to MSc levels in addition to standardised practicum experiences in exercise clinics in order to finally be recognised as health care professionals. The UK's NHS, free at point of access, provides little incentive for services and individuals with or at risk of developing long-term conditions seeking lifestyle interventions to prevent long-term conditions developing. The relative lack of cohesion between the health and fitness sectors also requires a profession to be included in both sectors. Australia, Canada and the US took strategic action to ensure that their Exercise Science graduates were prepared with the necessary knowledge, skills and behaviours to be employed as health care professionals.

In Australia Exercise and Sport Science Australia (ESSA) developed the *Accredited Exercise Scientist and Accredited Exercise Physiologist* pathways for their BSc and MSc programmes, respectively. In the US, The American College of Sports Medicine has long provided its clinical exercise physiologist certification. Whilst in Canada, Clinical Exercise Physiologists are recognised by the Canadian Society for Exercise Physiology to provide exercise testing and prescription for people with long-term conditions. Table 1 illustrates the processes for exercise science graduates to become trained, with some minor country-to-country differences.

Accredited Exercise Physiologists in Australia

When students register on a degree in Australia they can become an *Accredited Exercise Scientist* by virtue of completing their 3-year undergraduate degree, that includes the relevant standardised curriculum and work experience for this status. To graduate as an *Accredited Exercise Physiologist* and be recognised as healthcare professionals, students must complete a 4-year BSc in Clinical Exercised Physiology or complete a 3-year BSc in Exercise Science followed by a 2-year MSc in Clinical Exercise Physiology. Graduating as a recognised healthcare professional is possible due to the highly rigorous quality assurance and endorsement process with their governing body, ESSA, and the largely standardised approach to teaching, assessment and professional development that the students receive during their degrees. The standardised process of including compulsory practicum experience and assessment means there are no additional external examination processes through ESSA or any other body.

Clinical Exercise Physiologists in the US and Canada

Arguably the most well-known clinical track world-wide is the American College of Sports Medicine's (ACSM) Certified Clinical Exercise Physiologist pathway that is available worldwide. The ACSM's Registered Clinical Exercise Physiologist and Certified Clinical Exercise Physiologist certifications recently merged due to the similarity of roles that graduates of each track were performing, following a job task analysis procedure. The ACSM performs job task analyses to ensure that their certifications are accurately preparing graduates for the roles they will be performing in their occupations.

Their BSc Exercise Science and MSc Clinical Exercise Physiology programmes can be accredited by the Committee on Accreditation for the Exercise Sciences who are a third party accreditation body to quality assure the degrees for ACSM and other national bodies, but this is not yet compulsory. As a result of this arrangement ACSM directly assesses candidates' clinical experience log before they can sit the exam at a regional centre, with ACSM expecting candidates to be ready for the exam through their own independent study. Candidates are expected to gain experience that must be direct experience, without observation or simulation, to cover a range of long-term conditions and includes health assessment, exercise testing, exercise prescription, education and behaviour change. The assessment process assumes that the candidate is technically proficient as no practical assessment takes place for the certification. As with Australia, it is more straight forward for students to gain experience during their degree than to try to locate a placement following graduation due to access and insurance restrictions.

Canada has a similar certification programme for their graduates where graduates attend external practical and written assessments following successful completion of their exercise science course and evidence of their clinical experience, which is substantially lower than their ACSM and ESSA counterparts at only 200 hours. Despite the provincial structure of Canada's government, the certification is recognised in every province.

All of these accreditations/certifications require continuing professional development (CPD) programmes specifically in clinical exercise to re-accredit every 2-3 years to remain current and maintain cardiopulmonary resuscitation training. Renewal of the certification provides professional insurance too.

Table 1. Benchmarking of comparable professional associations representing clinical exercise physiologists

Accreditation Title	Accredited Exercise Physiologist (AEP)	Certified Clinical Exercise Physiologist (ACSM-CEP)	Clinical Exercise Physiologist (CSEP-CEP)
Accrediting organisation	Exercise and Sports Science Australia (ESSA)	American College of Sports Medicine (ACSM)	Canadian Society for Exercise Physiology (CSEP)
Country	Australia	United States of America	Canada
Degree	NUCAP-accredited exercise physiology program; 4-year equivalent degree within last 2 years	Minimum 4-year university degree in exercise science or related field. A graduate with a Bachelor of Science requires 1,200 hours of experience and a graduate with a Master of Science requires 600 hours of experience	Minimum 4-year university degree in exercise science or related field
Exam	No	Yes (written only)	Yes (written and practical)
Total practical experience **Healthy populations** **Cardiopulmonary** **Metabolic** **Musculoskeletal** **Neuromuscular** **Ageing** **Immunological/Haematological** **Other**	500 h 140 h (compulsory) 140 h (compulsory) 140 h (compulsory) Not specified Not specified Compulsory 80 h across any other domain	600 h Not specified 200 h recommended 120 h recommended 100 h recommended 40 h recommended Not specified 40 h recommended CPR for the professional rescuer or basic life support certification	200 h Not specified 50 h (compulsory) 50 h (compulsory) 50 h (compulsory) 25 h (compulsory) 25 h (compulsory) Not specified CPR level C certification and course in emergency first aid
Webpage URL	https://www.essa.org.au/	https://www.acsm.org/get-stay-certified/get-certified/cep	http://www.csep.ca/english/view.asp?x=748

CPR = Cardiopulmonary resuscitation; NUCAP = National Universities Curriculum Accreditation Program. Adapted from Smart *et al.* (2016)

Opportunities for Accredited Clinical Exercise Physiologists in health care in the UK

At present without a recognised training route, graduates need to find their own path by piecing together qualifications and trying to gain experience on their own, whilst hoping to locate one of the few NHS Trusts that employ clinical exercise physiologists. The UK should develop a clinical exercise physiology training pathway taking on board key learning from the other countries showcased in Table 1.

The UK merely needs to keep up with the clinical Joneses from our overseas counterparts by cooperating to make use of the parts of their clinical exercise physiology training, practicum and accreditation models that suit the UK healthcare service. There needs to be a differentiation of Clinical Exercise Physiologists from the generic Sport and Exercise Scientist title to demonstrate the clinical knowledge, skills and behaviours that are required, similar to the Sport and Exercise Psychologist Accreditation Route (SEPAR) that BASES and key members have successfully developed so that the public and clinicians can have faith in a standardised and quality assured training, clinical experience, assessment and CPD process.

The Professional Standards Authority for Health and Social Care (PSA) oversees the nine statutory bodies that regulate health professionals in the United Kingdom and social care in England, including the Health and Care Professions Council (HCPC). Having the Clinical Exercise Physiology profession recognised and regulated by the PSA through the development and recognition of university degree courses and CPD would be a large step towards Clinical Exercise Physiologists being recognised as a health care profession, leading to a standard career path.

This might beg the question that if this is a new profession then where might such graduates be employed? The NHS Long Term Plan (NHS, 2019) requires the implementation of personalised care, workforce development, greater access to healthcare services for patients that need them. Macmillan recently published their principles and guidance for prehabilitation that details the precise requirements for preparing people, particularly those living with and beyond cancer, to recover from this disease and its treatment. Exercise is the cornerstone of prehabilitation, along with nutrition and psychological support, and such professionals must be trained in clinical exercise physiology to accurately and sensitively understand the assessment of functional status and appropriately prescribe and lead exercise for people presenting with a heterogenous group of conditions and a complex range of problems that arise from cancer and its treatment.

Previous issues of The Sport and Exercise Scientist have also highlighted the role of clinical exercise physiologists in health care including cancer (Scott *et al.*, 2020), falls prevention (de Biase *et al.*, 2020) and cystic fibrosis (Shelley & Owen, 2020).

Summary

The time is right to collaborate with nations that have set the bar for providing standardised expert training and accreditation, along with respected healthcare institutions in the UK, where there is a workforce shortage of trained and experienced clinical exercise physiologists. If we supply the training and the recognised accreditation pathway then there are organisations ready to employ such professionals. The time is now to propose an accreditation pathway for a Clinical Exercise Physiologist role. ■

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References:

de Biase, S. et al. (2020). Multidisciplinary team-working in the falls prevention pathway: the role of exercise scientists in delivering strength and balance exercise. The Sport and Exercise Scientist, Issue 64, Summer 2020, 18.

National Health Service. (2019). NHS long term plan. Available: https://www.longtermplan.nhs.uk/publication/nhs-long-term-plan/

Scott, A., Campbell, A. & Jack, S. (2020). Exercise-based prehabilitation workforce development for people living with cancer. The Sport and Exercise Scientist, Issue 63, Spring 2020, 28-29.

Shelley, J. & Tomlinson, O. (2020). The role of exercise scientists in the multi-disciplinary care team for Cystic Fibrosis The emerging role of exercise scientists. The Sport and Exercise Scientist, Issue 65, Autumn 2020, 24-25.

Smart, N, Wiliams, A. & Lyndon, K. (2016). The role and scope of accredited exercise physiologists in the Australian healthcare system. Journal of Clinical Exercise Physiology. 5(2), 16-20.

The use of Sketchnotes to improve students experience, learning and attainment

Dr Ashley Richardson shares his experiences with using Sketchnotes.

Introduction

Abertay University has identified technology enhanced learning (TEL) as a priority. This refers to the application of communication and information technologies to teaching and learning. It has a number of potential benefits including the facilitation of active participation of students, individually or collaboratively, and encouraging high-level learning. Within the current Covid-19 environment, many universities are switching to a blended or entirely online approach, which requires the need for efficient use of TEL.

One method that can be utilised within this environment is the use of digital graphical notes (Sketchnotes). Sketchnotes have been defined as, "Rich visual notes created from a mix of handwriting, drawings, hand-drawn typography, shapes and visual elements like arrows, boxes and lines." (Rohde, 2013). It is proposed that the use of a Sketchnotes can aid a student in making a topic more accessible, initially allowing them to further explore traditional electronic content with a reduced level of anxiety or fear.

Biomechanics is a core component of the sport and exercise programmes offered at Abertay University. Therefore, it is important that students' learning and attainment is optimised using novel strategies of presenting information in a variety of formats. The Sketchnote resource is proposed as an attempt to improve all students' experience, learning and attainment. Hsieh *et al.* (2008) supports the notion of additional support being needed in biomechanics with students reported to having difficulty in grasping basic biomechanical principles due to subject anxiety - particularly with the mathematical elements of biomechanics.

By combining words and images, a Sketchnote resource provides a framework for the student based on a reduced volume and visual output. Sketchnotes exposes the students to a different form of note taking, which they then have the option of adopting. Notetaking efficiency has been linked to greater attainment - Sketchnote resources may be of benefit to students in this regard. I hope this article provides not only another method of disseminating information for educators but also highlights the importance of effective notetaking to all learners.

Study aims

The aims of the study were to:

1. Showcase the potential for graphical resources as a learning tool for enhancing the provision of education at Abertay University.
2. Raise awareness of students to the importance of notetaking efficiency.
3. Improve confidence of students within the subject field of biomechanics.
4. Ascertain whether it increases engagement with other electronic resources on the virtual learning environment.

Method

Before any data collection began, a mapping and scoping exercise was completed, aligning the resources to current second and fourth year biomechanics curriculum. Topics were deliberately not linked to specific lectures to allow students to see the crosstalk between sessions. Following this, there was a continual development of electronic materials. Using GoodNotes 4 iPad application, Sketchnote resources were created for select topics and uploaded to a separate folder on respective module virtual learning environment pages.

The results of this research draw upon the experiences of 11 undergraduate sports students (second year, n=5; fourth year, n=6) at Abertay University. A conscious decision was made to obtain informal student feedback to ascertain honest opinions of the Sketchnote resources. Each session was a semi-structured focus group lasting approximately 20 minutes and comprised myself leading a conversation utilising the questions in Table 1, with subsequent follow up questions based off student responses. The sessions were not recorded and student responses were recorded on an iPad Pro using the GoodNotes 4 application.

Table 1. Example of questions asked to students

Generic Questions
• How did you find the module?
• Did you engage or use the Sketchnote resources?
• You did use the Sketchnote resources, what did you like about them or dislike?
• Would you consider using or have developed your own Sketchnotes when revising/studying?
• Do you consider the Sketchnote resources a time effective way to study?
• Did you go on and access further resources due to using the Sketchnotes?
• How well articulated do you think these are an entry point to a topic?

Results

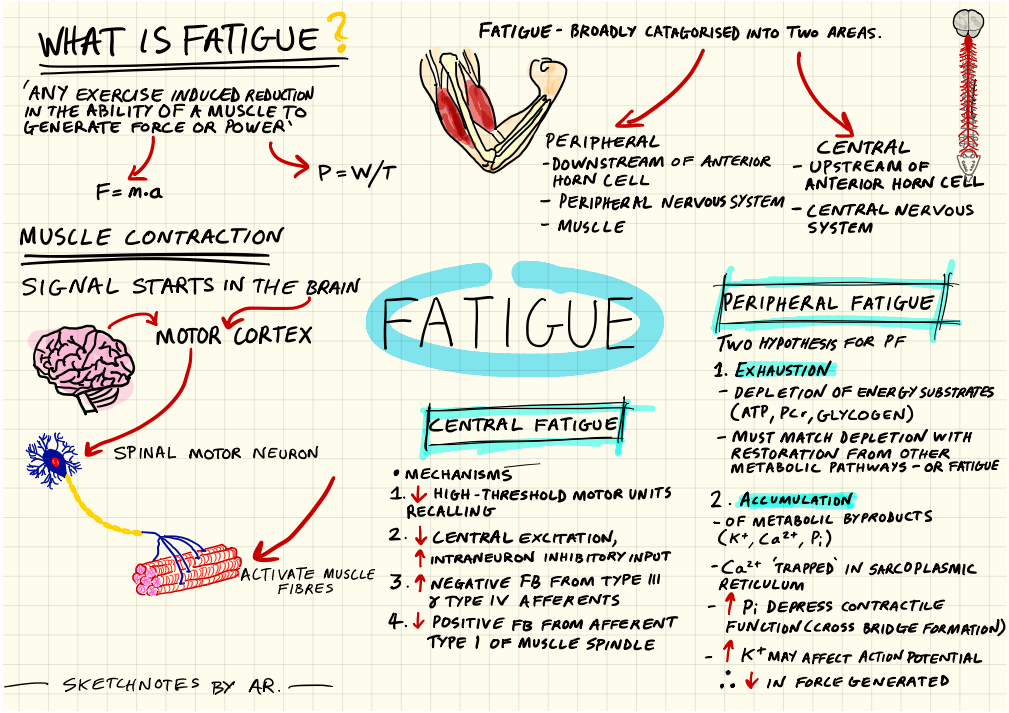
A number of key themes were developed from notes taken at focus group sessions. These were:

1. Accessibility to new topics.
2. Providing structure to module content.
3. Organisation of their own notes.
4. Further potential of use with modules with exam-based assessments.

Accessibility to new topics. All students commented that a positive aspect of the Sketchnote resources was increasing the accessibility to new complex topics. From the Sketchnote resources they would gain a broad understanding of the topic being summarised before accessing further resources. The fourth-year cohort particularly emphasised their use before accessing journal articles within a similar area.

The informal element, i.e. the handwritten aesthetic, was received positively by the students. It was commented that this added to the resource along with the illustrations, allowing them to better visualise some biomechanical concepts. Some students did identify that beyond one or two uses they did not feel the need to access the resource any further as they had "grasped" the topic and were using more detailed mediums of information.

Providing structure to module content. Students stated that they found the Sketchnote resources useful in terms of providing structure to the content being delivered on the module; especially regarding how topics linked together. Additionally, they identified if their lecturer had determined this particular information worthy for inclusion it must be important and relevant. Therefore, it helped to guide them to specific further resources or informed what



Above: Example Sketchnote resource for topic "fatigue"

information needed including within an introduction section of an assessment.

Organisation of their own notes. A couple of students stated that the Sketchnote resources influenced their own notetaking, whereas the majority stated their note taking strategies had not changed. Students that did alter their practice stated that they predominantly adopted it for simplicity of summarising topics on a one-page format. Regarding the use of illustrations on their own notes, students had not widely implemented them as they considered them difficult to draw. Students did, however, state they would copy important figures/graphs to summarise topics.

Further potential of use with modules with exam-based assessments. A consensus was drawn amongst the students that they felt the Sketchnote resources would be of benefit to modules that have an examination as an assessment. If wider adoption was to occur, modules with exams should consider use or develop tasks whereby students create their own Sketchnotes for revision purposes.

Discussion

The overall aim of this project was to ascertain whether visual notes could enhance learning and attainment within the biomechanics subject. Considering the predominantly positive response from students within focus groups and positive numbers regarding access on the virtual learning environment (75% of the cohort downloaded the resources), it can be considered that Sketchnote resources are a viable alternative method for learning.

There is some developing evidence that it is advantageous for the learner to take longhand written notes in comparison to laptop note taking (Mueller & Oppenheimer, 2014). With students increasingly using laptops within class, it is important that students are aware of different note taking techniques. Two main issues have been identified with laptop note taking: distraction (particularly with access to internet) and that often notes are verbatim transcription. This has been shown to lead to worse performance on subsequent tests of both conceptual and factual content in comparison to those that engaged with longhand notes (Mueller & Oppenheimer, 2014). Therefore, taking notes on laptops may result in shallower processing of information. Sketchnotes may offer an alternative method of longhand note taking, whereby the student is actively processing the information into a one-page infographic, which may aid learning.

Williams and Eggert (2002) outline, "That the most effective notes highlight an overall framework for a lecture and embellish that framework with critical specifics." As highlighted previously, laptop note takers may copy down all the details but may not attend to the main ideas or structure of the lecture, reducing understanding and long-term recall. This again points to the potential value of Sketchnotes. Finding visual metaphors for key ideas or principles can help learners to process the information they are receiving.

An important point of the Sketchnotes may be the non-linear element unlike a typical lecture, or lecture slides. Piolat and colleagues (2005) identified that nearly all non-linear note taking strategies benefit learning outcomes more than the linear recording of information. Graphs and concept maps that foster the selection and organisation of the information should be prioritised (Piolat *et al.*, 2005). This is standard practice when developing Sketchnotes, whereby it is integral to find some way to visually organise the information (Rohde, 2013).

It may be important as an instructor to provide Sketchnotes to students to provide an organisational structure. Ambrose *et al.* (2010) proposes when students are provided with an organisational structure in which to fit knowledge they learn more effectively and efficiently. Therefore, it may be a balance for the lecturer to provide Sketchnotes and provide opportunities for students to develop their own. A potential limitation of the current project was that with the focus groups being completed at the end of the module there was a bias towards gathering student opinion from more engaged students who had higher attainment.

Conclusions

In conclusion, due to the positive reception of the Sketchnote resources and evidence of their use within pedagogical academic literature, I will continue to develop and adapt these resources. I plan to embed tasks within sessions for students to develop their own resources to improve their note taking skills and encourage deep learning with wider concepts considered. ■

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References:

Ambrose, S.A. et al. (2010). How learning works: Seven research-based principles for smart teaching. CA: John Wiley & Sons.

Hsieh, C. & Knudson, D. (2008). Student factors related to learning in biomechanics. Sports Biomechanics, 7(3), 398-402.

Mueller, P.A. & Oppenheimer, D.M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. Psychological Science, 25(6), 1159-1168.

Piolat, A., Olive, T. & Kellogg, R.T. (2005). Cognitive effort during note taking. Applied Cognitive Psychology, 19(3), 291-312.

Rohde, M. (2013). The sketchnote handbook: the illustrated guide to visual note taking. CA: Peachpit Press.

Williams, R.L. & Eggert, A.C. (2002). Notetaking in college classes: Student patterns and instructional strategies. The Journal of General Education, 173-199.

Cannabidiol and the athlete

Andreas Kasper and Prof Graeme Close FBASES provide a brief insight into the considerations surrounding cannabidiol use in elite sport.

What is cannabidiol (CBD)?

Cannabis is a herbaceous plant that is perhaps best known for its role as a recreational drug. There is, however, growing interest in some of the specific cannabinoids found within the plant and the potential benefits that these may possess from both a medical and athletic perspective. Broadly speaking, there are two main strains of the cannabis plant, these being *Cannabis Sativa L-strain* (commonly referred to as hemp) and *Cannabis Indica* (commonly referred to as marijuana). The main difference between the two strains is the content of the primary psychotropic cannabinoid Δ^9-Tetrahydrocannabinol (THC). The Sativa L-strain must contain less than 0.2-0.3% THC to be classed as hemp, where other strains contain as much as 30% dry weight of THC.

Whilst the Indica strain appears to be primarily manufactured as an illicit recreational drug, the Sativa L-strain has a variety of legal uses including the manufacture of clothing, insulation, biofuel, a source of protein and most recently to produce medicine/supplements. The cannabis Sativa L-Strain plant is made up of over 140 cannabinoids, of which CBD is of particular interest, due to its proposed anxiolytic, analgesic, anti-inflammatory and anti-oxidative capacity, alongside anecdotal reports of improved sleep (Bergamaschi *et al.*, 2011; McCartney *et al.*, 2020; Mechoulam & Hanus, 2002; Russo *et al.*, 2007). In addition, it has been suggested that CBD has a relatively safe adverse effects profile (Bergamaschi *et al.*, 2011). As a consequence, in 2018, the World Anti-Doping Agency (WADA) removed CBD from the prohibited list but left all other cannabinoids on there (THC is a threshold substance set at 150ng/ml in urine). This article will briefly look at some of the controversies that sport practitioners must be aware of to fully appreciate the CBD conundrum.

The growth in use of CBD and the quest for pain relief

Since the removal of CBD from the WADA prohibited list in 2018, the use of CBD within sport is growing, with athletes openly discussing using it in both the traditional and social media. In addition, there are increasing reports of private sporting organisations/franchises, Olympic organisations and national governing bodies signing partnership agreements with CBD companies including Major League Soccer, USA Triathlon and The Toronto Wolfpack Rugby League.

In the first study of its kind, we measured the prevalence of CBD use within an elite male rugby union and league population (Kasper *et al.*, 2020). Findings suggested that as many as 26% of rugby players currently or had previously used CBD, and a further 14% of those who had not used CBD stated that they would like to try CBD in the future. Interestingly, the use of CBD within rugby increased with age. This is perhaps unsurprising given that CBD is claimed to be a potent analgesic and rugby players, as they reach the latter stages of their career, often seek alternate pain relief to Non-Steroidal Anti-Inflammatory Drugs (NSAIDS) and opiates that are not without serious physical and metal side effects (Scott, 2012).

Of the previous and current users of CBD, the main rationale for use was to enhance recovery or reduce pain (80%), although only a fraction of users actually perceived benefits to pain/recovery (14%). This supports unpublished data from our laboratory where a commercially available CBD product (2.75% concentration providing approximately 20 mg of CBD) yielded no effect on acute or chronic muscle soreness versus a taste matched placebo.

There are a large number of commercially available CBD products available. Indeed, in our study on rugby players as many as 13 different CBD brands were identified as being used. It is difficult with CBD products to establish exact doses that are being administered with suggestions for use often involving placing drops under the tongue and the amount of CBD labelled as the total for the entire bottle rather than a typical consumed dose. However, commonly used commercial CBD products suggest between 10-30 mg per day, which is an order of magnitude less than a typical medicinal CBD product such as Epidiolex®. Currently, the Food Standards Agency (FSA) has suggested a safe upper limit of 70 mg per day although there is, to date, no evidence on the efficacy of typical doses in a sporting setting. The lack of an effect on pain relief in our rugby study could be related to the low doses that are frequently used in commercial CBD supplements or a genuine lack of benefit in a rugby-specific soreness context. At the time of writing this article, there are no other studies looking at use within elite sporting populations.

Risks of inadvertent doping

A major concern for athletes when it comes to CBD is despite it not being prohibited by WADA, supplementation remains a major risk

in terms of an anti-doping rule violation (ADRV). This is a particular concern given that in our rugby study, although players were seeking advice prior to purchase, the major sources of information were obtained from either the internet or other teammates rather than qualified nutritional advice.

The first reason why CBD poses a major ADRV risk is that there are currently no 'Informed Sport' batch tested CBD products and, therefore, there are risks of inadvertent doping though contamination with prohibited substances. Perhaps more concerningly is that studies have reported that many commercially available CBD products have far greater THC concentrations within them than stated on the label (Food Safety Authority of Ireland 2020; Gurley *et al.*, 2020; Poklis *et al.*, 2019). Indeed, some CBD products had illegal quantities of THC within them that were not stated clearly on the product label.

Another concern for athletes wishing to avoid inadvertently doping is that THC accumulates in adipose tissue where it can be stored for long periods of time. Studies have reported that as little as 24 hours of food deprivation caused lipolysis and the release of THC from stored tissue back into circulation (Gunasekaran *et al.*, 2009). It is, therefore, possible that athletes who are reducing body fat or partaking in prolonged exercise may self-intoxicate with stored THC, which could pose an ADRV risk.

Finally, much more is still to be learned with regards to the stability profiles of cannabinoids, with little known about the effects of storage in heat and light on the various cannabinoids found within derivatives of the Sativa L-Strain plant. There are suggestions that *in-vitro* CBD can convert to THC; a finding that again must be fully explored before recommendations can be made to athletes. Given the lack of batch testing, the contamination of products with illegal quantities of THC and the unknown effects of storage and release of THC, the risk of inadvertent doping is indeed significant and should be a major concern for the athletes considering the use of CBD.

The entourage effect

Despite the proposed physiological and psychological benefits of CBD supplementation, there is still an argument to suggest that the perceived benefit may be somewhat attributed to levels of other cannabinoids within products (mainly THC) as opposed to solely the CBD itself (Russo, 2019) - this is referred to as the entourage effect. Given that the only cannabinoid currently not prohibited by WADA is CBD, if this is the case then creating a pure CBD product, even if this is batch tested, may be of no use to athletes. For example, research investigating chronic pain in patients suffering from fibromyalgia has shown there to be increased effect whilst using products containing THC as opposed to CBD alone (van de Donk *et al.*, 2019). It is therefore crucial that studies are performed in an athletic context investigating the effects of isolated CBD and full spectrum CBD (containing the other cannabinoids) to assess if the benefits can be achieved in a context that would allow its use in sport.

The CBD conundrum

Despite WADA removing CBD from the prohibited list in January 2018 there still remains many unanswered questions that need to be addressed before athletes can consider using CBD with any degree of certainty. This article has tried to introduce some of the major concerns whilst at the same time acknowledging that if these issues can be navigated then CBD may have potential to help athletes specifically with regards to pain management and recovery. We believe the most pertinent questions that need to be addressed include:

1. Are there beneficial effects in terms of sleep and pain management in athletes?
2. What is an effective dose and do athletes need to take chronically (i.e. "loading") to see an effect?
3. Does pure CBD work or is the entourage effect essential?
4. What are the side-effects?
5. Does THC accumulate and result in an ADRV?

To date, nobody fully knows the answers to those questions, which although is a problem for athletes is actually exciting for research scientists providing an avenue for novel research.

Summary points

- CBD is one of over 140 cannabinoids found in the cannabis plant, which has been claimed to have beneficial effects on pain management, sleep and recovery.
- Despite not being prohibited by WADA, all other cannabinoids are prohibited and given small amounts of these cannabinoids are found in all CBD products (except synthetic CBD). It, therefore, poses a serious risk to athletes.
- Recent studies have suggested that many CBD products contain significant quantities of prohibited and illegal cannabinoids such as THC.
- A recent study in rugby players suggests that 26% of players either do or have used CBD. Worryingly, the vast majority of these players seek advice form the internet rather than qualified support.
- It is essential that studies are performed to try and fill gaps in our knowledge. ■

Andreas Kasper

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Prof Graeme Close FBASES

Graeme is a former professional rugby league player and now Professor at Liverpool John Moores University. He consults in performance nutrition within elite sport including England Rugby and is a BASES accredited sport and exercise scientist.

References:

Bergamaschi, M.M. et *al.* (2011). Safety and side effects of cannabidol, a cannabis stiva constituent. Current Drug Safety, 6, 237-249.

Food Safety Authority of Ireland. (2020). Recall of various CBD foods and food supplements due to the presence of THC delta-9-tetrahydrocannabinol Update 2. Available: www.fsai.ie/news_centre/food_alerts/CBD_recall.html

Gunasekaran, N. et *al.* (2009). Reintoxication: The release of fat stored Δ^9-tetrahydrocannabinol (THC) into blood is enhanced by food deprivation or ACTH exposure. British Journal of Pharmacology, 158, 1330-1337.

Gurley, B.J. et *al.* (2020). Content versus label claims in cannabidiol (CBD)-containing products obtained from commercial outlets in the state of Mississippi. Journal of Dietary Supplements, 20, 1-9.

Kasper, A.M. et *al.* (2020). High prevalence of cannabidiol use within male professional rugby union and league players: A quest for pain relief and enhanced recovery. International Journal of Sport Nutrition & Exercise Metabolism, 30, 315-322.

McCartney, D. et *al.* (2020). Cannabidiol and sports performance: A narrative review of relevant evidence and recommendations for future research. Sports Medicine, 6, 1-18.

Mechoulam, R. & Hanus, L. (2002). Cannabidiol: An overview of some chemical and pharmacological aspects. Part I: Chemical aspects. Chemistry & Physics of Lipids, 121, 35-43.

Poklis, J.L., Mulder, H.A. & Peace, M.R. (2019). The unexpected identification of the cannabimimetic, 5F-ADB, and dextromethorphan in commercially available cannabidiol e-liquids. Forensic Science International, 294, e25-e27.

Russo, E.B. et *al.* (2007). Cannabis, pain, and sleep: Lessons from therapeutic clinical trials of Sativex, a cannabis-based medicine. Chemistry & Biodiversity, 4, 1729-1743.

Russo, E.B. (2019). The case for the entourage effect and conventional breeding of clinical cannabis: No "strain", no "gain". Frontiers in Plant Science, 9, eCollection.

Scott, J. (2012). Robbie Hunter-Paul: Days on drugs were just a blur. Daily Star. https://www.dailystar.co.uk/sport/rugby-league/robbie-hunter-paul-days-drugs-18557662

van de Donk, T. et *al.* (2019). An experimental randomized study on analgesic effects of pharmaceutical-grade cannabis in chronic pain patients with fibromyalgia. Pain, 160, 860-869.

Fact, fiction or fad?

Dr Robert McCunn is the sport and performance columnist for The Sport and Exercise Scientist.

One of the big challenges for any practitioner working in professional sport is keeping abreast of new developments within their field, while simultaneously getting on with the face-to-face delivery components of their job. These developments can be both technological or methodological in nature. Whereas in healthcare settings new drugs and technologies usually face a long and arduous journey from conception to being used on the front line, this is less commonly the case within sport. Most of the time in the sports setting the consequence of adopting a new idea that turns out not to fulfil its early promise is losing a match or a race rather than your life, so it's easy to explain the more liberal approach. Even still, something we should all be wary of is being too quick to adopt and live by the latest in vogue practice.

Perhaps the best current example of a "new" practice gaining and subsequently losing traction within the sport science field is the use of the acute:chronic workload ratio. I expect most readers will be well aware of this metric and how it is often used in practice, so I won't go over old ground in much detail. In a nutshell, it is a value often used to quantify whether an athlete is doing too little or too much training. For a great summary of the arguments for and against its use and a bit of the backstory as to why it has become somewhat controversial I would recommend the following blog post: https://drlauracaughtoffside.com/2020/04/26/the-acutechronic-workload-ratio-worthwhile-or-worthless/ (Bowen, 2020).

The premise of monitoring the amount of training athletes are doing with a view to optimising their performance and minimising injury risk is intuitive and sound but as Impellizzeri *et al.* (2020) explain there are good reasons not to lean too heavily on the acute:chronic workload ratio when making decisions. However, only a handful of years ago it would've seemed crazy, given its widespread adoption, for this metric not to have been a cornerstone of your daily decision-making as an applied practitioner!

Similarly, subjective athlete reported outcome measures such as the responses generated through daily wellness and fatigue questionnaires are widely collected and used by practitioners but are also coming under the microscope. Jeffries *et al.* (2020) highlighted that most of these types of questionnaires lack content validity, or rather, the content validity of the questions has not been substantiated yet. Absence of evidence does not equate to evidence of absence etc…Yet, this is another example of something many of us use, which is not that well supported from a scientific point of view.

The obvious question the above examples raise is: how does one avoid getting caught up in the latest trend and potentially relying on a method that is later discredited? Honestly, my own opinion is that we probably can't, without being ultra conservative in our approach. In any case I would say that being too conservative isn't a realistic option within the elite sport environment since by its very nature it is about pushing boundaries in pursuit of results. Obviously, ensuring we cause no harm to anybody through our practice should underlie everything we do. What I would say is important though is how we talk about and present the tools and methods we use with athletes to them and the coaches we work with. We should resist presenting the things we propose as definitive and try to caveat them appropriately so as not to raise expectations too much.

> Being willing to change your mind now and again and trying to keep up-to-date with the latest research in our field are two key components of being a good sport scientist in my book- keep doing that and you'll be fine.

The tricky part is doing this without coming across as either unsure or non-committal. The need to project confidence when making recommendations to athletes/coaches and making sure not to overpromise is a fine balance. My own advice on this challenge is to consider how it would feel to be too confident in the present moment and subsequently find yourself arguing against your previous stance with an athlete/coach in a few months or even years in light of new evidence. Maintaining your credibility will be easier down the line if you are able to remind certain parties that you were honest about the potential usefulness (or not) of whatever practice you implemented.

Maybe my advice is a bit unsatisfying and non-committal in itself! What gives me, and hopefully you, some comfort is remembering that practitioners and academics worth their salt understand how difficult the job of applying science in sport can be. They know it is not possible to always get it right. As long as you are doing your best and acting with integrity then you will be respected by your peers. Being willing to change your mind now and again and trying to keep up-to-date with the latest research in our field are two key components of being a good sport scientist in my book - keep doing that and you'll be fine. ■

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References:

Bowen, L. (2020). The acute:chronic workload ratio - worthwhile or worthless? Available: https://drlauracaughtoffside.com/2020/04/26/the-acutechronic-workload-ratio-worthwhile-or-worthless/

Impellizzeri, F. *et al.* (2020). Acute:chronic workload ratio: conceptual issues and fundamental pitfalls. International Journal of Sports Physiology and Performance, (Epub Ahead of Print).

Jeffries, A.C. *et al.* (2020). Athlete-reported outcome measures for monitoring training responses: a systematic review of risk of bias and measurement property quality according to the COSMIN guidelines. International Journal of Sports Physiology and Performance (Epub Ahead of Print).

Final Word with Prof Adam Hawkey FBASES

One book that influenced you

The first sport science book I ever read was *Sport Science* by Roy Hawkey. As you may have conjectured from the surname, the author is related (my father - a chartered biologist with an interest in sport). This allowed me to discuss aspects of the book with him while I was studying for my GCSEs and consequently had a huge influence on my future career path. I even managed to feature in both editions of the book: an x-ray of my fractured clavicle, highlighting sports injuries and my sprint start, used to demonstrate the utilisation of sequential still photos for analysing movement.

One thing that made me want to be a sport and exercise scientist

In additional to my aforementioned familial influence, I was also a keen sportsperson in my teenage years (playing both youth football for my hometown, Brighton, and hurdling in national and international competitions). Initially, and somewhat selfishly, I wanted to learn more about how to improve my performance. When the inevitable injuries occurred, I developed a particular interest in the causes, prevention and rehabilitation of sports injuries.

One moment that changed the course of my career

Probably the area of my work that I am asked about the most is human spaceflight. People always seem fascinated by the physical challenges associated with leaving the relative safety of Earth (especially a human mission to Mars). So, being able to work with the likes of Drs Irene Long and Phillip Scarpa as part of the National Aeronautics and Space Administration's (NASA) Biomedical Task Group at the Kennedy Space Center in Florida remains a standout moment for me. Whilst I have been working with astronauts and medical staff from NASA (and other agencies) for two decades now, that first opportunity was certainly the catalyst for a host of future collaborations and research: most recently a *Mission to Mars* project with The Physiological Society and NASA astronaut, and Penn State University Professor, James "Jim" Pawelczyk.

One proud moment

Recently, I was invited to China to advise staff at the Jiangsu Olympic Sports Training Bureau and the Wellbone Medical Technology Company in Nanjing. Being able to learn traditional techniques in sports medicine and to share my knowledge and experience to develop new training and well-being facilities in China was especially rewarding. I was extremely proud to be the keynote speaker and honoured guest at the Inaugural International Sports Research and Sports Rehabilitation Seminar. Being featured on Chinese National television to an audience of >100million people was a particular highlight.

One thing I think the Government should implement immediately

Promoting physical activity, exercise and sports participation (and the reduction of sedentary behaviour) should now be central to improve the "health and wealth" of the nation. Medical professionals and the sport and exercise science community (with BASES very much at the forefront) have been driving this agenda for years, if not decades. The recent pandemic and associated lockdowns have highlighted just how important keeping active is to our physical and mental health. As Prof Ed Laskowski (Mayo Clinic, USA) and I have been enthusiastically endorsing recently, "Movement is Medicine" and we should be seizing every opportunity to "prescribe" this medicine in educational, workplace and home settings.

Above: Adam with his daughters and other family members at one of Orlando's water parks

One bit of advice that really influenced me

Kriss Akabusi (British 400m hurdles record holder) once said to me (and wrote as a personal message in a copy of his biography) that "commitment precedes confirmation." That advice has always stuck with me and continues to be somewhat of a mantra to this day. (He followed this phrase with "Keep Smiling" - also great advice, so I try to do that too)!

One piece of advice for up and coming sport and exercise scientists As I have gotten older (and hopefully wiser?) I've learnt that you should never be afraid to ask for help. We can't possibly know everything (and it would be boring if we did). So, ask questions, learn from those around you and, possibly most importantly, try to better understand yourself. My good friend Miles Henson (Co-founder and Director of People Academy) recently shared some of The People Dimension techniques he uses with Olympic athletes, coaches and corporations. Gaining a better awareness of how to communicate effectively and adapt to different people and situations are all key factors with regards to personal and professional development.

One person I would like to have dinner with

They say you should never meet your heroes, but I would find it hard to pass up a sit down with Leonardo Di Vinci. He had such a huge influence on so many facets of society, including science, medicine, art and engineering, and he continues to impress and astonish me. Being a fellow left-hander is also part of the appeal - although whilst I am adept at reading backwards and upside down, my ability to perform mirror writing is not comparable to the great man himself!

One thing that I like to do on days off

Spending time with my family is *the* most important thing to me. Theme parks are always our "happy place" and we are regular visitors to those both in the UK and the USA. Strongly influenced by my continued NASA connection (and associated trips to Florida), this regularly involves combining a Kennedy Space Center visit with prolonged stays at Disney and Universal resorts in Orlando. ■

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