Middlesex University		
24 – Sport and Exercise Sciences, Leisure and Tourism		
Changed behaviour in elite sport practice through performance analysis interventions		
Sep 2010 – Dec 2020		
Nic James	Professor	Sep 2010 - present
Sep 2010 – Dec 2020		
N		

Integration of our performance analysis-based research within National and International coaching processes in Olympic and Paralympic teams led to the introduction of new data capture, analysis and visualisation methods that helped transform the impact of data driven feedback. The impact of these performance analysis interventions led to the provision of better feedback to practitioners, coaches and players and transformed training and match day performance through work with the English Institute of Sport (EIS), UK Sport, elite teams in New Zealand (High Performance Sport, NZ (HPSNZ)), squash (England National squads and elite players), tennis (LTA) and rugby (Ireland RFC). This resulted in improved preparation and performance of athletes competing at the Olympic and Paralympic games (Rio 2016), Commonwealth games (Glasgow 2014, Gold coast 2018) and the Rugby World Cups (England 2015, Japan, 2019).

The research underpinning this case study is based upon an understanding of how small changes in elite performance can have dramatic effects and attention to fine detail is crucial to making champions. Whilst elite coaches make decisions on performance, the performance analyst enhances this by presenting performance in a visual way, underpinned by strong science, allowing patterns to be seen, systematic reviews of opponents and other performance related tasks undertaken, improving the use of coach's available time. Our research has been developed over many years, using a research method that actively forges relationships with professional teams who want novel data capture and analysis techniques to improve training and match performances. To develop this approach, initial research was carried out in collaboration with the EIS, working with the English Squash team (2010 – 2017) and then GB Canoe Slalom (2012 - 2016).

Research work with England Squash (supported by studentships from EIS) was initially concerned with with a view to developing better playing strategies against them. This research, led by Prof James at Middlesex University, in collaboration with UK (Prof Hughes) and International researchers (Dr Vučković, Dr Perš) devised a new methodology for data capture that recorded movement using a computer vision background elimination technique, and shot data manually transcribed, on a novel 15 cell court [ ]. This new methodology allowed contextual variables, including availability of time, shot type and location, as well as information relating to the previous shot, to be analysed, within a multi-factorial model, hence providing situationally specific information related to playing patterns. This methodological approach, appropriate for, and used in other sports (football, rugby union, tennis, padel, dancesport), also allowed future specific questions to be answered such as how tactical shot selection had changed as a consequence of rule changes [ ]. Over time, future refinements in the research were implemented to answer more specific questions raised by England Senior Squash coaches. The culmination of this work involved assessments of tactical shot selections using a two-step cluster analysis, to better understand the factors affecting decision-making. This research demonstrated both consistency and variability for different shots in different court locations primarily due to the availability of time but didn't account for individual player differences [ ]. To contextualise this finding for individual player preparation a case

study of the top 2 players in the world was undertaken to determine the extent to which tactical shot selections vary within players as a consequence of the standard of their opponent [ ]. pfETvo]TJ/Tm6 0 0 4 [(R)-5(e)4(s)3(ea)-1(r)4(c)-3(h)-4( )-4(w)3(a)-4(s)-4( )-4(p)-4(r)-3(o)-4(j)-4(e)-4(c)-3(t)-4(e)-4(d)-4( )-4(a)-4(t)-4( )-4(t)-4(h)-4(e)-4( )-4(E)15(I)-4(S)-4( )-4(b)-4(y)-4( )-4(D)-4(r)-4( )-4(B)-4(r)-4(y)-4(a)-4(n)-4(t)-4( )-4(t)-4(h)-4(r)-4(o)-4(u)-4(g)-4(h)-4( )-4(t)-4(h)-4(e)-4( )-4(d)-4(e)-4(v)-4(e)-4(l)-4(o)-4(p)-4(m)-4(e)-4(n)-4(t)-4( )-4(o)-4(f)-4( )-4(c)-4(o)-4(n)-4(s)-4(u)-4(l)-4(t)-4(a)-4(n)-4(c)-4(y)-4( )-4(s)-4(e)-4(r)-4(v)-4(i)-4(c)-4(e)-4(s)-4( )-4(f)-4(o)-4(r)-4( )-4(d)-4(i)-4(f)-4(f)-4(e)-4(r)-4(e)-4(n)-4(t)-4( )-4(O)-4(l)-4(y)-4(m)-4(p)-4(i)-4(c)-4( )-4(s)-4(p)-4(o)-4(r)-4(t)-4(s)-4( )-4(\()-4(a)-4(t)-4(h)-4(l)-4(e)-4(t)-4(i)-4(c)-4(s)-4(,)-4( )-4(b)-4(a)-4(d)-4(m)-4(i)-4(n)-4(t)-4(o)-4(n)-4(,)-4( )-4(c)-4(a)-4(n)-4(o)-4(e)-4( )-4(s)-4(l)-4(a)-4(l)-4(o)-4(m)-4(,)-4( )-4(c)-4(y)-4(c)-4(l)-4(i)-4(n)-4(g)-4(,)-4( )-4(f)-4(e)-4(n)-4(c)-4(i)-4(n)-4(g)-4(,)-4( )-4(g)-4(y)-4(m)-4(n)-4(a)-4(s)-4(t)-4(i)-4(c)-4(s)-4(,)-4( )-4(h)-4(o)-4(c)-4(k)-4(e)-4(y)-4(,)-4( )-4(j)-4(u)-4(d)-4(o)-4(,)-4( )-4(m)-4(o)-4(d)-4(e)-4(r)-4(n)-4( )-4(p)-4(e)-4(n)-4(t)-4(a)-4(t)-4(h)-4(l)-4(o)-4(n)-4(,)-4( )-4(s)-4(a)-4(i)-4(l)-4(i)-4(n)-4(g)-4(,)-4( )-4(t)-4(a)-4(e)-4(k)-4(w)-4(o)-4(n)-4(d)-4(o)-4(,)-4( )-4(t)-4(r)-4(i)-4(a)-4(t)-4(h)-4(l)-4(o)-4(n)-4(\)-4( )-4(a)-4(n)-4(d)-4( )-4(P)-4(a)-4(r)-4(a)-4(l)-4(y)-4(m)-4(p)-4(i)-4(c)-4( )-4(s)-4(p)-4(o)-4(r)-4(t)-4(s)-4( )-4(\()-4(b)-4(o)-4(c)-4(c)-4(i)-4(a)-4(,)-4( )-4(p)-4(a)-4(r)-4(a)-4( )-4(s)-4(w)-4(i)-4(m)-4(m)-4(i)-4(n)-4(g)-4(,)-4( )-4(w)-4(h)-4(e)-4(e)-4(l)-4(c)-4(h)-4(a)-4(i)-4(r)-4( )-4(r)-4(u)-4(g)-4(b)-4(y)-4(\))-4( )-4(f)-4(o)-4(r)-4( )-4(t)-4(h)-4(e)-4( )-4(E)-4(I)-4(S)-4(,)-4( )-4(a)-4(s)-4( )-4(w)-4(e)-4(l)-4(l)-4( )-4(a)-4(s)-4( )-4(t)-4(h)-4(e)-4( )-4(I)-4(r)-4(e)-4(l)-4(a)-4(n)-4(d)-4( )-4(R)-4(u)-4(g)-4(b)-4(y)-4( )-4(U)-4(n)-4(i)-4(o)-4(n)-4( )-4(t)-4(e)-4(a)-4(m)-4(,)-4( )-4(t)-4(h)-4(e)-4( )-4(L)-4(a)-4(w)-4(n)-4( )-4(T)-4(e)-4(n)-4(n)-4(i)-4(s)-4( )-4(A)-4(s)-4(s)-4(o)-4(c)-4(i)-4(a)-4(t)-4(i)-4(o)-4(n)-4( )-4(a)-4(n)-4(d)-4( )-4(L)-4(e)-4(i)-4(c)-4(e)-4(s)-4(t)-4(e)-4(r)-4( )-4(C)-4(i)-4(t)-4(y)-4( )-4(F)-4(C)-4(.)-4(A)-4(d)-4(d)-4(i)-4(t)-4(i)-4(o)-4(n)-4(a)-4(l)-4( )-4(r)-4(e)-4(s)-4(e)-4(a)-4(r)-4(c)-4(h)-4( )-4(w)-4(a)-4(s)-4( )-4(u)-4(n)-4(d)-4(e)-4(r)-4(t)-4(a)-4(k)-4(e)-4(n)-4( )-4(\()-4(s)-4(u)-4(p)-4(p)-4(o)-4(r)-4(t)-4(e)-4(d)-4( )-4(b)-4(y)-4( )-4(s)-4(t)-4(u)-4(d)-4(e)-4(n)-4(t)-4(s)-4(h)-4(i)-4(p)-4(s)-4( )-4(f)-4(o)-4(r)-4( )-4(E)-4(I)-4(S)-4(\))-4( )-4(t)-4(o)-4( )-4(e)-4(v)-4(a)-4(l)-4(u)-4(a)-4(t)-4(e)-4( )-4(“)-4(w)-4(h)-4(a)-4(t)-4(”)-4( )-4(t)-4(h)-4(e)-4( )-4(performance analysts, working for the EIS, were delivering to GB Olympic and Paralympic coaches [. Td5pF2 11.02 Tm0 gearch thech 7(o3(ghverin)4(g tghver)-4(by)he)3( )-4(E)15(I)-4

Paralympic teams, through further advisory work with individual analysts and the delivery of specific workshops.

In relation to elite sport practice, impact has been particularly significant in squash where much of this work was pioneered, but has also been evident in other elite sports. The period of research and collaboration with the English National squash squads was one of unprecedented success for England squash. Three players (Laura Massaro, Nick Matthew and James Willstrop achieved world number one ranking between 2010-2016, including Laura Massaro in 2016 and Nick Matthew in 2014 - a feat that has not been achieved since - and individual Gold medals were won at the Commonwealth games by Nick Matthew (Glasgow 2014) and James Willstrop (Gold coast 2018).

Whilst the precise link between our research and performance is difficult to demonstrate, the testimonies of a number of senior sports scientists and coaches indicates the importance of this relationship. For example, the head of performance analysis at the EIS stated: “

Likewise, the head of Sports Science at HPSNZ [ ] (previously England squash team manager and performance analyst) noted “

Three major areas of impact from this work have been evident: (1) the development of more accurate performance profiles of opponents and greater tactical planning; (2) the introduction of training adaptations; (3) improved communication between coaches and performance analysts.

Our research has led directly to a number of major adaptations in training. In squash, the analysis of changes in tactical shot selection as a consequence of rule changes [ ] led to changes in squash specific training. The coach of England squash stated “

”. Fitness sessions were altered to better reflect the changes in rally durations and the proportion of shots played to the front of the court. A new form of ‘ghosting’ (in response to [ ]) was introduced (this involves running typical squash trajectories, at elite level primarily for fitness conditioning, lower level players also develop better movement patterns) where the video of a player in competition was projected onto the front wall of the squash court. A player on court then mirrored the movement of the player on the video. This was used to condition players for the new patterns of play but also to prepare players for the demands of playing against a specific higher ranked player and opponents who displayed very different tactical approaches [ ]. The research on tactical shot selections [ ], to better understand the factors affecting decision-making, allowed coaches to better prepare players by identifying situations, and devising training sessions to improve performance, where anticipation was possible, defensive shots were tactically superior to more attacking ones, and vice versa, and what type of shots were to be expected from forthcoming opponents in different tactically important situations. A previous England coach [ ] and coach of 11 World titles said that “