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Pathway 2 Podium: A Multidisciplinary and Mixed Method Approach to Enhancing the Efficacy of Talent Development Systems

Langham-Walsh, Eleanor

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Pathway 2 Podium: A Multidisciplinary and Mixed Method Approach to Enhancing the Efficacy of Talent Development Systems

Eleanor Langham-Walsh

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Supervisors: Dr Vicky Gottwald and Dr James Hardy

Declaration and Consent

Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw'r thesis hwn, ac eithrio lle nodir yn wahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid yw sylwedd y gwaith hwn wedi cael ei dderbyn o'r blaen ar gyfer unrhyw radd, ac nid yw'n cael ei gyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan y Brifysgol, am gymwysterau deuol cymeradwy.

I hereby declare that this thesis is the results of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.

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Thesis Abstract

This thesis expands on the current expertise development literature building upon previous research in the field (Güllich et al., 2019; Jones et al., 2019). It aims to highlight problems associated with identification in talent systems and looks to undertake multidisciplinary and prospective research to gather insight into sport specific nuances in talent development. It is the first research of its kind to longitudinally and prospectively examine all multidisciplinary factors relevant to talent development within individual sports. This thesis contains six chapters, four of which are empirical studies.

Chapter 1 critically reviews the relevant literature relevant to talent identification and development (TID) specifically: the underpinnings of "talent"; the problem with talent identification; talent development models and approaches; and influential factors in athlete TID. This chapter addresses the empirical limitations of previous TID research providing rationale for this thesis. These discussions are centred around the lack of longitudinal, multidisciplinary, and prospective research that examines sports as individual entities providing us with a framework for our research.

Chapter 2 explores the relative age effect in gymnastics and takes a novel approach emphasised by Jones et al. (2018) by further examining the prevalence of intra-sport differences. Poisson regression analysis indicated no relative age effect in the full sample of elite, international, women's artistic gymnasts but an effect that manifested when analysing apparatus independently. Our results identified that relatively younger gymnasts were 27% and 21% more likely to make major international beam and vault finals respectively. Our findings can be attributed to the influence of self-fulfilling prophecy (Merton, 1948) upon coach and gymnast expectations, as well as the technical mechanisms underpinning skill development involved in the underdog hypothesis (Gibbs et al., 2012). This chapter adds to the limited research base surrounding the influence of the RAE in gymnastics, whilst also being the first study to our knowledge to examine the differences of apparatus specialism.

Chapter 3 presents three studies that seek to develop the Athlete Psychosocial Survey (APS), a brief profiling tool gauging athletes' scores on psycho-social factors influencing elite performance. The first two studies consisted of item generation and instrument construction, with initial analysis confirming the preliminary concurrent and convergent validity of the measure. The third study utilised a novel analytical strategy and provided evidence for the predictive validity of the APS with the ability to discriminate between two samples of high- and low- level hockey players with 87% accuracy. The practicality of our measure means that coaches and practitioners can gauge many psychosocial constructs pertinent to athlete development and readily incorporate

them into their talent development programmes. This in turn aids the progression of talent development systems by enabling the integration of multiple perspectives alongside greater athlete insight for coaches and practitioners than what is currently available.

Chapter 4 takes a longitudinal, prospective, and multidisciplinary approach to talent development within canoe sprint. Data was collected over a period of 18 months and analysed using state of the art machine learning analysis. Following this an 11-feature model was identified consisting of multidisciplinary variables that could discriminate between high- and low- potential athletes with 79% accuracy. Specifically, this chapter highlighted the interactive influence of an athlete's early developmental experiences, the microstructure of practice, and their ability to cope with challenge on their development. The results of this chapter were discussed with a working group of British Canoeing managers, coaches, and support staff to enhance the interpretation of the findings and provide recommendations going forward.

Chapter 5 followed on from a quantitative, multidisciplinary investigation of factors relevant to the development of canoe slalom athletes and qualitatively examined the psychosocial factors and experiences that underpinned an athlete's developmental journey. Taking a critical realist approach, we built upon Hardy et al.'s (2017) findings and undertook semi-structured interviews with four pathway level athletes. Seven themes from our data emerged as influential to athlete progression specifically: (a) early developmental experiences, (b) relationship with sport, (c) personality, (d) ongoing developmental experiences, (e) athlete behaviors, (f) support networks, and (g) pressure zone and emotion regulation. Our findings add to the broader knowledge base surrounding the psychosocial processes underpinning the development of elite athletes whilst also providing important implications for applied practice.

Chapter 6 is a general discussion and compiles of the main findings from this thesis. We discuss the practical and theoretical implications that emerge from this research and propose future research directions to advance this research further.

Finally, Chapter 7 presents examples of the dissemination and impact work completed alongside this thesis.

Chapter 1:

General Introduction

National Governing Bodies (NGBs) around the world invest hundreds of millions of pounds (UK Sport, 2018) into maximising the chance of medal success. With the ever-increasing opportunities for commercial and financial rewards within the modern Olympic and Paralympic landscape (Smart, 2018), competition for Olympic and World Medals is at an all-time high. NGBs, clubs, and coaches seek to provide an environment where they can nurture these potential high achieving athletes through the delivery of talent identification and development (TID) programmes. However, the efficacy and predictive accuracy of these systems is somewhat limited, with research showing that early performance and involvement in these programmes is not associated with later success in the sport (Ackerman, 2013). Güllich and Cobley (2017) show that as little as ~2% of athletes involved in TID programmes go on to achieve long term success, potentially indicative of over-investment of resources by funding bodies. The present chapter will first explore the theoretical and philosophical underpinnings of talent to get an enhanced understanding of the foundations of TID programmes. It will then go on to review the relevant talent identification literature, examining problems with talent identification and then explore talent development models. Finally, this chapter will explore factors identified as influential within talent development and their subsequent role within TID systems.

1.1 Underpinnings of "Talent"

The nature-nurture debate is one of the oldest philosophical debates within psychology and still holds influence over various psychological standpoints. It centres on the involvement of both the environment and genetics on human behaviour and development, and whilst today, many experts recognise the important role of both factors, past debates have often taken a more one-sided approach (e.g. Freud's theories on innate drives; Freud, 1920). The extreme nativist view (also known as the nature perspective) takes the standpoint that genetics influence our behaviour, and that behaviour and development are a product of our genetic traits. The origins of this perspective come from early philosophers like Plato and Descartes whose views originated through philosophy and religious beliefs. Plato held the view that once a human dies their soul is reincarnated into another human and all knowledge from that former life is passed on (Allen, 1959); knowledge is something that is innate and not learned. The Cartesian school of thought (Descartes, 1641) also adopted a similar view that the body and mind were separate, a concept also known as dualism. Descartes explained that God put innate ideas in the mind and that whilst one could examine these ideas they could not be manipulated. These views typically take on a nature perspective and have paved foundations for scientific theories following them. Lombroso's theory of the born criminal (Lombroso-Ferrero, 1911) explained that criminality was an inherent characteristic characterised by physiological features that bore similarity to apes and early man (e.g. large jaws and high

cheekbones). Chomsky (1965) also took a strong nativist approach when he proposed his language acquisition device, which accounted for a child's innate ability to learn language.

The nurture perspective, on the other hand takes a behaviourist approach and assumes that all behaviour is learned through the environment. In Locke's (1690) Essay Concerning Human Understanding, he rejected the orthodox Cartesian viewpoint of innate ideas, taking the stance that the mind is like a blank slate (Tabula Rasa). He explained that experience and perception are the determinants of knowledge, a school of thought now known as empiricism. This lead the way for a shift away from the biologically deterministic perspective and towards the behaviourist perspective first introduced by Watson (1913); a point of view encompassing the nurture standpoint. Watson and Rayner (1920) provided support for this perspective through their well-known Little Albert study where they induced a phobia in a child through classical conditioning. This study aided the acceptance of nurture in the scientific field and continued the advancement of the behaviourist perspective. Bandura (1977) followed up on from this with the development of social learning theory (SLT), which explains how behaviour is learnt through observing, imitating, and modelling. His Bobo doll experiment (Bandura et al., 1961) lent support to SLT by demonstrating how aggressive behaviours can be learnt through observation and imitation. Children who were exposed to an aggressive model within a play setting were more likely to imitate the exact behaviour they had observed when left to play by themselves. In comparison, children who had observed a non-aggressive model subsequently behaved less aggressively. Whilst support has been provided to both sides of the nature-nurture argument, today most researchers adopt an approach that considers an interaction between the two. This view is also widely acknowledged within TID programmes with most experts recognising that both factors play a critical role (Simonton, 2001). However, the underlying nature-nurture perspectives, still have an influence on perceptions of what defines a talented individual.

Research from Galton (1869) sets the foundations for the scientific study of talent specifically, by explaining that genius, or talent, is an inherited phenomenon passed down through generations. He defined talent as "an ability that was exceptionally high and at the same time inborn" (p. 8). His research centred around demonstrating that achievement across a variety of domains (e.g., science, poetry, music, and sport) was determined by genetic factors with his findings showing that high performing individuals often ran in families. The nature perspective taken by Galton puts forward the view that talent is something that is born and not made and underpins a lot of talent identification perspectives to date. For example, Cobley et al. (2012) define talent as "the quality (or qualities) identified at an earlier time that promotes (or predicts) exceptionality at a future time" (p.3), and Brown (2001) as a special ability that comes about naturally. Others take an approach more in line with the nurture position, with Gagné (2005)

defining talent as “the outstanding mastery of systematically developed abilities (or skills) and knowledge” (p. 120). Davids et al. (2017) also acknowledge the role of the environment in talent, describing talent as “the functional relationship developed between a performer and a specific performance environment” (p. 193). Due to differing underlying perspectives there does not seen to be a global definition of talent, and thus inconsistencies in how we may identify it. Whilst the consensus among definitions is that talent is a trait and often “exceptional” or “special” and above the average ability, different definitions place different emphasis upon where talent develops from (i.e., born or made), and likely stems from the position taken within the nature-nurture debate. Within this thesis, talent is framed as a trait that can be developed and influenced over time from an initial propensity into exceptional performance.

1.2 The Problem with Talent Identification

Talent identification has been defined as “the process of recognising current participants with the potential to excel in a particular sport” (p. 703; Vaeyens et al., 2008). The reality of working in elite sport means that resources are often limited, and so talent identification provides a means to utilise these resources effectively by targeting athletes with the most potential for success. However, the success of identification itself is somewhat limited and whilst recommendations are made to enhance the efficacy of identification (Till & Baker, 2020), the demand for “quick-hits” within a sport means that what is recommended often does not translate into practice (Baker et al., 2018).

1.2.1 Early Selection

TID systems begin at an early age and despite the lack of research in this age group (Johnston et al., 2018), children as young as eight are being identified as having future sporting potential (Ford et al., 2020). However, an early identification and subsequent selection approach is somewhat problematic, with Güllich (2014) highlighting that only 7% of players selected for a professional soccer academy at U10 were selected again at U19. Some traits will not present themselves until early adulthood with research from Jones et al. (2018) emphasising the importance of tactical awareness and problem solving skills in rugby players, but only once maturation differences amongst players has dissipated. This is consistent with research from Collins and MacNamara (2012), who explained that traits facilitating high level performance come about through key developmental experiences, and so may not become prevalent until later on in an athlete’s career.

Furthermore, selection before the onset of puberty can provide relatively older athletes with an unfair advantage in relation to their relatively younger peers. A consistent finding within the talent identification and development literature is the influence of an athlete’s age in relation to their

peers. The relative age effect (RAE; Barnsley et al., 1985) is a phenomenon whereby the chronological age-grouping of children and adolescents can lead to an overrepresentation of athletes born earlier in the year due to enhanced physical and mental capabilities. If selection occurs early, before these differences have dissipated, then there will likely be a selection bias towards these relatively older athletes. This limitation highlights the need to both measure factors over time and identify athletes at later ages instead of relying on a single time point in a young athlete as a method of selection. Whilst there is a need for identification due to limited resources, future researchers and practitioners should be aware of factors that may not emerge until later in development and consider this when making their selections.

1.2.2 Unidimensional Approach

Within talent identification, there is a clear emphasis upon the role of physical capabilities on talent identification. In their systematic review on talent identification literature, Johnston and colleagues (2018) identified that 60% of the studies they examined only looked at physical profiles. Whilst physical tests and measurements are easy to administer, they are often low in predictive accuracy. For example, Lidor et al. (2005) found that physiological and anthropometrical tests did not discriminate between handball players selected or not selected onto a junior National handball team. This is likely down to there also being a plethora of factors shown to be influential to development that go beyond just that of physical tests. Traits such as tactical awareness, team interaction, and decision making, are all relevant to performance in team sports (Burgess & Naughton, 2010). Psychosocial and behavioural traits in combination with strong support teams and coach-athlete relationships have been shown to underpin Olympic, Paralympic, and World Champions (Burns et al., 2019). Additionally Watson (2017) highlighted the importance of sleep on athlete performance and injury reduction. Section 1.4 reviews multidisciplinary factors commonly influential to TID in more detail. When we consider that there are multiple factors relevant to an athlete's development, identification based upon single factors alone (e.g., physical tests) is unlikely to identify the athletes most likely to succeed. There are several recommendations for considering a variety of different factors and taking a multidisciplinary approach to identification (Johnston et al., 2018), however this poses its own challenges. Longitudinally capturing multiple components of an athlete's journey is time consuming and impractical for most sporting organisations (Till & Baker, 2020). However, future research and applied work should take a concerted effort to approach talent identification in a multidisciplinary manner and not just utilise single discipline measures.

1.2.3 Potential or Performance

A final key area of concern within the talent identification process is performance being used as a predictor of potential with research showing that early performance is not associated with later success in the sport (Ackerman, 2013; Barreiros et al., 2014; Gullich & Cobley, 2017).

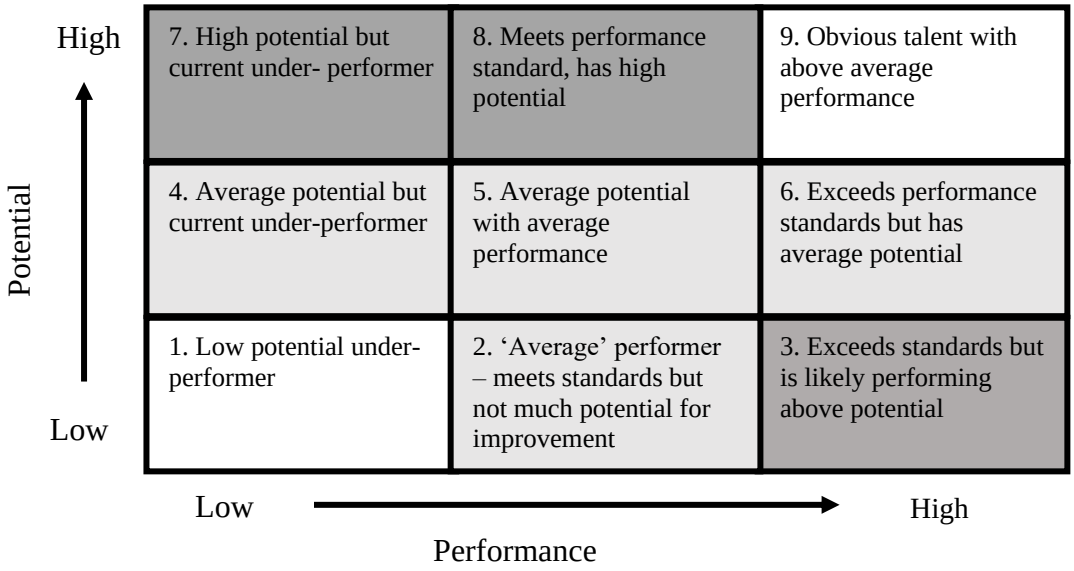
Schumacher et al. (2006) found that only 29.4% of elite cyclists had taken part in a cycling junior World Championship. From those who participated in a junior World Championship only 34% then went onto participate at a major elite competition, indicating that strong performances at a junior level were not pre-requisites for success at high-end sport (Johnston et al., 2018). Despite this, performance indicators are regularly used by coaches to identify athletes believed to have potential in the sport (Vaeyens et al., 2008). Baker et al. (2018) highlighted varying levels of risk regarding the complexities underlying athlete selection when considering potential versus performance (see Figure 1.1); athletes in the dark grey represent highest levels of risk whilst those in white represent the lowest levels of risk. Talent can be lost if the focus is primarily on performance, as high potential but under-performing athletes may not meet the quota for selection. Subsequently, they may have less access to opportunities for competition and development and potential may not be realised. Conversely, high-performing but low potential athletes will get opportunities and resources that would have been more beneficial to their higher potential counterparts. Given the limited resources available in sports, this presents a high level of risk and provides an explanation for why the turnover from identification to high level performance is so low. An additional problem with basing identification upon performance is the cross-sectional nature of this type of identification. Johnston et al.'s (2018) review captured the scarcity of longitudinal research on talent identification highlighting the need for development in this area. The elite sport environment is interactive and dynamic (Phillips et al., 2010), and excluding longitudinal measurement in favour of identification on a single performance timepoint negates to consider this. Future studies should look beyond performance as a predictor of potential and seek to identify factors influential to high performance across multiple time points.

1.3 Talent Development Approaches

Once athletes have been identified and selected, traditional expertise approaches attempt to provide a framework for the development of "talented" performers.

Figure 1.1

Risk Matrix for Talent Identification Decisions



Note. From "Compromising Talent: Issues in Identifying and Selecting Talent in Sport," by J. Baker, J. Schorer, and N. Wattie 2018, *Quest*, *70*(1), 48–63 (https://doi.org/10.1080/00336297.2017.1333438)

1.3.1 Deliberate Practice

The 10,000-hour rule (Ericsson et al., 1993) is one of the earliest approaches to the development of elite performance and proposes that expert performance is developed through deliberate practice as opposed to an innate ability. Ericsson and colleagues (1993) described deliberate practice as a highly structured activity that a learner is engaged in, with the specific goal of improving performance. For the accuracy, speed, and performance of cognitive, perceptual, and motor tasks to be improved practice needs to be intentional, repetitious, appropriate for the current skill level, and include immediate feedback and knowledge of results. Their study on music academy violinists found that the best violinists had accumulated on average 10,000 hours of deliberate practice, significantly more than lower performing groups. The results of their second study also replicated these findings in a group of pianists. The authors attributed the differences in performance to the amount of recorded deliberate practice undertaken within that specific domain.

The main premise of the theory of deliberate practice is that those who engage in large amounts of deliberate practice earlier, will be more likely to develop into elite performers.

Whilst the theory of deliberate practice is popular and well-cited, emerging research is beginning to identify that 10,000 hours of deliberate practice is not the only contributor to expertise development, and that there are other factors that come into play. A meta-analysis by Macnamara et al. (2014) identified the amount of variance deliberate practice accounted for in performance within the domains of: games (26%), music (21%), sports (18%), education (4%) and other professions (<1%). Following on from this, a meta-analysis by Macnamara et al. (2016) in sports performance found that again only 18% of the variance was explained by deliberate practice. This provides support for the importance of deliberate practice as a predictor of performance, but not as the only factor accounting for the differences.

The deliberate practice perspective takes an early specialisation approach to talent development implying that starting training from an early age would pose an advantage by enabling an athlete to undertake more deliberate practice and subsequently improve performance (Ericsson et al., 1993). However, the early specialisation approach has often been criticised by researchers concerned with the consequences early deliberate practice may have on the development of athletes. A review by Baker et al. (2009) identified detrimental factors associated with large amounts of deliberate practice at a young age, for example increased susceptibility towards injury following early intensive training. Imbalances caused by rapid bone growth during maturation combined with increased stress due to physical training could increase the likelihood of osteochondrosis. This is backed up with research from Jayanthi et al. (2015) who found that there was an increased risk of injury in children that specialised in a single sport, which increased as the degree of specialisation intensified. Early specialisation has also been associated with greater levels of dropout (Wall & Côté, 2007) as well as increased burnout among athletes (Difiori et al., 2014).

1.3.2 Developmental Model of Sports Participation

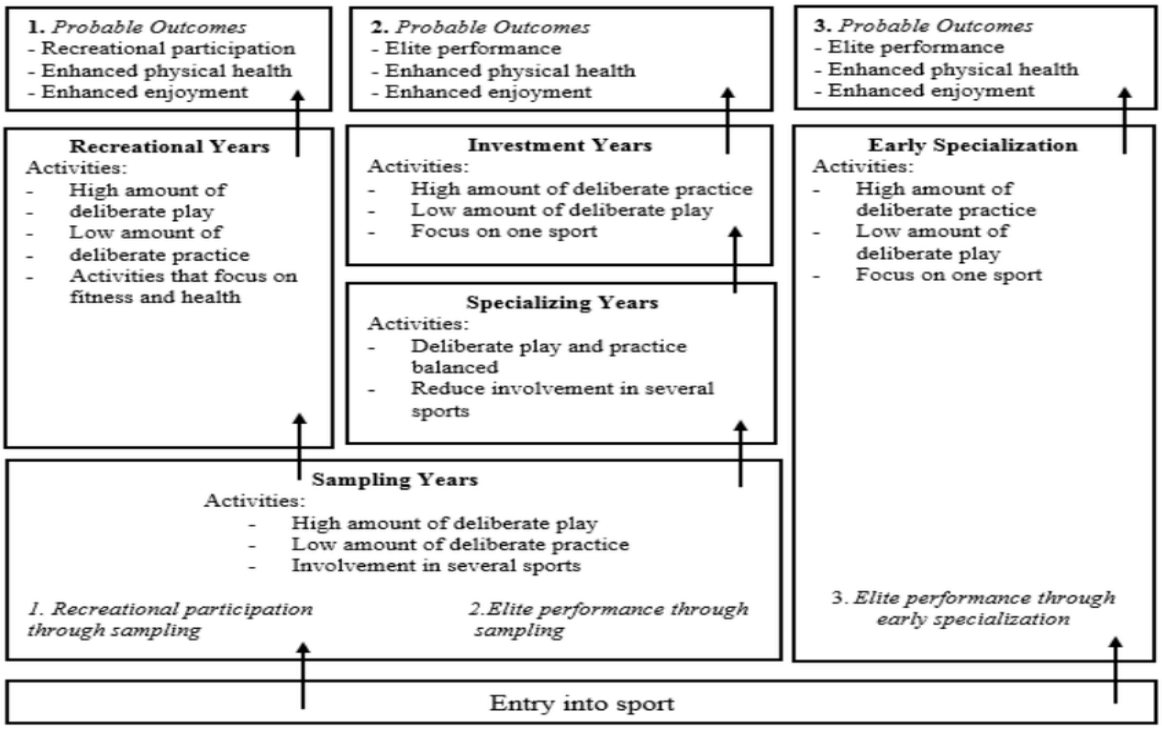
Côté et al. (2007) proposed additional sporting trajectories within their developmental model of sports participation (DMSP), outlined in Figure 1.2. As an additional route to high performance, they outlined the early diversification route where, from the ages of six to twelve, children invest in sampling, the participation in a variety of sports. They also engage in low amounts of deliberate practice and a high amount of deliberate play, practice that is free from focus, inherently enjoyable, and done for its own sake (Côté et al., 2007). Following on from this an individual will engage in the specialisation years (aged 13-15) where they take part in fewer activities and an equal amount of deliberate practice versus play. These years are a transitional stage towards the investment years (aged 16+) where the focus is on individual sport and primarily consists of deliberate practice. The

DMSP identifies seven postulates that integrate the environment and key processes behind performance, participation, and personal development (Côte et al., 2009) needed to invest their effort into highly specialised training in one sport.

1. Early diversification (sampling) does not hinder elite sport participation where peak performance is reached after maturation.
2. Early diversification (sampling) is linked to a longer sport career and has positive implications for long-term sport involvement.
3. Early diversification (sampling) allows participation in a range of contexts that most favourable affects positive youth development.
4. High amounts of deliberate play during the sampling years build a solid foundation of intrinsic motivation through involvement in activities that are enjoyable and promote intrinsic regulation.
5. A high amount of deliberate play during the sampling years establishes a range of motor cognitive experiences that children can ultimately bring to their principal sport of interest.

Figure 1.2

Developmental Model of Sport Participation



Note. From "Practice and Play in the Development of Sport Expertise," by J. Côté, J. Baker, and B. Abernethy, 2017, *Handbook of Sport Psychology*, (pp. 184–202), (10.1002/9781118270011)

6. Around the end of primary school (about age 13), children should have the opportunity to either choose to specialise in their favourite sport or to continue in sport at a recreational level.
7. Late adolescents (around age 16) have developed the physical, cognitive, social, emotional, and motors skills needed to invest their effort into highly specialised training in one sport.

Like the early specialisation route, a probable outcome of early diversification is elite performance. However, contrastingly, this pathway is also associated with more favourable outcomes. Côté et al.'s (2020) overview of early sport specialisation and sampling supported these postulates and highlighted that early diversification is associated with increased participation and reduced attrition, greater personal development and well-being, and a reduction of injuries. Those who specialised later were also shown to achieve higher levels of performance. However, the DMSP does also acknowledge the necessity for early specialisation in sports like gymnastics where peak performance is often reached before the onset of puberty (Côté et al., 2007).

1.3.3 Long Term Athlete Development Model

The Long Term Athlete Development (LTAD) Model (Balyi & Hamilton 2004) offers two pathways: the early specialisation model and the late specialisation model, which provide a framework of athlete development for NGBs, coaches, and practitioners consisting of four and six stages respectively (see Figure 1.3). Within the model, the authors recommend the use of peak height velocity as a reference point for biological age. During the FUNdamentals stage (age 6-9 males / age 6-8 females) participation in multiple sports is encouraged with the aim to build fundamental movement skills such as agility and balance within a fun environment. During the Learning to Train stage (age 9-12 males / age 8-11 females), the emphasis is upon building specialised movement and sports skills. Balyi and Hamilton (2004) highlighted the importance of these two stages and that passing them would likely be detrimental to sport engagement and performance. For children participating in early specialisation sports, they recommended amalgamating these two stages together or finding a way to combine them. The role of the Training to Train stage (age 12-16 males, age 11-15 females) is to consolidate sport specific skills as well as starting to develop key aerobic strength and fitness. The authors specifically highlight the importance of considering individual athlete maturation level with regards to the timing of this stage. The objective of the Training to Compete (age 16-18 males, age 15-17 females) and Training to Win (age 18+ males, age 17+ females) stages is to optimise maximum fitness and sport specific skills and performance. The final phase, the Retirement / Retainment stage, is aimed at retaining athletes in the sport through sport-related careers such as coaching and officiating.

The LTAD model is particularly popular among coaches and practitioners (McKeown & Ball, 2013) providing long-term implications for athlete training and development. It has been utilised to advance training programmes important to athlete development for example plyometric (Lloyd et al., 2011) and resistance (Granacher et al., 2016) programmes. However, a key critique of the LTAD model is that it neglects to consider the multi-dimensional nature of development by offering only single-track routes. It assumes that if all children follow the paths highlighted in the framework, they will achieve elite performance. This excludes the role of external influences, for example psychosocial characteristics (Gould et al., 2002) and early developmental experiences (Côté, 1999), shown to impact upon overall athlete development.

Figure 1.3

Long Term Athlete Development Model

Early Specialisation Model	**Late Specialisation Model**
1. Training to Train stage 2. Training to Compete 3. Training to Win 4. Retirement / retainment	1. FUNdamental stage 2. Learning to Train 3. Training to Train 4. Training to Compete 5. Training to Win 6. Retirement / Retainment

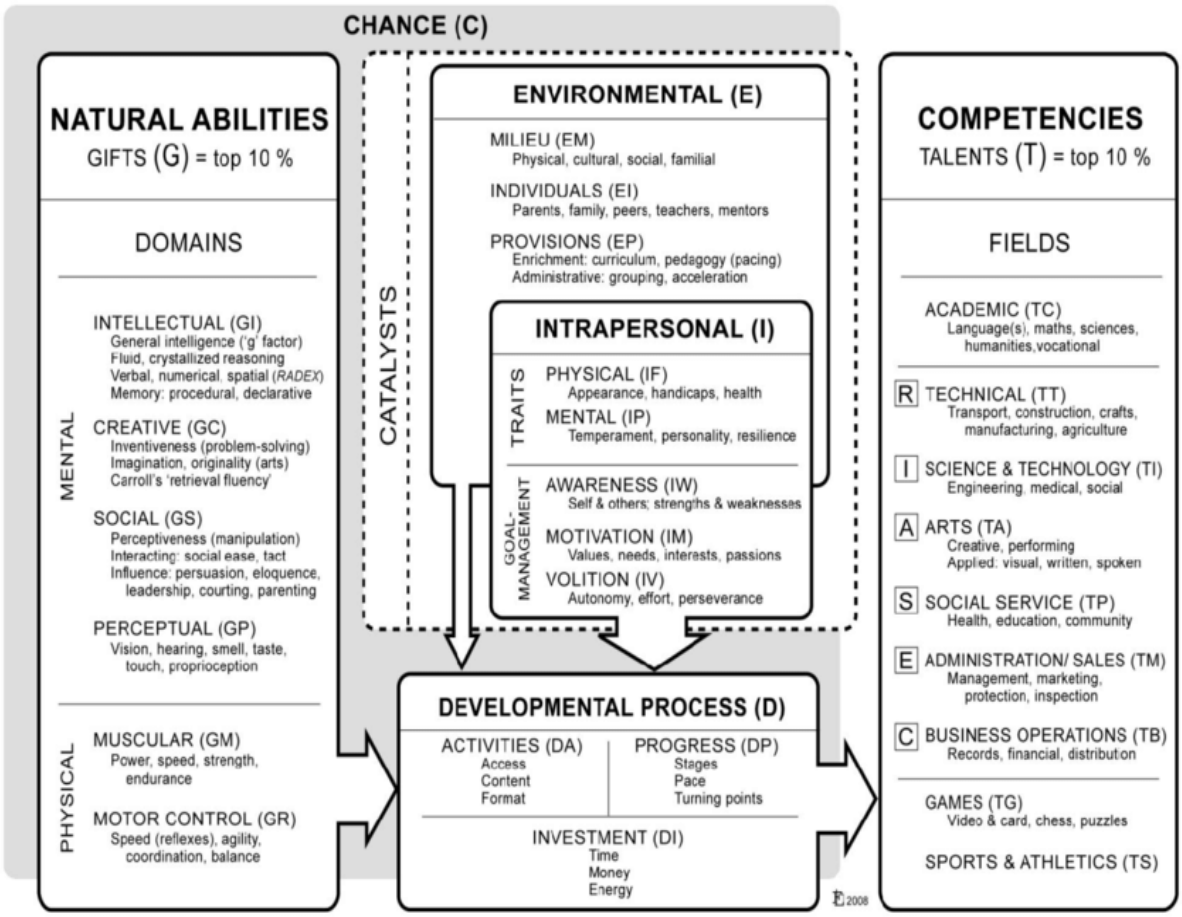
Note. From "Long Term Athlete Development: Trainability in Childhood," by I. Balyi and A. Hamilton, 2004, *Olympic Coach*, *16*(1), 4–9

1.3.4 Differentiated Model of Giftedness and Talent

In comparison, the Differentiated Model of Giftedness and Talent 2.0 (DMGT; Gagné, 2009) is against a one size fits all approach and recognises the influence of multiple components on the development of talents or competencies (see Figure 1.4). The DMGT distinguishes six natural abilities or gifts (intellectual, creative, social, perceptual, muscular, and motor control) where individuals are within the top 10% of their peer groups. Despite being more easily observed in young children due to the reduced influence of other factors, these gifts are not innate and may manifest themselves later in development.

Figure 1.4

Differentiated Model of Giftedness and Talent



Note. From "Building Gifts into Talents: Detailed Overview of the DMGT 2.0," by F. Gagné, 2009, *Leading Change in Gifted Education: The Festschrift of Dr. Joyce Vantassel-Baska, (pp 61-80).*

Talent in domain specific fields emerges through the development process of these gifts and is comprised of activities, investment, and progress. A child is first identified or selected into a system and offered activities within an environment designed to aid learning. They will move through different stages (e.g., novice – elite) towards their end goal and invest significant resources with regards time, money, and psychological energy into their development. The authors also outlined that other turning points would occur during the athlete's long-term development for example experiencing a significant turning point or critical foundational experience (cf. Hardy et al., 2017).

The talent development process is either facilitated or hindered by intrapersonal and / or environmental catalysts. The DMGT identifies intrapersonal catalysts as personal traits (e.g.,

personality and physical characteristics) and self-management processes for example motivation and awareness, whilst environmental catalysts refer to the diversity of environment, the psychological influence of significant others within this environment, alongside access to provisions (e.g., talent development programmes). Unlike other talent development models, the DMGT recognises the influence of chance (e.g., injury, family income, and year of birth). Whilst Gagne highlighted that chance was not a causal factor, he identified its importance upon the degree of control developing individuals had over their environment.

1.3.5 Summary

With the exception of the DMGT2, a similarity among the outlined talent development models is the sole focus upon the training stages. Traditionally, talent development models (such as the DMSP) have neglected the influence of external factors beyond the training environment despite research indicating that athlete development is influenced by a variety of additional factors (Güllich et al., 2019). These models also negate to consider the non-linear progression of athletes who may move from one stage to another at different points in their development. The DMGT2 moves away from this by taking more in-depth consideration of external influences, such as parents and family and interpersonal skills the athlete might possess. It adopts the multidisciplinary nature of talent development and is a strong addition to the literature. Despite this, none of the talent development models have considered what practice looks like within the developmental environment and instead assumes a generic view of practice (such as deliberate practice, or simply outlining that the format will have an influence). Moving forward literature into talent development and models produced going forward should seek to give a more detailed account of which practice is likely to be beneficial to development alongside consideration of the multitude of factors shown to be important to the talent development process.

1.4 Influential Factors

To summarise so far, there does not seem to be one consistent developmental approach that can be utilised within and across sports. There are, however, key variables that are consistently recognised as having an influence over talent development. This next section will explore some of these variables, identifying the influence they have and the implication this has on athlete development.

1.4.1 Microstructure of Practice

Whilst there is a strong association between volume of practice and expertise development (Ericsson et al., 1993), recent literature has highlighted the importance of considering the microstructure of practice with regards to athlete progression (Farrow & Robertson, 2017; Jones et al., 2020). Skill acquisition literature also highlights the importance of challenge within training and

how this can subsequently enhance skill development. Challenge point framework (Guadagnoli & Lee, 2004) advocates for an "optimal" level of challenge dependent on the (a) skill level of the performer, (b) the task complexity, and (c) the task environment, where learning is most robust. Increasing task difficulty may increase learning potential but could also lead to a drop in performance; an optimal challenge point exists where learning potential is maximised and decreases in performance is minimised. The authors stipulate that task difficulty may occur as a function of contextual interference, whereby the presence of interference during practice enhances learning (Battig, 1966; Shea & Morgan, 1979). Whilst initial performance may be weaker in the acquisition phase, retention and transfer will be improved (Shea & Morgan, 1979). Contextual interference may occur due to variability of practice (Schmidt, 1975), whereby frequent changes present an individual with multiple versions of a task (e.g. choppy waters on a water-based sport course encouraging a change in paddling stroke). Through exploration of the practice structures of elite and super-elite cricketers, Jones et al. (2020) found that super-elites undertook more varied practice than their elite counterparts highlighting the need for investigation of this within expertise research.

An additional component of the microstructure of practice relating to expertise development is the specificity of practice principle (Henry, 1958), which states that practice conditions should mimic the targets conditions to enhance optimal learning. With competition performance the intended output, training under conditions that mimic a competition scenario are likely to result in better performance. Research has indicated that training under conditions of anxiety (e.g. race simulations) have been shown to increase performance under pressure (Lawrence et al., 2014; Oudejans & Pijpers, 2009) . One might also infer that the specificity of practice principle would apply to the training of the motor programme during training and whether the skills were trained as part or whole movements. Previous research investigating the microstructure of practice in expertise development has provided support for the specificity of practice principle (Jones et al., 2020; Rothwell et al., 2017). However, research in an applied setting within this domain is scarce and further investigation is needed.

1.4.2 Relative Age Effect

As outlined in Section 1.2.1, the RAE has implications for talent identification, with a selection bias towards relatively older athletes often due to their advanced maturity status (Cobley et al., 2009). Whilst there is a vast amount of support and proposed underlying mechanisms for a RAE favouring those born earlier in the year (Cobley et al., 2009), recent research has also identified a reversal in the RAE and consequently an overrepresentation of relatively younger athletes at elite levels (McCarthy et al., 2016). Gibbs et al. (2012) found that a strong RAE existed among Canadian-born National Hockey League (NHL) players in the minor league rosters and first round draft picks. However, for the average player in the NHL this effect was significantly diminished and had reversed

at the most elite levels of play. As little of 13% of the 2009 All-stars team and the 2010 Olympic team were born in the first three months of the year. The underdog hypothesis (Gibbs et al., 2012), explains that challenge experienced by relatively younger athletes encourages the development of attributes needed for superior performance, for example technical and psychological skills. Whilst these traits may not be salient within the younger age groups, when maturation differences have disappeared and relatively older athletes no longer have a physical advantage, these traits become more beneficial to performance (Cumming et al., 2018). Jones et al. (2018) explained that an overrepresentation of Q4 (those born in the last quarter of the year) rugby forwards was attributed to a "rocky road" (Collins & MacNamara, 2012) developmental trajectory, whereby initial challenges promoted the development of psychological resilience and mental toughness to give athletes not only the physicality but also the mindset needed to succeed.

1.4.3 Challenge

Experiencing challenge, both physically and psychologically, throughout an athlete's journey has also been identified as a key contributor to success. The underdog hypothesis (Gibbs et al., 2012), as outlined in Section 1.4.2, proposes that the development of core psychological, technical, and / or tactical skills needed for success at the highest levels comes about through the experience of challenge (e.g., being smaller or less advanced than others). Collins and MacNamara (2012) also emphasised that potential talented performers needed challenge to facilitate high level performance. They explained that the skills gained from overcoming these situations (e.g., resilience and coping mechanisms) could transfer to the sporting domain and provide athletes with an adaptation that was beneficial to their long-term development. Whilst trauma may occur organically (e.g. parental divorce or a death in the family), the authors highlighted the importance of not relying on chance but instead integrating challenge throughout a pathway. Hardy et al. (2017) also acknowledged the importance of challenge and recognised that a negative critical life event in the athlete's formative years could facilitate their need for success. However, they also emphasised the need for this event to occur in temporal proximity to a positive critical sporting event to buffer against the potential maladaptive outcomes associated with negative experiences (Douglas et al., 2010).

1.4.4 Psychosocial Factors

For years psychosocial factors have been identified as crucial to the development of elite performers (Gould et al., 2002). In particular, the early developmental environment of an athlete and the values they are exposed to, is something of noticeable influence. Research has highlighted that values held by a parent are often adopted by their child (Sabatier & Lannegrand-Willems, 2005), identifying the importance of the athlete's early environment in the development of traits influential to their progression. For example, a culture of striving in early formative years where a

child experiences an environment of expectation, a strong work ethic, and a high competitive environment can influence the development of an athlete and shape the behaviours which they exhibit within their sport (Hardy et al., 2017). Furthermore, the motivational climate an athlete is exposed in their development to can underpin intrinsic motivation (Granero-Gallegos et al., 2017) alongside a focus and desire on winning (Waldron & Krane, 2005). An athlete's own goal orientation is also important for their development with a mastery focus consistently shown to be adaptive to athlete development (Morris & Kavussanu, 2009). Whilst outcome goals have traditionally been associated with more mal-adaptive outcomes (e.g. increased likelihood of burnout; Daumiller et al., 2021), research also emphasises the dual role of both outcome and mastery focus on positive athlete development (Harwood et al., 2000).

In addition to the role of the early environment, there is substantial evidence highlighting the importance of personality on athlete development and progression (Allen et al., 2013). Whilst there is an abundance of personality traits shown to have both direct and indirect influence (e.g. obsessiveness & extraversion; Vallerand et al., 2008; Woodman et al., 2010), two of the most prevalent personality traits are conscientiousness and perfectionism (Gould et al., 2002), which have been shown to be important for both training behaviours and performance (Orlick & Partington, 1998). Alongside more "traditional" personality traits, there is new research coming to light surrounding the positive influence of less socially desirable characteristics (e.g. ruthlessness; Vaughan & Madigan, 2020) which warrants further investigation.

Training behaviours of elite athletes are also relevant with high-level athletes able to maximise their training and performance opportunities to enhance their development (Burns et al., 2019). This was something identified in Hardy et al.'s (2017) study of elite and super-elite athletes where they found that both elite and super-elite athletes exhibited a high commitment to training. They also identified that super-elites had a high quality of preparation, a variable which discriminated between the two groups. MacNamara et al. (2010a, 2010b) also highlighted the importance of these variables within their Psychological Characteristics of Developing Excellence (PCDEs). The PCDEs are psychological factors that facilitate the translation of potential into talent and encompass factors such as mental skills, attitudes, emotions, and desires.

1.5 Summary of Research Limitations

To summarise, there is an abundance of literature covering TID perspectives, but unfortunately, much of this research fails to follow best practice recommendations. Based upon their experiences researching and working within TID systems, Till and Baker (2020) proposed recommendations to overcome these challenges in TID. For example, they recommend developing multidisciplinary tools that can be used to monitor athletes across multiple timepoints as well as

taking a multi-dimensional and longitudinal approach to research before using this to inform practitioners and policy makers. For the most part, current research ignores the longitudinal and multidisciplinary nature of talent development (Güllich et al., 2019) in favour of one-dimensional and cross-sectional factors. Statistical analysis within the field of expertise often takes a linear approach, only considering individual domains in isolation which are then combined to produce development models and form the basis of TID programmes within sport.

Recently, there has been a move towards utilising machine learning techniques within talent development research (Güllich et al., 2019; Jones et al., 2019). This has enabled more in-depth investigation of the multitude of factors shown to be influential to athlete development. Exploring the interactions between these variables is a prominent step forward highlighted by the far superior predictive values of these studies. However, the retrospective nature of these studies is problematic as an athlete's recall over time is questionable and can often systematically be biased (Côté et al., 2005). Bahrick et al. (1996) found that positive achievement was associated with greater accuracy of recall, which has significant implications for these studies. Given the comparison of groups based upon performance level, this could bring into question the recall of some of the lower-level athletes. Whilst there has been an attempt to protect against these limitations (e.g., use of a matched pairs design and triangulation of athletes, parents, and coaches), future research should consider taking a prospective approach to research in this field.

There is also a lack consideration of both inter- and intra- sport differences within expertise research. Whilst studies taking a broad-brush approach across sports have strong implications through their identification of key determinants of high level performance (Burns et al., 2019; Gould et al., 2002; Güllich et al., 2019), the assumption that all sports exist as homogeneous entities is somewhat simplistic. This method neglects to consider sport and positionally specific demands and practice structures (see Jones et al., 2019) that will ultimately have long-term development implications for individual sports. This is particularly relevant with regards to practice structure, with current development models only offering a generalised view of "practice" (e.g. deliberate practice or play; Côté et al, 2007) and limited applied research investigating the microstructure of practice.

1.6 Thesis Rationale

There is an abundance of research into TID that is utilised by both coaches and practitioners. However, as discussed above, areas of this literature are flawed providing reasoning for the limited efficiency of TID programmes to date. As identified within the review of the literature, early selection based solely upon physical characteristics can often lead to a bias within cohorts of selected athletes (Jones et al., 2018), something not always considered within TID systems.

Subsequently, I looked to provide additional support for the problems associated with early identification by examining the differences in the RAE within gymnastics, a relatively neglected sport in the RAE literature. Chapter 2 provided a basis for the thesis by highlighting why research should move away from an identification only perspective, instead taking an approach that considers the multidisciplinary development of athletes over time, not simply at a singular timepoint based upon physical characteristics alone. It also emphasised the importance of taking a sport-specific approach due to the unique findings that emerged in gymnastics comparison to more traditional sports (Cobley et al., 2009). To undertake multidisciplinary research, it was key to be able to measure these constructs efficiently (Till & Baker, 2020). Whilst the literature highlights psychosocial factors to be prominent in athlete development (e.g. MacNamara et al., 2010a, 2010b; Hardy et al., 2017), there is a lack of measures that encompass the majority of relevant constructs. This precludes the ability to undertake multidisciplinary research that is inclusive of psychosocial factors. Chapter 3 addressed this through the development and preliminary validation of the Athlete Psychosocial Survey (APS). Evidence was provided on how to use the APS in a sport-specific (hockey) manner to enhance psychosocial areas of development. In line with the premise of this thesis, Chapter 4 followed on and used the APS as part of longitudinal, prospective, and multidisciplinary research and builds upon previous literature using similar methodologies within the field (Güllich et al., 2019; Jones et al., 2019) that enabled us to encompass the interactive and multidisciplinary nature of talent development. Specific focus was placed upon canoe sprint adding value to the literature based by identifying nuanced characteristics specific to individual sports. A multidisciplinary approach was taken to data collection collecting athlete psychosocial, practice and training, and health and wellbeing data prospectively over 18 months. Machine learning techniques were then employed to identify critical interacting variables of interest. This addressed previous limitations of the talent development literature by being the first study to examine longitudinally and prospectively the multidisciplinary factors relevant to talent development within a single sport. Whilst undertaking research with a large breadth is beneficial, adding depth to findings is a crucial next step. To follow on from this, in-depth qualitative analysis within Canoe Slalom in Chapter 5 added richness to initial findings and provided additional support to conclusions made. It addressed previous limitations in the literature by examining a sport specific sample and protected against recall accuracy. In summary, the aim of this thesis, was to highlight problems associated with identification in talent systems and look to understand the differences in psychosocial, practice and training, and health and wellbeing components of athlete progression across sports. This thesis seeks to prospectively identify influential components that contribute to overall athlete development.

1.7 Pathway 2 Podium Project

The framework for this thesis was developed in collaboration with UK Sport and British Canoeing as part of a wider project, The Pathway 2 Podium Project, which aimed to prospectively examine athletes from their development through to podium across a variety of sports. This project is a follow up to the GBM project (Güllich et al., 2019), which retrospectively examined the journeys of Great British elite- and super-elite athletes identifying common and discriminating features that were influential to their success. The Pathway 2 Podium Project aimed to address the limitations of this original study by using a prospective data collection methodology and examining multiple sports as both individual and grouped entities. Undertaking this research as part of a wider project ensured the opportunity to have input from experienced researchers, academics, and practitioners across multiple disciplines. It also influenced the nature of the data collection and the constructs that were collected. Throughout this thesis, I have used the word I to clearly indicate what work was completed by myself and when my thoughts guided the development of ideas. I have used we when idea development or data collection was undertaken by others. Overall, there were five sports involved in the Pathway 2 Podium Project, canoe sprint and slalom, swimming, rowing, and hockey. Initial uptake of sports into the project was challenging and it was 18 months until data collection was able to commence. The lack of sport sign-up and delay in data collection provided an opportunity for researcher skill development and the chance to examine a research interest where there was a noticeable gap in the literature. From this, the first study came about. . This study was initially undertaken within gymnastics due to the fact gymnastics had been identified as a potential sport involved in the project providing some explanation for the discontinuity between the first study and the remainder of the thesis. However, this study also framed the thinking of subsequent chapters by highlighting problems with early identification.

1.8 Thesis Structure

This thesis is presented as a series of research articles (Chapters 2 – 5) which represent the dual aims of writing for both thesis and publication. Because of this, some introductory information contained in Chapter 1 may also be repeated throughout the empirical chapters. Supplementary information for Chapters 2 -5 is presented in the appendices.

1. Chapter 2 examines the relative age effect in gymnastics exploring both inter- and intra-sport differences.
2. Chapter 3 addresses the issue of uni-dimensionality in talent identification and development programmes. The Athlete Psychosocial Survey was developed and validated across three separate studies to provide a tool for use within multidisciplinary investigations.

3. Chapter 4 presents a prospective, longitudinal, and multidisciplinary investigation of Great Britain canoe sprint pathway athletes utilising a contemporary machine learning approach. Pattern recognition analysis was used on a set of 808 multidisciplinary variables collected over 18 months to develop a framework of critical variables pertinent to development.
4. Chapter 5 takes a more in-depth approach and qualitatively examines the mechanisms underpinning the development of Great Britain canoe slalom pathway athletes.
5. Chapter 6 provides a general discussion of the theoretical and applied implications of this thesis alongside future research directions.
6. Finally, Chapter 7 provides an outline of the dissemination and impact of this work within British Canoeing.

Chapter 2:

Relative Age Effect? No "Flipping" Way! Apparatus Dependent Inverse Relative Age Effects in Elite, Women's Artistic Gymnastics[1]

[1] This chapter is published as:

Langham-Walsh, E., Gottwald, V., & Hardy, J. (2021). Relative age effect? No "flipping" way! Apparatus dependent inverse relative age effects, in elite women's artistic gymnastics. *PLOS One, 16(6),* e0253656.

2.1 Abstract

In contrast to research on team-sports, delayed maturation has been observed in higher-skilled gymnasts, leading to atypical distributions of the relative age effect. Recent studies have reported intra-sport differences in the relative age effect and given the task demands across women's artistic gymnastics apparatus, we expected to find evidence for the influence of apparatus specialism. We examined the presence of a relative age effects within a sample of elite, international, women's artistic gymnasts (N = 806, $N_{countries}$ = 87), and further sampled our data from vault, bars, beam, and floor major competition finalists. Poisson regression analysis indicated no relative age effect in the full sample (p = .55; $R^2_{adj.}$ = .01) but an effect that manifested when analysing apparatus independently. The Index of Discrimination (I_D) analysis provided evidence of an inverse relative age effect identified for beam (p = .01; I_D = 1.27; $R^2_{adj.}$ = .12), a finding that was corroborated by a marginal effect in our vault finalists (p = .08; I_D = 1.21; $R^2_{adj.}$ = .06). These novel findings can be attributed to the integrated influence of self-fulfilling prophecy upon coach and gymnast expectations, as well as the technical mechanisms underpinning skill development involved in the underdog hypothesis.

2.2 Introduction

A consistent finding within the talent identification and development literature is the influence of an athlete's age in relation to their peers (Cobley et al., 2009). The relative age effect (RAE; Barnsley et al., 1985) is a phenomenon whereby the chronological age-grouping of children and adolescents can lead to an overrepresentation of athletes born earlier in the year within a cohort. Inherent in sporting and education systems, children and adolescents are frequently grouped together based on chronological age; for example, a child's birth month within the British September to August school year influences which school year they are assigned to (Cobley et al., 2009). However, within this type of grouping there can be nearly 12 months difference between the oldest and youngest, leading to a variation in cognitive (Cobley et al., 2009), physical (Silva et al., 2010), and emotional (Lewis & Haviland, 1993) development. One of the more conventional explanations of the RAE in sport is the maturation-selection hypothesis (Cobley et al., 2009), which assumes enhanced anthropometric characteristics as a function of chronological age. These developmental advantages may manifest in a number of ways including: stature and mass; speed (McCunn et al., 2017); and greater muscular strength and aerobic power (Balyi et al., 2013). Ultimately, this results in a selection bias towards relatively older athletes, which provides enhanced access to coaching and resources, further exacerbating the effect (Cobley et al., 2018).

Additional purported underpinnings of the RAE include a broader spectrum of multidisciplinary mechanisms. Psychological approaches adopt the notion of self-fulfilling prophecy (Merton, 1948), whereby behaviours grounded on what may be false beliefs can lead to

these perceptions coming true; these behaviours can take the form of Pygmalion and/or Galatea effects. Pygmalion effects occur when an athlete is influenced by expectations from others, such as a coach investing more time into an athlete because they display higher levels of physical prowess. In line with this notion, Peña-González et al. (2018) found that coaches held greater expectations for soccer players born within the first quarter of the year (Q1) in comparison to those born in the last quarter (Q4). Similarly, Galatea effects can occur when an athlete is influenced by their self-expectations; for example, increasing practice hours as a reflection of their self-beliefs about their high potential (Hancock et al., 2013).

Whilst the above mechanisms support the robust RAE within sport (Cobley et al., 2009), there is emerging evidence of inter-sport differences (between sport differences). For instance, within women's artistic gymnastics, where atypical birth date distributions have been reported, these findings are likely a result of biases towards delayed-maturation for success (Hancock et al., 2015). More specifically, Hancock et al. (2015) report null effects within a sample of female gymnasts. The lack of a RAE remained when their sample was broken down into regional, provincial, elite-provincial, and national competitive standards for the under-15 age group, as well as national competitive standard for the over-15 age group. This same null effect was also identified by Delaš Kalinski et al. (2017, 2018) in their respective samples of male and female Olympic gymnasts. The authors accounted for this null finding as a consequence of the advantage of later maturation for the relatively younger gymnasts and the advanced cognitive maturity of those that are relatively older cancelling each other out (Delaš Kalinski et al., 2018). Whilst there was no RAE in the national standard over-15 age group, when all over-15 standards were combined Hancock et al. (2015) found a reversed RAE. The authors attributed this to the biomechanical advantages possessed by relatively younger athletes post puberty where, due to smaller cognitive discrepancies post maturation, relatively older gymnasts could no longer offset this advantage.

Another possible mechanism behind atypical findings within gymnastics, may be a consequence of gender, in other words, the female sampling that is dominant in this small pocket of research. With very few studies within the RAE literature focussing upon female participants (only 2% of studies from Cobley et al.'s 2009 meta analysis examine female participants) it is important to look into additional RAE considerations contrasting to those occurring within male sports. Distributions favouring those born in the second quarter of the year have been previously found in female sports (Delorme et al., 2011; Weir et al., 2010), indicating that the RAE may be a more complex phenomena in females than it is for males. For males, the increased production of testosterone during puberty results in less adipose tissue, a greater VO2 max, and leaner body mass; characteristics, which arguably aid the execution of gross motor skills and benefit males' athletic performance and amplify any RAE (Malina et al., 2004). Whilst additional height and weight may

benefit females in the same way it does for males, being that females typically mature earlier than males (Tanner & Whitehouse, 1976), any benefits of physical prowess may also begin to dissipate earlier. Interactions between biological and socio-cultural factors may also have a stronger influence on the female RAE (Vincent & Glamser, 2006). Transition through adolescence is often characterised by social expectations to conform to the stereotypical female body, which may lead to relatively older and early developed girls dropping out from the system (Shakib, 2003). In contrast, a relatively later maturing athlete would have more time prior to onset of puberty, for athletic skill- and motivational-development to make them more likely to remain in the sport (Vincent & Glamser, 2006).

The development of theoretically driven hypotheses regarding nuances in the RAE has led researchers to begin to examine intra-sport differences (within sport differences). These intra-sport differences are typically a consequence of variations in task demands dependent on an athlete's role within their sport. For example, Brustio et al. (2019) examined the prevalence of RAEs across different track and field disciplines. Whilst there was a consistent RAE favouring relatively older athletes, this effect was stronger within events that are particularly influenced by the anthropometric and strength qualities of athletes (e.g., hurdles and throwing). Similarly, Jones et al. (2018) found positional differences in super-elite rugby union players, wherein a Q1 effect was found for the backs (where there was a greater distribution of backs born in the first quarter of the year), yet the reverse, a Q4 effect, was observed for forwards (where there was a greater distribution of forwards born in the last quarter of the year). Jones and colleagues (2018) reasoned that these differences were due to the respective qualities required across the positions. The overrepresentation of Q4 rugby forwards could be attributed to a "rocky road" developmental trajectory (see Collins & MacNamara, 2012), whereby challenge promotes the development of resilience and mental toughness needed to succeed at the elite level. Similarly, the 'underdog' hypothesis (Gibbs et al., 2012), has been presented in these contexts to account for the paradoxical benefits of challenge experienced by relatively younger athletes competing against their older counterparts. Compared to rugby, the nature of task demands in women's artistic gymnastics is equally if not further varied across apparatus and thus, it stands to reason that we expect to see differences in RAE as a function of apparatus specialism.

Research investigating the RAE within individual sports, especially gymnastics, is sparse and the examination of apparatus differences is an original and practically relevant development for the literature. The present study examined apparatus-differences for the RAE in international standard, women's artistic gymnastics, a relatively neglected sport and expertise level within the research literature. The hypotheses were twofold; first, based on previous studies in women's artistic gymnastics (Delaš Kalinski et al., 2018; Hancock et al., 2015), there was no expectation to see a RAE within a sample of elite female gymnasts when our sampling ignored apparatus specialism.

Second, and arguably the more valuable contribution to the knowledge base, a change in RAE dependent on task demands across different gymnastics apparatus (e.g., power requirements necessary for vault versus the levels of agility required for the beam) was hypothesised.

2.3 Methods

2.3.1 Participants

Full sample of international gymnasts. Our initial sample of female, elite, international gymnasts was obtained from "The Gymternet" gymnast database (Hopkins, n.d.) using the rvest package (Wickham, 2019) in R Studio (RStudio Team, 2020). The database originated in 2015 (and subsequently only archives data from this date onwards) and is the most comprehensive and current database of gymnasts available. It contains archival data on women's artistic gymnasts who have competed at major international championships from 2015; data for this study was collected in January 2019 (N = 806, M_{age} = 20.63, $N_{countries}$ = 87). The sample included gymnasts that were currently competing in junior (U16; n = 95, M_{age} = 15.69, $n_{countries}$ = 42) and senior (n = 493, M_{age} = 20.66, $n_{countries}$ = 76) age groups. We did not explore a country effect as these results would have been underpowered in relation to our power calculation. For a summary of each country within the analysis, please see Appendix A.

Apparatus specialists. A separate sample of apparatus specialists was comprised of gymnasts who had made an Olympic, World or European apparatus final from 2006 (where the current scoring system was first adopted) to 2019. These competitions were chosen as they were deemed the highest-level international competitions available. Whilst consideration to competitions such as the Pan American and Asian Games was given, the lack of variation in elite level countries competing at these games meant they were not included. Gymnasts who were not truly representative of the elite level would likely make finals due to the lack of competition among participants. Dates of births were obtained through English Wikipedia. Vault (n = 91, M_{age} = 25.14, $n_{countries}$ = 30); Uneven Bars (n = 93, M_{age} = 24.37, $n_{countries}$ = 21); Beam (n = 117, M_{age} = 24.48, $n_{countries}$ = 23); Floor (n = 105, M_{age} = 24.48, $n_{countries}$ = 23).

2.3.2 Analysis

I adopted an analytical strategy, in line with recent RAE investigations (Brustio et al., 2019; Doyle & Bottomley, 2019), by employing Poisson regression analysis to analyse our data. The more commonly used χ^2 analysis is often low in statistical power (Brustio et al., 2018) and assumes a uniform distribution of births, despite there being evidence of a skewed distribution (Buckles & Hungerman, 2013). Whilst it is possible to control for this, this is difficult to do when samples span across a variety of countries (Doyle & Bottomley, 2019). Poisson regression uses an explanatory variable (x) to explain the frequency count of an event (y) using the formula $y = e^{(b0+b1x)}$. Within our

study, x was the week of birth in the January – December year measured as a decimal fraction within a one-year interval (0,1; T_b). To calculate T_b, birth week (W_b) of each athlete was transformed using the formula $T_b = (W_b - 0.5)/52$ (Brustio et al., 2019; Doyle & Bottomley, 2018) with .5 referring to the midpoint of the week. Doyle and Bottomley (2019) recommend that authors do not produce a simplified odds ratio (e.g., comparing Q1 to Q4) as it only explores set intervals and ignores a large range of points. Therefore I calculated the Index of Discrimination (I_D) using the formula e^{-b} (Doyle & Bottomley, 2018, 2019), which provides a standardised relative odds for a gymnast born at the start of the year in comparison to the end of the year that allows comparison across future studies. I also adapted the formula from e^{-b} to e^{b} to reflect a positive β coefficient and consequent reversal of the RAE (Hancock et al., 2015) and applied this formula for those cases.

Data were standardised and Poisson regressions run in R studio using the 'glm' function of the 'stats' package (R Core Team, 2019). T_b was also added into the model in its quadratic term so we could account for the possibility of an atypical distribution of gymnasts born across the year (Doyle & Bottomley, 2019). I used the 'r.squaredLR' function from the 'MuMIn' package (Barton, 2020) to calculate a likelihood ratio R^2 in accordance with Nagelkerke (Nagelkerke, 1991). Confidence intervals were calculated using the 'confint' function from the 'MASS' package (Venables & Ripley, 2002). To enable the comparison between this analysis and the traditional χ^2, I also ran a χ^2 analysis using the 'chisq.test' function from the 'stats' package (R Core Team, 2019) and follow up post hoc analysis using 'chisq.multcomp' from the 'RVAideMemoire' package (Maxime, 2017).

2.4 Results

Means and standard deviations, Poisson regression statistics, and the I_D for each sample are outlined in Table 2.1. The coefficient on T_b^2 (our quadratic term) was nonsignificant for all our samples ($p > .05$; $R^2_{adj.}$ ranged = .00 - .13) providing no evidence of either a greater or smaller distribution of gymnasts born within the middle of the year.

2.4.1 No RAE within elite women's artistic gymnasts

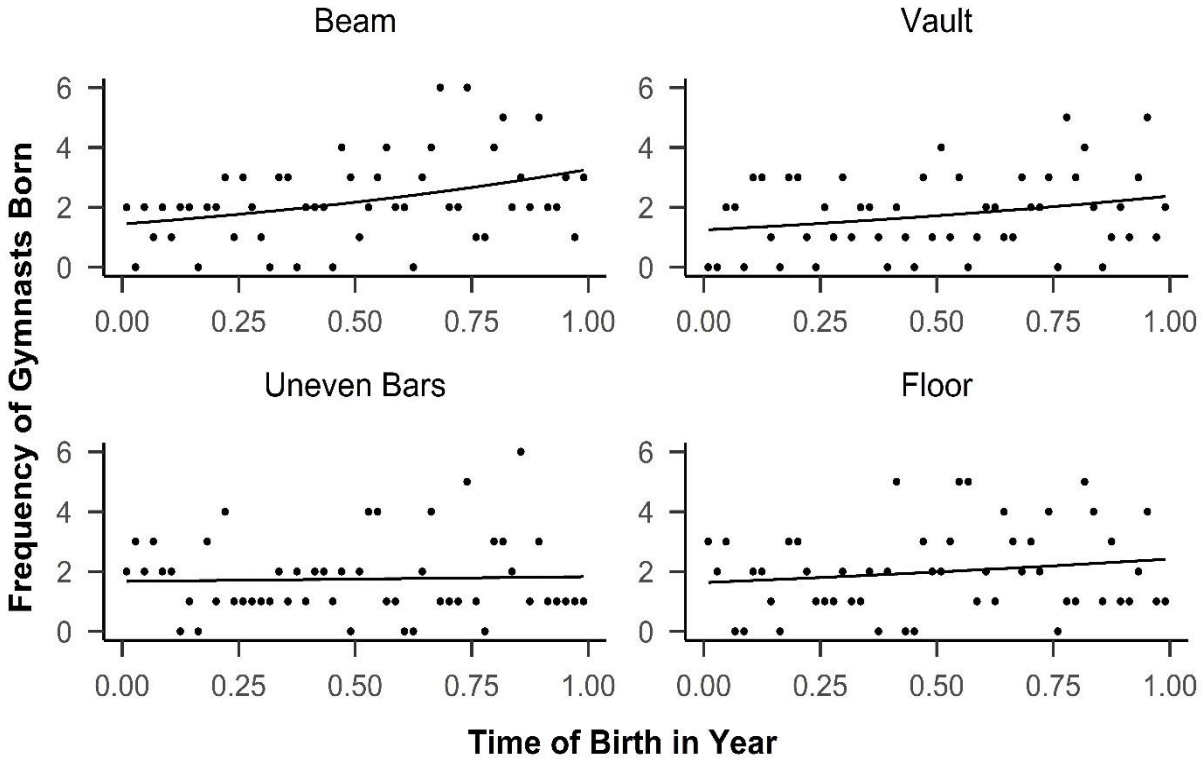
There was no RAE observed within our sample of elite gymnasts competing internationally ($p = .55$; $R^2_{adj.} = .01$), a finding that remained consistent when I examined currently competing junior ($p = .14$; $R^2_{adj.} = .07$) and senior ($p = .64$; $R^2_{adj.} = .00$) gymnasts. The χ^2 analysis also indicated a lack of RAE for the full sample χ^2 (3, N = 806) = 2.96, p = .40), junior χ^2 (3, N = 95) = 3.45, p = .33), and senior gymnasts χ^2 (3, N = 493) = 4.89, p = .18).

2.4.2 RAE is conditional upon task demands

Scatter plots for the frequency of the RAE by birth week for each apparatus are shown in Figure 2.1.

Figure 2.1

Frequency of Gymnasts Born per Week for Apparatus Specialists



Beam. A RAE favouring relatively younger gymnasts was shown in the sample of elite beam specialists (p = .01; $R^2_{adj.}$ = .12, 95% CI [.05 - .43]). Gymnasts born at the end of the year were 27% (I_D = 1.27) more likely to make a World, European or Olympic beam final than those born at the start of the year. χ^2 analysis indicated a significant difference χ^2 (3, N = 117) = 8.44, p = .04) however follow up post hoc analysis was non-significant between all quarters.

Vault. Consistent with the sample of elite beam specialists, a similar RAE, favouring gymnasts born later in the year in the sample of elite, vault specialists, neared significance (p = .08; $R^2_{adj.}$ = .06, 95% CI [-.02 - .40]). These gymnasts born at the end of the year were 21% (I_D = 1.21) more likely to make a World, European or Olympic vault final than those born at the start of the year. The χ^2 analysis was non-significant χ^2 (3, N = 91) = 3.11, p = .40).

Table 2.1

RAE According to the Poisson Regression Group Membership by Birth Week

Predictor	*N*	W_b	T_b	β_0	β_1	I_D	$R^2_{adj.}$	95% CI	*p*
International elite gymnasts									
Full sample	806	26.25 ± 15.06	.50 ± .29	2.74	-.02	1.02	.01	[-.09, .05]	.55
Juniors	95	24.23 ± 14.14	.46 ± .27	.59	-.15	1.16	.07	[-.36, .05]	.14
Seniors	493	26.87 ± 15.35	.51 ± .30	2.24	.02	1.02	.00	[-.07, .11]	.64
Apparatus finalists									
Beam	117	30.21 ± 14.37	.57 ± .28	.77	.24	1.27	.12	[.05, .43]	.01***
Vault	91	29.29 ± 14.91	.55 ± .29	.54	.19	1.21	.06	[-.02, .40]	.08*
Bars	93	27.17 ± 15.49	.51 ± .30	.56	.03	1.03	.00	[-.18, .23]	.80
Floor	105	28.20 ± 14.44	.53 ± .28	.68	.11	1.12	.03	[-.08, .31]	.25

Note. * indicates $p < .1$, ** indicates $p < .05$, *** indicates $p < .01$.

Uneven bars. In comparison, to the previous two apparatus, there was no RAE (p = .80; $R^2_{adj.}$ = .00) found in the sample of elite, uneven bars specialists. The χ^2 analysis was non-significant χ^2 (3, N = 93) = 1.15, p = .76).

Floor. A similar finding was noted for elite, floor specialists where there was no RAE within our sample (p = .25; $R^2_{adj.}$ = .03). The χ^2 analysis was non-significant χ^2 (3, N = 105) = 6.58, p = .09).

2.5 Discussion

The aim of the present research was to investigate the RAE within women's artistic gymnastics, considering the influence of specific apparatus demands. In line with the previous studies exploring the RAE within women's artistic gymnastics, I hypothesised that there would be no RAE within our full sample of female, elite, internationally competing gymnasts that ignored apparatus specialism. Secondly, and possibly the more novel contribution to the present literature, I hypothesised that the RAE would be conditional upon apparatus demands. The results supported both hypotheses, revealing no RAE in the overall sample of women's artistic gymnasts that were competing at an elite, international level, but a change in the RAE when we examined the different apparatus specialisms. For gymnasts that had made a beam, and to a slightly less extent, a vault final at a major international championship (e.g., Olympics), we found that there was a greater distribution of relatively younger gymnasts in comparison to their older counterparts. The lack of an effect emerging from any of the χ^2 analysis despite one being present in the Poisson regression, also highlighted the importance of taking a more nuanced approach by utilising birth weeks in RAE analysis as opposed to the crude quartile measure. Within the sample of bars and floor specialists, however, there was an equal distribution of birth dates across the year and no evidence of a RAE.

The expectation regarding the lack of a RAE when ignoring apparatus specialism was based on previous research in women's artistic gymnastics (e.g. Hancock et al., 2015). Similarly, Baker et al. (2014) observed this "null" pattern in a sample of junior, female gymnasts and within female figure skating, another sport where athlete progression can benefit from delayed-maturation. With delayed-maturation a potential characteristic of higher-skilled gymnasts (Baxter-Jones & Helms, 1996), a reasonable explanation for this finding is that for female gymnasts, being bigger is not necessarily better and can, under certain circumstances, be detrimental. Unlike most of the RAE literature showing an overdistribution of those born earlier in the year, these findings do not support the traditionally advanced maturation hypothesis. Whilst a female gymnast may not be disadvantaged by being older, the effect of being older is less dominant than in other sports; gymnasts that are relatively younger and typically smaller also possess an advantage. Even though this could indicate a bias towards these gymnasts, artistic gymnasts have been shown to grow shorter than their genetic predisposition (Georgopoulos et al., 2002) and so despite being relatively

older, the advanced maturation may not be too much of a detriment. As others have theorised (e.g. Hancock et al., 2015), it is possible that previously reported null effects could be attributed the mix of counteracting expertise levels. Cobley and colleages (2009) found that the RAE did not increase linearly with expertise, but instead the RAE at the elite level (professional / senior national representative) decreased to that of below a youth representative. This research, however, controlled for this potential confound by only utilising a sample of elite, internationally competing gymnasts whilst also accounting for the age group they were competing in. It is also worth considering that this null effect may be attributed to the impact of different competition structures around the world. Some countries offer a competitive structure whereby gymnasts compete by skill level rather than age (e.g., American 1-10 levels structure), meaning that there is less comparison across age groups and possibly diluting any RAE influence.

When I undertook a more subtle examination of the RAE by investigating the role of apparatus specialism, I found that female gymnasts who made a beam final were 27% more likely to be born at the end of the year than born at the start. Whilst we acknowledge the potential speculation in our explanation, I feel a self-fulfilling prophecy perspective (Merton, 1948), likely provides the most robust explanation for these findings. Despite often being smaller, younger female gymnasts are still required to develop skills at the same pace as their relatively older counterparts to enable them to be competitive. Coaches may have an expectation that these relatively younger and consequently smaller gymnasts would struggle on power events (e.g., vault). However, they may also believe that this disadvantage can be offset by a strong performance on other apparatus (e.g., beam) where size is unlikely to impact upon skill development. In turn, coaches may invest more time and resources into these younger gymnasts' development on beam leading to stronger performances overall (Pygmalion effects; Hancock et al., 2013). This theorising is reinforced by Krahenbühl and Leonardo (2020) whose findings indicated that a coach's expectation upon a player influenced that athletes' opportunity for participation, resources, and subsequent performance. Support for a self-fulfilling prophecy oriented explanation of our findings is further bolstered by evidence of Galatea effects. Hancock et al. (2013) explains that once expectations have been put on an individual, the individual acts in line with these expectations. With reference to our results, these gymnasts, influenced by their coaches' beliefs, could spend more time practicing on apparatus they believe that they could have success on (beam). A greater amount of deliberate practice has been consistently linked to increased performance (Baker & Young, 2014) providing a complementary explanation for the increased prevalence of relatively younger gymnasts making beam finals.

The vault findings also demonstrated an effect whereby athletes born later in the year tended to be more successful. In this instance, the challenge experienced by relatively younger female

athletes may enhance the development of core psychological, technical, and/or tactical skills that are needed to succeed at the highest levels (Gibbs et al., 2012). Other studies providing support for the underdog hypothesis often place importance on the psychological skills (e.g., resilience, mental toughness) developed by relatively younger athletes (Jones et al., 2018). In this case however, the implication is that the development of superior technical skills is what provides relatively younger female gymnasts with the advantage. The task demands of vaulting in gymnastics requires speed and power and the ability to "vault" over a stationary object. Due to the height of the apparatus, younger gymnasts can struggle to get over the vault as they are smaller and less powerful in comparison to their older counterparts. As these relatively younger athletes are unlikely to have maturation advantages, we theorise that coaches of these athletes will place more emphasis upon developing modifiable aspects of vaulting performance (e.g., technique). Subsequently, these gymnasts will spend more practice time in the developmental stages where optimum learning and motor skill development takes place (Kirk, 2005). This will enable such gymnasts to develop the technique needed to perform well on this apparatus and offset their potential maturation disadvantage. As gymnasts that are relatively older are typically bigger, they can rely on their height, weight, speed, and power alone to perform vaults successfully. However, as there is less apparent urgency for technical development, these gymnasts may "miss out" on developing the technical foundation needed to progress once the advantage of being bigger has disappeared. In line with Bradshaw's (2004) findings, having a strong technical development on vault enhances overall performance and subsequent long-term progression. This would enable the relatively younger gymnasts to undertake more difficult and challenging vaults once they reach senior levels and subsequently be more likely to make vault finals. The implications of this finding are that it is important to develop strong technical foundation, regardless of a gymnast's physical attributes. Whilst relatively older gymnasts with enhanced maturation might succeed initially, if they do not spend time refining technique, they will be less likely to excel at the higher levels.

Across bars and floor apparatus I identified no relative age effect with an equal distribution of athletes across all birth weeks. With relation to bars we accounted for this finding with a similar premise to that of Delaš Kalinski et al. (2018) in that the cognitive maturity of relatively older athletes enabled them to cope with the technical demands of the apparatus whilst those who were relatively younger were benefitted by relatively later maturation (e.g., being smaller enhances the rotational speed and strength to mass ratio of the relatively younger gymnasts). With bars being a very technical apparatus but also being favoured by gymnasts with a greater strength to mass ratio, together these effects cancel each other out. I also propose a similar offsetting effect on floor whereby again relatively younger gymnasts would be benefitted by later maturation in terms of being smaller and able to perform more rotation (around both vertical and frontal axis). However,

additional power is needed on floor in order to be able to gain height on tumbles to perform rotation and in this case being relative older and subsequently having more power would likely benefit (Balyi et al., 2013).

It is important to address the limitations within our study. Firstly, whilst the sample of Olympic, European, and World finalists captured a high level of gymnastics, we were potentially missing out gymnasts from high level countries (such as China & USA) competing under different continents. It is likely that these gymnasts would have been captured within the Olympic and World sample but is worth bearing in mind when considering the results. Furthermore, I was unaware of the competition structure (e.g., age versus ability based) throughout gymnastics within all the countries included and are subsequently unaware of the impact that it might have. It is also worth considering that our results could be affected by gender bias due to the female sampling that is dominant within aesthetic sports. The magnitude of RAEs is smaller in female sports where unexpected distributions favouring Q2 athletes (athletes born in the second quarter of the year) have also been identified (Smith et al., 2018). Without also undertaking this research with a comparative male sample, we are unable to know the true influence of gender on this effect. Finally, whilst I have inferred that maturation may have an influence on the mechanisms underpinning the RAE (e.g., on coach expectation), I did not have a measure of this and so cannot confirm our conclusions fully.

To test the above theorising, future research ought to capture both maturation (e.g., height and weight) and psychosocial (e.g., self-efficacy and coach expectations) data longitudinally alongside any RAE analysis undertaken. Also capturing data reflective of technical ability (such as execution scores from a competition) would enable the confirmation of vault findings from this study and confirm that younger gymnasts were more likely to make vault finals due to their superior technical ability. Further conclusions could be drawn from the additional data, and add increased depth to the literature base. Furthermore, future research ought to longitudinally gather this data from a group of gymnasts of pre-competition age and follow them until they reach the peak of their career. Whilst in this study we had a sample of junior athletes, the nature of early specialisation sport means that most of these gymnasts are likely nearing their peak and not representative of a true developmental stage. Getting data from this younger age group would identify if there was an initial bias or not, which would increase confidence in our theorising. Capturing a breadth of data across multiple timepoints would enable us to identify any changes in the RAE across the gymnasts' development. To add further to the knowledge base, future research should also investigate other gymnastics disciplines where differences in maturation and growth are prevalent (Georgopoulos et al., 2002).

There is very little research on the RAE in women's artistic gymnastics (Baker et al., 2014; Delaš Kalinski et al., 2018; Hancock et al., 2015), and unfortunately, due to the nature of the samples, the conclusions drawn are limited. The samples used in the previous studies cover a time period before the notable change of scoring systems in 2006, moving away from a "perfect 10" scoring system to an open-ended system. The current Code of Points in gymnastics has brought a new level of difficulty to the sport alongside an increase in the amount of possible deductions. Because of this, research using data from before 2006 has limited implications for today. Our data, collected only after this timepoint, has superior ecological validity enabling greater confidence in the conclusions made and the relevance of our findings. Furthermore, both Baker et al. (2014) and Hancock et al. (2015) utilised exclusively Canadian gymnasts, most of whom competed at the provincial standard or lower (Hancock et al., 2015). Our study utilises truly elite gymnasts from across 87 countries. Consequently, our findings have direct implications for modern-day women's artistic gymnastics and offer a genuinely global and elite perspective on the issue of the RAE.

In conclusion, our examination of intra-sport differences has added a much-needed depth, and a more sophisticated appreciation of the RAE in women's artistic gymnastics. The present study is the first to investigate apparatus specialism, utilising a contemporary analytical strategy facilitating an enhanced understanding of the theoretical underpinnings of the RAE. The findings of our study emphasise the need for RAE researchers to carefully consider both inter- and intra-sport differences for the holistic development of athletes.

Chapter 3:

The Athlete Psychosocial Survey: A Comprehensive Measure of Psychosocial Factors Pertinent to Athlete Development

3.1 Abstract

Traditionally, athletes are selected for talent development programmes based on anthropometric factors, performance in competition, and motor-performance tests (Gullich & Cobley, 2017); psycho-social factors that influence athlete development (Hardy et al., 2017) have been largely ignored. This study seeks to develop the Athlete Psychosocial Survey (APS), a brief profiling tool gauging athletes' scores on psycho-social factors influencing elite performance. Within our first two studies we undertook item generation and instrument construction with participants then completing the APS alongside corresponding "full" measures with previously established psychometric properties. Across both studies, bi-variate correlations revealed significant and theoretically relevant associations between the APS constructs and their respective "full" measures confirming the concurrent and convergent validity of the measure. The third study utilised a novel analytical strategy and provided evidence for the predictive validity of the APS. Using the APS, we were able to discriminate between the two samples of high- and low- level hockey players with 87% accuracy. The current chapter presents the APS as a multi-faceted tool enabling exploration of a combination of psycho-social factors that influence elite development. The APS has practical value within talent development systems as it can be used to measure multiple factors without placing burden on athletes and coaches.

3.2 Introduction

Governing bodies invest large sums of money into talent development (TID) programmes, yet very few adopt the multidisciplinary approach highlighted as important within recent literature (Güllich et al., 2019). Instead, talent development programmes commonly emphasise physical/anthropometric characteristics (Güllich & Cobley, 2017), neglecting the role of psychosocial factors shown to be influential (Hardy et al., 2017). Chapter 2 of this thesis emphasises the problems associated with doing so by highlighting how selection based upon physical characteristics alone can lead to a bias within cohorts of selected athletes. It does this by identifying a RAE that has likely occurred due to perceptions of gymnasts' physical capabilities during development, a current problem with identification. This omission is likely a consequence of lacking the means to be able to incorporate psychosocial measures into talent development. The development of a comprehensive and practical psychosocial measure would enable practitioners to capture and integrate perspectives beyond the standard anthropometric variables and competition data approaches. Whilst measures encompassing multiple psychosocial factors do exist (see Macnamara & Collins, 2011; Hill, MacNamara, & Collins, 2019), there remain some statistical, logistical, and conceptual issues that limit their practical utility. Accordingly, we report on the development of an innovative screening tool, which is the first to measure all relevant talent

development variables in a time efficient manner providing a solution to this important TID problem.

There is an inherent challenge associated with measuring the large number of empirically supported psychosocial factors associated with talent development in a logistically practical manner. To illustrate this, the Great British Medallist's (GBM; Hardy et al., 2017) project, investigating psychosocial determinants of expertise, adopted a qualitative method incorporating data from over 75 interviews with athletes, their parents and coaches, which although provided a huge amount of richness to the data, took over a year to transcribe and analyse. Similarly, Gould et al.'s (2002) study examining psychological characteristics and development of Olympic champions consisted of 30 qualitative interviews ranging from 60 – 150 minutes in length, that took 300 hours to analyse. Whilst the purpose of Hardy et al.'s (2017) and Gould et al.'s (2002) research is inherently different to collecting this data as part of an applied setting, it highlights how routinely adopting such a thorough approach is impractical and unrealistic for most sporting organisations who may be more inclined to administer psychometrically sound questionnaires measuring specific variables of interest (e.g., the 74-item Multidimensional Inventory of Perfectionism in Sport; Stoeber et al., 2006). This method however is overly narrow in focus and precludes the capturing of multidimensional variables potentially relevant to TID without administering multiple questionnaires. The completion of multiple questionnaires presents a potentially serious problem as athletes are known to dislike paperwork (Beckmann & Kellmann, 2003) and the excessive burden of completion (Galesic, 2006) would likely disrupt the interaction and working relationship between athletes, coaches, and sports science support staff.

There are however, two extant measures in the literature that have attempted to address the need for multiple questionnaires. For example, the Psychological Characteristics of Developing Excellence Questionnaire (PCDEQ; Macnamara & Collins, 2011); a 59-item questionnaire that assesses six PCDE factors (e.g., Support for Long-Term Success and Imagery use During Practice and Competition). Its companion measure, the 88-item Psychological Characteristics of Developing Excellence Questionnaire version 2 (PCDEQ2; Hill et al., 2019), measures another eight PCDE factors (e.g., Adverse Response to Failure and Perfectionistic Tendencies), and is designed to be completed alongside the PCDEQ. There are some real strengths of the PCDE approach with data collected from these questionnaires having strong implications for athlete development. It can also highlight psychological skills and sources of support that need improvement and thus is a popular measure with applied practitioners. However, there are conceptual, logistical, and statistical problems associated with these questionnaires. Conceptually speaking, although the PCDEQ primarily measures psychological skills and the PCDEQ2 adds conceptual reach by considering a broader range of characteristics, there are many relevant factors outlined in the talent development

empirical literature that are neglected (e.g., the Big Five personality types, mastery and outcome focus, and early life experiences). In addition, the measures themselves are both reasonably long, thus the combined use of both questionnaires (which is the recommended approach) makes for a time-consuming experience that unfortunately does not capture all relevant psychosocial factors. From a statistical perspective, it is noteworthy that these measures rely exclusively on the use of exploratory factor analysis. Such an approach is rather dated, is not theoretically driven, and does not enable the modelling of error, or provide evidence that the factor structure is replicable (Fabrigar et al., 1999). As such, our understanding of the structural validity of the measures remains incomplete and subsequently there is still a lack of an appropriate measure that is available to researchers and practitioners.

One way to combat the lack of a measure encompassing all (or even the majority of) the psychosocial factors of relevance for effective athlete development is to develop a short form measure with fewer items per construct. This would circumnavigate the issue of excessive questionnaire length and associated athlete burden and enable more constructs to be captured than are presently assessed. Since administering short form measures yields reduced participant completion burden, more factors can be measured without compromising working relationships and response quality, subsequently enhancing practicality. Psychologists have developed numerous short form measures (e.g., the Brief Cope; Carver, 1997 and the Perceived Stress Scale - 4; Cohen et al., 1983) with one of the most used being the Ten Item Personality Inventory (Gosling et al., 2003), a validated ten-item measure of the Big Five personality types. Although the traditional use of a longer measure may be considered preferential, in situations where this is not possible, a shorter measure provides a good, practical alternative (Gosling et al., 2003). The validity of brief measures can be just as good as their longer counterparts (Burisch, 1984) and where there are differences between the psychometric properties (e.g., reliability) of both versions, the practical gains of using the shorter form come to the forefront.

To this end, I report on a multi-phase, multi-study project that developed and then undertook preliminary validation of the Athlete Psychosocial Survey (APS). The first two studies primarily establish the construct validity of the APS whilst the third study examines the predictive validity of our measure. This chapter builds on from Chapter 2 of this thesis by providing a tool that encourages athlete development over time, which will aid coaches and practitioners in moving away from a sole reliance on physical characteristics as a method of talent identification. The purpose of the APS is to support development by identifying characteristics that athletes may need to improve on to increase their chances of long-term success. It can also be used on entry to a programme to give coaches and practitioners insight into new athletes. It is important to be aware of the potential issues associated with the APS being used for selection / identification of athletes, rather than for

development. For example coaches ruling out athletes due to certain traits or lack of traits and athletes consequently providing socially desirable responses. It is paramount that coaches should be provided with education and appropriate accompanying support to use to APS in an effective manner.

3.3 Study 1

In Study 1 I place an emphasis on explaining item generation and establishing convergent validity of the newly created subscales. In Study 1, conceptualisation originated with another PhD student working in collaboration with Weightlifting Wales and subsequent instrument development was undertaken by this PhD researcher, myself, and another PhD researcher on the Pathway to Podium Project. Data was collected by me and two other researchers on the Pathway 2 Podium project.

3.3.1 Method

Instrument Development.

Item Generation. The first steps in developing the measure were to identify variables of relevance and identify pre-existing or, to develop our own, short form questionnaires to measure them. To identify psychosocial factors that are potentially important for TID, we took constructs from the GBM psychosocial interviews (Hardy et al., 2017) that were highlighted as important for athlete development and reviewed the associated literature; from this we identified 28 constructs of relevance. For further information on these constructs please see Table 3.1. Following this, we developed an item pool of 195 items in order to assess these variables. It is important to consider the use of the broad term “family” within the section of life experiences questions given the continually changing makeup of families today. For example, caution should be given to the possibility of split families whereby one parent exhibits high and another low values of a particular trait. In this case, it may be that the athlete feels answering neutrally would be most reflective of their situation (due to both extremes cancelling each other out), however those administering the APS should be equipped to guide athletes on how to respond with their “family” in mind.

Item Justification. We revised the item pool using Rust and Golombok's (2009) guidelines that involved several rounds of reviewing candidate items. In line with previous research developing short-term measures (Carver, 1997; Gosling et al., 2003) we had a goal of identifying two items per construct. Previous research has highlighted that two item scales retain breadth of coverage of a construct whilst avoiding inclusion of items that are redundant (Gosling et al., 2003). Nevertheless, it is important to consider that using two items mean that we may not capture the full complexity of a construct. This is especially important for questions that were developed solely for the survey due to their unknown psychometric properties (e.g., we are unaware of how these items

would load onto their construct and subsequently if they would cover all areas). However, it was decided that as the purpose of the APS is to be used alongside other measures as part of a multidisciplinary investigation, developing a lengthier questionnaire would result in athletes having to complete additional questions, which could create more burden than necessary. The priority for the APS was to develop practical measure that could be completed quickly and so justified our use of two items only. We rated the items on a 1-5 Likert type scale regarding relevance to their intended variable and whether they were phrased unambiguously and grammatically clear. We then reviewed the items for the likelihood that they would lead to acquiescence, socially desirable, indecisive, and/or extreme responses. For items suspected of being liable to extreme responses we also considered whether the item was necessary to measure the construct accurately. Following this we decided to either retain, amend, or remove items until we were left with two items per subscale. The full set of items were subsequently reviewed and edited by a team of researchers with over 50 years of collective research experience to form the APS. For further detail and definitions please see Appendix B. To form the full questionnaire, each item was responded to on a 5-point Likert scale anchored by "Strongly Disagree", "Somewhat Disagree", "Neither Agree nor Disagree", "Somewhat Agree" and "Strongly Agree". We used a 5-point Likert scale as it has been shown have a greater ease of use for participants alongside being quicker to use than longer scales (Preston & Colman, 2000).

Participants. As lengthier questionnaires have been shown to have lower response rates and reduced response variability (Galesic & Bosnjak, 2009), we split the survey into its constituent three sections to reduce participants' burden. Each section of items was administered to a separate sample and responded to utilising Qualtrics online survey software (Qualtrics, 2019). Overall, there were 343 athletes across the three sections: Life experiences, $n = 111$ ($M_{\text{hours training per week}} = 5.65$, $SD = 4.73$; $M_{\text{years' experience}} = 7.61$, $SD = 7.39$); personality, $n = 111$ ($M_{\text{hours training per week}} = 6.56$, $SD = 5.69$; $M_{\text{years' experience}} = 9.23$, $SD = 6.52$); and training behaviours, $n = 121$ ($M_{\text{hours training per week}} = 5.90$, $SD = 5.19$; $M_{\text{years' experience}} = 9.38$, $SD = 6.89$). Additional demographics data surrounding age and sex of participants were not collected.

Measures. We assigned each variable a corresponding full-length questionnaire with previously established psychometric properties to test the convergent validity of our two item subscales. Further details on these questionnaires are provided in Appendix C.

Procedures. We received institutional ethics approval. We recruited participants by distributing an online link to the surveys through social media platforms. Once participants clicked on the link, they were able to access an information sheet and provide consent. Participants then completed the APS items for the respective section along with the corresponding full-length

measures. Questionnaires were scored based on the stated guidelines for each measure, with reverse scoring procedures followed where appropriate.

Analysis. To measure Cook's Distance (Cook, 1977) and identify any influential values I used the "Cookd" function from the "base" package in R Studio (R Core Team, 2019). No values met the criteria of having a Cook's Distance greater than 1 (Cook & Weisberg, 1982) and so I did not remove any participants.

A common approach to examining the psychometric properties of questionnaires involves a confirmatory factor analysis (CFA). It is recommended that in a multidimensional scale (such as the APS) at least three items load significantly onto each factor (Kline, 2015). However, given our necessity for two items per subscale to enhance the practical utility of the APS, this precluded the use of CFA. Instead I modified an approach that previous research has employed to understand the validity of two item measures by testing the correlation between the two item subscales and a longer corresponding measure (Gosling et al., 2003) enabling the examination of both the convergent and predictive validity of the APS. The use of error corrected disattenuated correlation coefficients allowed for a thorough test of the relationship between the APS subscales and their corresponding full measures. For eight of the subscales, there was not a longer measure of our identified subscale so subsequently we were correlating two different constructs. With this in mind, we could only examine the predictive validity and were not expecting large correlations for all constructs due to the different conceptualisations.

Disattenuated correlations enable researchers to account for measurement error within their data and so correct the underestimation of relationships inherent in bivariate zero-order correlations (Spearman, 1904). We used the following formula from Spearman (1904) to disattenuate the correlations: r_{dis} = r(x,y)/√(reliability x, reliability y). As disattenuation does not change the predictive power of a measure (Muchinsky, 1996), we can assume that if the uncorrected correlations are significant, this will also apply for the error corrected coefficients. The magnitude of correlations are reported with reference to Cohen's (1988) threshold values (.10 = small, .30 = moderate, .50 = large).

Finally, whilst computing Cronbach's alpha coefficients for pairs of items is uncommon, it has been used in the development of shorter questionnaires (e.g., Carver, 1997). To examine the internal reliability of the APS I used the "alpha" function from the "psych" package in R Studio (Revelle, 2019). Although .70 is the conventional cut-off for Cronbach's alpha coefficients, as we were using minimal subscales a larger cut-off would not be appropriate and instead I utilised a value of .50 (Nunnally, 1979).

Table 3.1

Athlete Psychosocial Survey Constructs

Construct	Empirical Rationale	Supporting References
	Life Experiences	
Environment of Expectation and Achievement	Within the families of elite athletes, there is evidence to show that parents emphasise the importance of achievement across several domains. There is also a culture of achievement where other members of the family also achieve success and become role models for the athlete.	Côté (1999); Wilson et al. (2019)
Strong Work Ethic	Family values are often transmitted from parents to children. An espoused value of a strong work ethic within an athlete's family is critical to their individual achievement with a strong work ethic a behaviour identified in elite athletes.	Sabatier and Lannegrand-Willems (2005); Olszewski-Kubilius (2018); Burns et al. (2019)
Highly Competitive Environment	Competition within families has been shown to prompt an increase in training workload, effort during competition, increase the use of mental skills, and enhance motivation, all of which would be beneficial to athlete progression and development.	Davis and Meyer (2008); Taylor et al. (2020)
Outcome Focus	Exposure to an environment focussing on outcome (e.g., an ego climate) as opposed to just taking part, has been shown to develop a "win at all costs" attitude enhancing an athlete's own outcome focus and desire to win.	Waldron & Krane (2005); Keegan et al. (2009)
Mastery Focus	Exposure to an environment where there was a high emphasis on mastery (e.g., a task motivational climate) can aid in the development of intrinsic	Granero-Gallegos et al. (2017); Gómez-López et al. (2019)

Construct	Empirical Rationale	Supporting References
	motivation, belief in ability, and development of an athlete's own mastery focus.	
Career turning points	Both positive and negative events within an athlete's career can elicit increased effort and motivation and develop skills such as resilience and mental toughness that are crucial to navigating the talent development environment.	Collins and MacNamara, (2012); Sarkar et al. (2015)
Positive Critical Sporting Event	Negative events within childhood, have been shown to facilitate the development of characteristics necessary for elite sport, however research generally suggestions that they also result in maladaptive outcomes. The experience of a foundational negative critical event in close temporal proximity to a positive critical (sport-related) event has been shown to buffer the negative responses and enhance a drive within the sport.	Van Yperen (2009); Douglas et al. (2010); Collins and MacNamara (2012); Hardy et al. (2017)
Attachment Style	Attachment theory is associated with how well individuals can adjust to behavioural, social, and emotional contexts. An individual's attachment style can influence their development including sporting relationships and development of a fear of failure.	Bowlby (1958); Davis et al. (2013); McNeill et al. (2017)
	Personality	
Difficulty with Emotional Expression	Research has indicated that some individuals seek out high risk environments as a means of emotion regulation, agency, and expression that they are unable to experience in day-to-day life.	Woodman et al. (2010); Barlow et al. (2013)
Counterphobic Attitude	Super-elite athletes are often drawn to the intense emotions present in high-level competitions subsequently enhancing their performance under pressure.	Hardy et al. (2017); Barlow et al. (2013)

Construct	Empirical Rationale	Supporting References
	The competition environment allows them to experience intense and specific anxiety that, unlike day-to-day life, they can manage and regulate.	
Need to Avoid Failure	Sport presents many situations that can be perceived as threatening, and there is evidence of a fear of failure in athletes being used as a driving force and motivator within their sport.	Conroy et al. (2001); Sagar et al. (2007); Sagar et al. (2009)
Need to Succeed	Achievement has been identified as an innate need that drives behaviour. A need for success within sport has been recognised as a discriminator between super-elite and elite athletes.	Murray (1938); Hardy et al. (2017)
Ruthlessness	Machiavellianism, a personality trait inclusive of ruthless behaviours has been shown to be a predictor of task performance in sport indicating that acting ruthlessly, is potentially necessary to secure one's targets and interests.	Paulhus and Williams (2002); Vaughan and Madigan (2020)
Selfishness	Being selfish and putting oneself first within sport is sometimes necessary to achieve one's own ambitions and further development. Selfishness has been highlighted as a trait amongst elite athletes and influential in helping them achieve success.	de Rond (2012); Ronkainen and Ryba (2020)
Perfectionistic Concerns	Perfectionistic concerns have been shown to be associated with negative outcomes such as burnout and mal-adaptive motivation so could have a potentially detrimental effect on athlete development.	Hill (2013); Hill et al. (2018)
Perfectionistic Strivings	Perfectionistic strivings are consistently recognised as being a positive influence among elite and super elite athletes and can buffer the negative outcomes that are associated with perfectionistic concerns.	Orlick and Partington (1998); Gould et al. (2002); Hill (2013)

Construct	Empirical Rationale	Supporting References
Socially Prescribed Perfectionism	A facet of perfectionistic concerns that is often present within the elite athlete population due to the role of others in the sport imposing perfectionistic standards upon an athlete.	Appleton et al. (2010); Hill et al. (2010)
Obsessiveness	Controlled motivations where there is an internalisation of the activity often underpin the profiles of athletes. This is subsequently a driving force behind practice and behaviours influential in development.	Vallerand et al. (2003); Vallerand et al. (2008); Donahue et al. (2009)
Extraversion	Extraversion has been shown to interact with other personality traits to develop problem-focussed coping which would be key for the development of an elite performer. Extraverted athletes also tend to have stronger coach-athlete relationships however have also been shown to have an increased propensity to become distracted.	Woodman et al. (2010); Allen et al. (2011); Allen et al. (2020)
Agreeableness	Higher level athletes have been shown to have higher levels of agreeableness than lower-level athletes. Agreeableness will also have an influence with athlete relationships within the sport (e.g., with coaches and teammates).	Allen et al. (2011); Jackson et al. (2011)
Conscientiousness	Conscientiousness is regularly identified as a predictor of performance and training behaviours within sport.	Orlick and Partington (1998); Gould et al. (2002);
Emotional Stability	Higher level athletes have been shown to have higher levels of emotional stability than lower-level athletes. With emotional stability key to coping with adversity, this trait will likely be beneficial to athlete development.	Woodman et al. (2010); Allen et al. (2011)
Open to New Experiences	Open to new experiences has been shown to interact with other personality traits to develop problem-focussed coping which would be key for the	Allen et al. (2011); Khan et al. (2016)

Construct	Empirical Rationale	Supporting References
	development of an elite performer. It has also been identified as prominent within higher performing athletes.	
Outcome Focus	An outcome focus / ego-orientation has frequently been highlighted as detrimental to athlete progression (e.g., increased chance of burnout). However, in combination with a mastery focus / task orientation, an outcome focus can enable an athlete to be driven towards a goal whilst also understanding the processes needed to make it happen.	Harwood et al. (2000); Hardy et al. (2017); Daumiller et al. (2021)
Mastery Focus	Mastery goals are consistently shown to be adaptive for athlete development for example associated with enjoyment, perfectionistic strivings, and reduced burnout.	Morris and Kavussanu (2009); Stoeber et al. (2008); Daumiller et al. (2021)
Total Preparation for Competition	Being physically and mentally prepared for competition has been identified as a characteristic of high-level performers and influential for athlete development.	Gould et al. (2002) Woodman et al. (2010); Macnamara and Collins (2011)
Commitment to Training	Training is integral to athlete development and performance with the quantity and quality of training shown to be influential.	Ericsson et al. (1993); Oliver et al. (2010)
Relative Importance of Sport	With elite sport requiring a large commitment, the relative importance placed upon the sport along with the commitment to excellence and ability to prioritise will be influential upon an athlete's progression.	Macnamara and Collins (2011); Hardy et al. (2017)

Note. We decided not to include the subscale of Negative Foundational Critical Life Events which was identified as a discriminator between elite and super-elite athletes (Hardy et al., 2017) but to revisit it a later point. We felt that our survey approach did not lend itself to tapping this construct well as the complexity of this issue means that questions around life events are either best assessed with measures that tap life events in detail (with

appropriate accompanying support) or via qualitative methods. Career Turning Points and Positive Critical Sporting Events were included in the present study however no corresponding full-length measure was utilised as there was not a previously validated measure reflecting these constructs. Additional subscales of Grandiose Narcissism, Vulnerable Narcissism, Empathic Thinking, Systematic Feeling, and Psychopathy were also identified and validated separately as part of ongoing research with the Rugby Football Union. These subscales were consequently included within the full version of the APS resulting in 33 constructs overall. Attachment Style, Extraversion, Agreeableness, Conscientiousness, Emotional Stability and Open to New Experiences items are already validated.

3.3.2 Results

Validity Oriented Correlations.

Life Experiences. Evidence of convergent / predictive validity was shown for all life experiences – orientated factors with three significant strong correlations, one significant moderate correlation and one small correlation nearing significance, all in the expected direction (see Table 3.2). Apart from one low correlation (r = .28), disattenuated correlations range from .46 – 1.00 with a mean of .71.

Personality. All personality-orientated factors also supported the convergent / predictive validity of our measure, with six strong and four moderate significant correlations (see Table 3.3). Disattenuated correlations range from .31 – 1.00 with a mean of .64.

Athlete Behaviours. Finally, evidence of convergent / predictive validity was also shown for all five, athlete behaviour-orientated factors with three strong and two moderate significant correlations (see Table 3.4). Dissatenuated correlations range from .38 - .60 with a mean of .50.

Internal Consistency. The results of the Cronbach's alpha analyses are shown in Appendix D. Despite only being two items per subscale, the mean alpha coefficient across all APS subscales was .63 and so exceeded the minimally acceptable value of .50 (Nunnally, 1979), supporting the internal reliability of our two item subscales. The items of the four factors that did not meet this requirement were scrutinised to better understand these results. It became apparent that these pairs of items tapped different components of their respective factors (akin to formative modelling); thus, lower reliability values would be expected.

Table 3.2

Means, Standard Deviations, and Correlations of Life Experiences Constructs

Variable	Study	*M*	*SD*	WOFO: Mastery	WOFO: Work ethic	WOFO: Competitiveness	POSQ: Ego orientation	POSQ: Task orientation
APS: EEA	1	6.39	1.76	1.00** (.51)				
	2	7.72	1.44	.70** (.34)				
APS: SWE	1	8.51	1.51		.63**(.49)			
	2	9.08	1.13		.77** (.59)			
APS: HCE	1	5.32	2.26			.73**(.59)		
	2	6.29	2.27			.56** (.45)		
APS: Outcome focus	1	5.66	2.06				.46**(.36)	
	2	6.38	2.48				.58** (.53)	
APS: Mastery focus	1	6.73	1.80					.28(.19)
	2	8.30	1.05					.63** (.39)

Note. APS = Athlete Psychosocial Survey. EEA = Environment of Expectation and Achievement. SWE = Strong Work Ethic. HCE = Highly Competitive Environment. WOFO = Work and Family Orientation Questionnaire. POSQ = Perception of Success Questionnaire. Convergent disattenuated correlations are shown on the diagonal. Where disattenuated values are greater than 1, it indicates measurement error is not randomly distributed (Johnson, 1944) and the value is reported as 1.00. Bivariate correlations are displayed in parenthesis. * indicates $p < .05$. ** indicates $p < .01$.

Table 3.3

Means, Standard Deviations, and Correlations of Personality Constructs

Variable	Study	*M*	*SD*	SEAS: In between participating	SEAS: Whilst participating	MNQ	PFAI	Dirty dozen: Machiavellianism	Dirty dozen	MIPS: Negative reactions to imperfection	MIPS: Striving for perfection	MPS: Socially prescribed perfectionism	Passion scale: Obsessive passion
APS: Difficulty with emotional expression	1	5.56	1.86	1.00** (.41)									
	2	5.63	1.77	1.00** (.39)									
APS: Counterphobic attitude	1	6.11	1.84		.51** (.33)								
	2	6.03	1.87		.49** (.33)								
APS: Need to succeed	1	6.05	1.86			.41** (.28)							
	2	6.10	1.64			.00 (.00)							
APS: Need to avoid failure	1	6.62	1.64				.44* (.20)						
	2	6.08	1.73				.31 (.18)						
APS: Ruthlessness	1	6.05	2.24					.31* (.25)					
	2	5.90	2.18					.46** (.36)					
APS: Selfishness	1	5.44	2.12						.53** (.38)				
	2	5.68	2.13						.35** (.28)				
APS: Perfectionistic concerns	1	7.04	1.60							.83** (.62)			
	2	7.50	1.81							.74** (.66)			
APS: Perfectionistic strivings	1	6.46	1.91								.70** (.51)		
	2	6.66	1.87								.79** (.61)		

Variable	Study	*M*	*SD*	SEAS: In between participating	SEAS: Whilst participating	MNQ	PFAI	Dirty dozen: Machiavellianism	Dirty dozen	MIPS: Negative reactions to imperfection	MIPS: Striving for perfection	MPS: Socially prescribed perfectionism	Passion scale: Obsessive passion
APS: Socially prescribed perfectionism	1	5.29	2.00									.76** (.57)	
	2	5.41	1.75									.66** (.44)	
APS: Obsessiveness	1	6.93	2.07										.90** (.69)
	2	7.33	1.86										.88** (.69)

Note. APS = Athlete Psychosocial Survey. SEAS = Sensation Seeking, Emotion Regulation and Agency Scale. MNQ = Manifest Needs Questionnaire. PFAI = Performance Failure Appraisal Inventory. MIPS = Multidimensional Inventory of Perfectionism in Sport. MPS = Multidimensional Perfectionism Scale.

Convergent disattenuated correlations are shown on the diagonal. Where disattenuated values are greater than 1, it indicates measurement error is not randomly distributed (Johnson, 1944) and the value is reported as 1.00. Bivariate correlations are displayed in parenthesis. * indicates $p < .05$. ** indicates $p < .01$.

Table 3.4

Means, Standard Deviations, and Correlations of Athlete Behaviour Constructs

Variable	Study	*M*	*SD*	POSQ: Ego orientation	POSQ: Task orientation	QTI	Self-regulated swim behaviours	IOS scale
APS: Outcome focus	1	7.19	2.45	.53** (.48)				
	2	8.41	1.57	.68**(.58)				
APS: Mastery focus	1	8.97	1.36		.38 ** (.31)			
	2	9.27	1.01		.59**(.42)			
APS: Total preparation for competition	1	6.27	1.94			.54** (.47)		
	2	6.57	1.57			.56**(.43)		
APS: Commitment to training	1	6.80	2.09				.60** (.50)	
	2	6.90	1.86				.48**(.32)	
APS: Relative importance of sport	1	4.78	2.23					.43** (.39)
	2	4.72	1.78					.40** (.26)

Note. APS = Athlete Psychosocial Survey. SEAS = Sensation Seeking, Emotion Regulation and Agency Scale. MNQ = Manifest Needs Questionnaire. PFAI = Performance Failure Appraisal Inventory. MIPS = Multidimensional Inventory of Perfectionism in Sport. MPS = Multidimensional Perfectionism Scale. Convergent disattenuated correlations are shown on the diagonal. Bivariate correlations are displayed in parenthesis. * indicates $p < .05$. ** indicates $p < .01$.

3.3.3 Discussion

The aim of the present study was to develop and undertake preliminary validation of the APS by exploring both the reliability and validity of the measure. The results were in line with expectations with 19 out of the 20 factors showing at least a moderate, significant relationship with the corresponding longer measures. The results from the internal reliability analysis corresponded with theory by achieving the benchmark score of .50 (Nunnally, 1979), providing us with preliminary psychometric support for the data from the APS.

Within the life experiences section of the APS, the near significant relationship between *Mastery Focus* and the *Task* subscale of the POSQ was the only small coefficient reported. This, however, still provides some initial support for the APS' *Mastery Focus* subscale. Unlike the APS and the majority of the corresponding questionnaires within Study 1, the POSQ is scored on a reversed Likert scale (Roberts et al., 1998). A limitation of this study is that participants completed the questionnaires online. Research by Clifford and Jerit (2014) has shown that participants completing questionnaires online face higher rates of distraction and report paying less attention than those in laboratory settings. Due to these higher rates of distraction, some participants may not notice the change in scale and consequently score the reverse of what they intended to, reducing the size of the correlation between the measures. Furthermore, the completion of questionnaires online meant that we could not guarantee description of the population to which the questionnaire was distributed to and the sample may be biased due to self-selection (Andrade, 2020). To add to this, there was a lack of demographic data collected, which limited the understanding of who completed the survey and subsequent implications to come from the results.

Upon closer examination, one might reasonably question why some of the demonstrated relationships were not stronger. However, given that in some cases I could only examine predictive validity, the strength of the correlations were as expected. For example, to date there is not a validated measure of *Counterphobic Attitude* but we felt that the *Emotion Regulation and Agency* subscale of the *Whilst Participating* scale from the Sensation Seeking, Emotional Regulation and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013) would relate well to this construct. It measures the extent to which an individual gets emotion regulation benefits from taking part in a high pressure environment (akin to someone with a high *Counterphobic Attitude*; Hardy et al., 2017). This first study adds to the literature, as previously there has not been a measure that encompasses most of the psychosocial factors influential to athlete development. Whilst previous questionnaires (e.g. the PCDEQ; Macnamara & Collins, 2011) are widely used and provide lots of benefits for athlete development, the APS builds on them by addressing a broader range of concepts enhancing its application within development systems. This study has further added to the literature through the initial development and validation of short-from versions of longer, previously used

questionnaires (such as the POSQ; Roberts et al., 1998). This provides alternative options for both researchers and practitioners who may need to measure these constructs in a time efficient manner.

Overall, the findings from Study 1 are encouraging, and provide preliminary support for the APS. To further the understanding, concerted efforts are warranted to examine the replicability of these results and to administer the study in its whole form, not its individual sections. Undertaking a second study also provides the opportunity for participants to complete the APS and its corresponding full-length measures offline, reducing the negative implications associated with online surveys. Additionally, collecting more detailed demographic data (e.g., years of experience and hours of training per week) could enhance the understanding of the findings and subsequent application. Further examination of the lower correlation coefficients reported in the present study was also prudent; Study 2 investigated these issues. The inclusion of a second study afforded me the opportunity to confirm the validity and reliability findings identified in Study 1 and to further examine these properties using a more robust sampling procedure involving attention check procedures.

3.4 Study 2

3.4.1 Method

Participants. Ninety-nine varsity level athletes regularly competing for their University took part in the study ($M_{\text{hours training per week}} = 6.59$, $SD = 3.29$; $M_{\text{years' experience}} = 7.03$, $SD = 2.72$). Our sample consisted of 47 males and 52 females across 31 different sports.

Measures. I utilised the same measures that were used in Study 1. In addition, I added three attention check items (e.g., *Please answer somewhat agree for this statement)*, to identify whether the participants were attentive whilst completing the questionnaire. Attention check questions ensure scale validity (Curran, 2016), and allowed us to remove participants who might provide dubious data.

Procedures. In contrast with Study 1, I administered the full intact APS (measuring the initial 28 constructs of relevance identified within the first study) and all corresponding full measures. Administering the full APS was done to better replicate how the APS would be completed within an applied setting. Varsity level athletes were recruited through first- and second-year undergraduate sports science lectures. Information about the study was given verbally to the participants, as well as via a written information sheet, prior to consent. Under quiet conditions, participants independently completed a paper copy of the APS immediately followed by the corresponding full measures. Trained researchers were available to answer questions and ensure the accuracy of the questionnaire completion.

Data Analysis. Seventy-nine athletes met the inclusion criteria of answering correctly on all three attention check questions. This met the sample size requirement of 50 for 95% power (Erdfelder et al., 1996). No participants were removed following Cook's Distance analysis (Cook, 1977), as outlined in Study 1. I then replicated the analysis strategy used in Study 1.

3.4.2 Results

Validity Oriented Correlations.

Life Experiences. The findings from the life-experiences orientated results of the present study largely confirmed the results reported in Study 1 (see Table 3.2). All the life experiences-oriented coefficients outlined in Table 3.2, were approximately the same or stronger compared to Study 1 and were all reflective of strong associations between the APS and the corresponding lengthier measures. Disattenuated correlations ranged from r = .56 to .77 with a mean of .65.

Personality. Again, the current study's findings confirmed the results from Study 1 with personality-orientated coefficients of at least moderate strength for eight of the factors (see Table 3.3). Significant disattenuated correlations ranged from r = .35 – 1.00 with a mean of .67. Unlike the first study there were two non-significant coefficients between need to succeed and the MNQ (r = .00, p = .98), and need to avoid failure and the PFAI (r = .31, p = .11).

Athlete Behaviours. I further found replication with Study 1 with all APS behaviour-orientated factors having moderate to large strength associations with the longer associated measures (see Table 3.4). Disattenuated correlations ranged from r = .40 - .68 with a mean of .54.

Internal Consistency. The results of the Cronbach's alpha analyses are shown in Appendix D. Despite an increase in items completed by participants, the mean alpha coefficient was .60, well-exceeding the minimally acceptable value of .50 (Nunnally, 1979) and confirming the internal reliability identified in Study 1.

3.4.3 Discussion

I conducted a second study to confirm the validity and reliability findings identified in Study 1 and examine the replicability of our results within a more robust sample. Like Study 1, our Cronbach's alpha value exceeded the benchmark of .50 (Nunnally, 1979). As well as providing additional support for the convergent validity and internal consistency, the consistency of results across the two studies speaks to the stability of findings associated with the APS.

In the first study, we found a relatively weak relationship between *Mastery Focus* and the *Task* subscale of the POSQ that neared significance. I felt that this result was likely due to participants' suboptimal concentration (i.e., reverse scored items completed under distraction filled conditions) when completing the measures. The more stringent sampling criteria and questionnaire

completion procedure within Study 2 confirmed this as the relationship between these two subscales was strong and significant.

Despite significant, moderate relationships in Study 1 for the factors *Need to Succeed* and *Need to Avoid Failure*, no significant relationship between these factors and their longer corresponding measures were found in Study 2. As illustrated previously, the nature of the corresponding questionnaires may influence the strength and significance of the relationship and so we do not believe this to be a cause for concern. The *Achievement* subscale of the MNQ (Steers & Braunstein, 1976), is not a global measure of a need for achievement but specifically measures need to achieve within a work setting. *Need to Succeed* in the APS is aknowledged to be specific to the sporting activity (Hardy et al., 2017). Whilst we may expect a relationship between the two, we also anticipated that this relationship may not be consistent across the two studies due to both scales being related to different domains. This same rationale can be applied to *Need to Avoid Failure*. Whilst the PFAI (Conroy et al., 2002) can be adapted to a sport setting, it makes specific reference to when an individual is failing and not their need to avoid it.

Whilst I have a sample of competitive athletes within this study, a limitation of the data collected is that the participants are not representative of an elite cohort (the target population for the APS). Furthermore, whilst all participants were competing at University level, the standard could vary amongst different sports and athletes which could have a potential influence on the data. Collecting data from an elite sample whilst also gathering information relating to the different levels of performance an athlete has taken part in is a key. Furthermore, with Study 1 taking place online and Study 2 collected in person, I should be cautious of comparing the results across both studies. Previous research (Lonsdale et al., 2006) has identified that there can be differences in responses between questionnaires that are completed online compared to those using a traditional paper and pencil format, and so is important to consider when comparing the two studies. I am confident with the conclusions drawn from the first two studies with the results from Study 2 offering additional support for the validity of the APS. With the aim of this paper to develop a survey that can be administered to elite athletes in a practical setting, it is crucial that I follow on from our first two studies and administer the APS to this level of performer. Doing so could also enable us to further the validation by assessing the predictive validity of the APS making use of two contrasting levels of athletes. Subsequently, as an additional step in the validation process I conducted a third study utilising a representative sample of elite pathway athletes. Within this study we collected data with greater ecological validity for the intended purpose of the APS, whilst also gaining insight into the predictive validity of the measure. I administered a contemporary and sophisticated pattern recognition approach (Güllich et al., 2019; Jones et al., 2019) that enabled us to model the complex interactions within talent development systems. More specifically, I expected

to be able to predict group membership of elite and recreational level performers based upon scores on the APS and identify critical variables that discriminated between the two groups, enhancing the predictive validity of the measure. The justification for this is that it would enable a more directed and sport-specific focus for coaches and practitioners. Whilst the APS as a whole offers a broad examination of factors influential to development, areas of particular importance may differ among sports. Identifying variables that are specific to individual sports means coaches and practitioners can place a specific focus on aiding athlete development on constructs most beneficial to their sport whilst also providing generalised overall support on other factors lending increased backing to the practical application of the APS. I also anticipated that discriminating variables identified in previous research (i.e. *Selfishness;* Hardy et al., 2017) would come out as critical variables, key to progression of these athletes.

3.5 Study 3

3.5.1 Method

Participants. We recruited 90 hockey players to take part in the study (M_{age} = 27.97, *SD* = 10.14; $M_{\text{hours training per week}}$ = 3.39, *SD* = 1.78; $M_{\text{years' experience}}$ = 13.52, *SD* = 8.16). This sample was made up of 35 players (17 males and 18 females) who had been selected for a national development programme for the 2019/20 season (M_{age} = 20.26, *SD* = 1.77; $M_{\text{hours training per week}}$ = 4.85, *SD* = 1.35; $M_{\text{years' experience}}$ = 12.25, *SD* = 23.37), and 55 amateur hockey players (13 males and 32 females (M_{age} = 31.84, *SD* = 9.43; $M_{\text{hours training per week}}$ = 2.26, *SD* = 0.90; $M_{\text{years' experience}}$ = 14.20, *SD* = 8.44) from across 22 UK clubs. The national development programme is programme funded by UK sport to provide opportunities to players who have the potential to become Olympic medallists. To ensure that our sample was truly representative of an amateur level, we only included players in this sample if they had only ever played at club level or lower.

Measures. Participants completed the APS consisting of the 28 constructs outlined in Table 3.1. Additional constructs of Grandiose Narcissism, Vulnerable Narcissism, Empathic Thinking, Systematic Feeling, and Psychopathy identified and validated separately as part of ongoing research with the Rugby Football Union were also included.

Procedures. Players in our elite pathway sample completed the APS under quiet conditions at a national development programme training camp. These players were recruited, and data was collected by another PhD researcher on the Pathway 2 Podium project. Trained researchers were available to answer questions and ensure the accuracy of completion. Prior to this, an information sheet about the study had been provided enabling players to provide their informed consent. Data from the amateur level hockey players were collected online via a secure platform (Qualtrics, 2019) during the COVID-19 lock-down restrictions. I approached points of contact from amateur hockey clubs around the UK and gave information about the study. I provided them with a link containing

an information sheet and a consent form which they then distributed to members of their clubs. Participants were invited to provide consent and then completed the full APS online. To encourage accurate responses, participants were informed that they would be provided with an individual personality profile upon completion.

Analysis. Whilst previous measurement development studies have used discriminant function analysis to predict and classify group membership (e.g., Hill et al., 2019), I employed pattern recognition analysis for the present study. Pattern recognition is a machine learning process that uses algorithms to mirror the complex interactions in talent development systems (e.g., the interaction between personality and training behaviours) and generates a model of interacting variables that predict group membership. This contrasts with a discriminant function analysis that utilises multiple linear main effects to predict group membership. It is also more appropriate for the current study given the number of psychosocial variables captured by the APS (n = 33) and its ability to deal with wide datasets.

In the first two studies I used Cook's Distance to identify influential values that would have a large effect on the regression model. As I was not generating a regression model in the third study, we used the boxplot function from the "graphics" package (R Core Team, 2019) in R Studio to identify values of influence that were outside one and a half times the interquartile range. Using this I removed nine outliers from the amateur sample based upon the participants' age, number of years in the sport, and hours of training per week.

Following outlier removal, I normalised our variables so that the values lay between 0 and 1 meaning that all our variables were on a common scale. I then employed a pattern recognition function developed by Anderson (2020) in R Studio which utilises the "rWeka" package (Hornik et al., 2009). This function was based upon previous pattern recognition approaches successfully used before in TID research (Güllich et al., 2019; Jones et al., 2019). Pattern recognition analysis consists of feature selection and classification that is used to identify group membership based upon discriminating features (Güllich et al., 2019; Jones et al., 2019). Feature selection refers to the selection of a subset of variables based on their relative importance at predicting group membership, and classification is concerned with each participant being assigned a group based upon scores of each variable. In Study 3, I attempted to correctly classify our participants to either 'elite pathway' or 'amateur' hockey player categories.

I ran both a feature selection and classification of the data to determine a model of "critical" variables that would enable a more directed interpretation of the APS and specifically discriminated between the two groups. Whilst it is important to explore a wide interpretation of variables, identifying "critical" variables can direct a focus within the pathway for further athlete progression

(e.g., developing aspects that have been shown to be key influencers) and so does not take value away from the full APS. Some variables captured by the APS may be commonalities between the groups in that they are influential for development of hockey players regardless of ability, but they do not provide practitioners with more specific variables of relevance for the development of hockey players.

For the feature selection process, the importance of each variable at predicting group membership was based upon its appearance in four different feature selection algorithms: correlation attribute evaluator (Hall, 2000); relief F attribute evaluator (Kira & Rendell, 1992); support vector machine attribute evaluator (cf. Guyon et al., 2002); and correlation-based feature selection subset evaluator (Hall & Smith, 1998), and a critical subset of variables were identified as our final model. As the different feature selection methods all have different criteria, the more times a variable appears within the feature selection algorithms, the more confidence we have in its predictive ability. Using multiple feature selection methods also prevents overfitting that may occur in smaller samples (Saeys et al., 2007). The ability of the model to classify participants into their relevant groups was evaluated against four classification algorithms; Naïve Bayes (John & Langley, 1995), J48 decision tree (Quinlan, 1993), Support Vector Machine (SMO; Platt, 1999), and K-nearest neighbours (Aha et al., 1991). To reduce the risk of overfitting, a leave-one-out cross validation procedure was employed across both the feature selection and classification processes.

3.5.2 Results

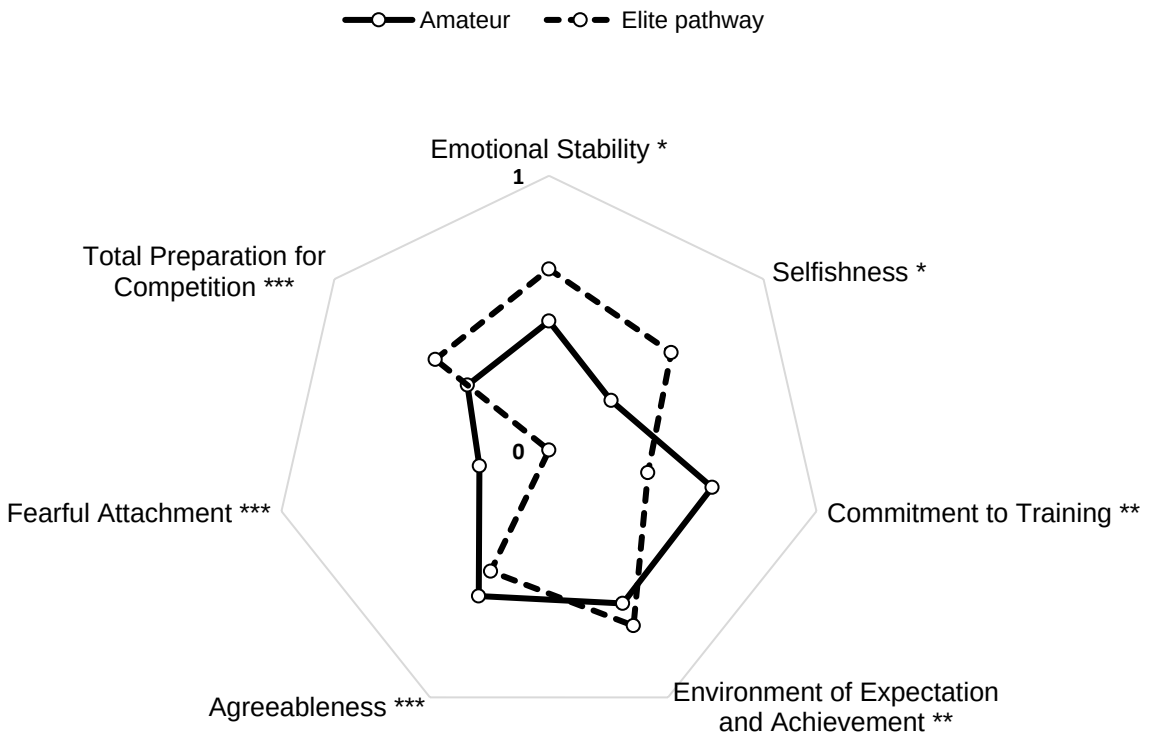
The results of the classification process can be found in Table 3.5.

Feature Selection. Seven interacting factors were identified as being of high relative importance in discriminating between the two groups and so were retained in our final model. These were Emotional Stability, Selfishness, an Environment of Expectation and Achievement, and Total Preparation for Competition, which were higher in the elite pathway group, and Commitment to Training, Agreeableness, and a Fearful Attachment Style which were lower. For a visual representation of the feature selection please see Figure 3.1.

Classification. Classification of the model, revealed that it was possible to predict group membership with an average accuracy of 86%, indicating an excellent predictive power with an average area under the curve (AUC) of .87 (Hosmer & Lemeshow, 2000). The average sensitivity parameter of .78, identified that 78% of our elite pathway sample were classified correctly, whilst the average specificity parameter was .94, suggesting that 94% of our amateur sample could be correctly classified

Figure 3.1

Model Discriminating Between Amateur and Elite Pathway Hockey Players



Note. Data points reflect the normalised mean values for each group. Points closer to 1 indicate that the group mean was higher whilst points closer to 0 indicate it was lower. * indicates feature appeared in two algorithms, ** indicates feature appeared in three algorithms, and *** indicates feature appeared in all four algorithms.

Table 3.5

Summary Statistics for Classification Algorithms

Classifier	Accuracy (%)	Sensitivity	Specificity	Average area under ROC curve
Naïve Bayes	87.65	.77	.96	.93
Support vector machine	87.65	.74	.98	.86
J48 decision tree	86.42	.86	.87	.80
K-nearest neighbour	85.19	.74	.93	.89
All classifiers	86.73	.78	.94	.87

Note. Accuracy = percentage of correctly classified observations. Sensitivity = 1 – false positive rate. Specificity = 1 – false negative rate. ROC = Receiving operating characteristic. Average area under ROC curve is a measure of how well the model can correctly distinguish between the two groups.

3.5.3 Discussion

Study 3 examined the predictive validity of the APS within a sample of relatively high- and low- level hockey players. Previous talent development measurement development research (Hill et al., 2019) has failed to predict high level athletes much better than that of chance (44% of group members correctly classified). The results markedly exceeded this and are encouraging with regards to the application of the APS. I found support for the predictive validity of the APS and was able to discriminate between the two samples with 87% accuracy (70/81 players accurately classified). This study was also able to correctly predict 94% (43 / 46) of the amateur group and 78% (28/36) of the elite pathway group membership, lending support to the predictive validity of our measure.

Whilst the emphasis of this current study is on the predictive validity of the APS, the seven discriminating variables are also likely to have some implications for the development of elite hockey players. Machiavellianism has been shown to be a predictor of task performance in sport (Vaughan & Madigan, 2020) indicating that acting ruthlessly and selfishly, is potentially necessary to secure one's targets and interests. Consequently, it is of no surprise that the construct of *Selfishness* is higher and *Agreeableness* lower in our sample of elite pathway players. Scoring higher on *Total Preparation for Competition* and experiencing an *Environment of Expectation and Achievement* is also consistent with previous research. High levels of *Total Preparation* are consistent with Gould et al.'s (2002) findings Olympic champions had a high ability to plan and prepare which in turn influence successful performance. Exposure to an *Environment of Expectation and Achievement* in early development is influential for an athlete in developing an attitude that excellence is normal and expected (Hardy et al., 2017) and again something that would benefit the elite pathway players in their progression. Finally, the trait of *Emotional Stability* is key for athletes to cope with adversity (Woodman et al., 2010). With the journey to elite performance a "rocky road" (Collins & MacNamara, 2012), being relatively emotionally stable compared to others, will have aided the elite pathway players in reaching the level they are at. As a *Fearful Attachment Style* is negatively related to *Emotional Stability* (Williams et al., 2019), this provides rationale for the higher levels exhibited by the amateur sample. However, I interpret this result with some caution as a questionnaire rating is unlikely to capture the complexities of an individual's attachment style. Like many of the constructs within the APS it provides a starting point, but further examination is needed to explore this construct in-depth.

Unfortunately, not having a matched pairs design is a potential limitation of this study highlighted by the split of ages in the amateur group compared to the elite pathway sample. On average, the amateur sample was over ten years older than the elite pathway sample meaning that we are unable to know what impact age (and other demographic variables such as gender and socio-economic background) have upon the findings. Whilst it is expected that family and personality

traits will be relatively stage (Cobb-Clark & Schurer, 2012), it is likely that the training behaviours would change over time as athletes experience different coaches, opportunities and significant moments. Considering this, I cannot be certain of the effect of outlined demographic variables upon the variables that have come out as key and should bare this in mind when interpreting these findings.

The consistency of the findings with previous research offer support for APS's construct validity; however unlike the GBM findings (Hardy et al., 2017), *Commitment to Training* was higher in our group of lower level athletes. Given the different emphasis placed on training at the club versus elite pathway levels, perhaps this finding should not be a surprise. For most hockey players it is likely far easier to commit to a recreational standard of training compared to the quality and intensity of training and practices expected within talent development pathways. Additionally, given that our elite pathway athletes' careers have yet to emulate the achievements and performance standards of previous high level elite athletes, and on average are younger than the amateur sample, it is possible that their appreciation of and commitment to high quality training will further develop as they excel in their sport. This reasoning could also account for the relatively lower prediction rate of elite-pathway in comparison to amateur athletes. Not all hockey players in the elite pathway group will progress to perform at a higher level than what they are playing at currently and consequently may fit the profile of an amateur player better.

3.6 General Discussion

One of the acknowledged problems with current talent development systems is an over reliance on measures biased towards understanding an athlete's physical capabilities (Gullich & Cobley, 2017). There is substantial evidence for key determinants of expertise being psychosocial in nature (MacNamara et al., 2010b) and thus, a practical tool to identify these factors will likely increase the efficacy of talent development systems. Because of the paucity of appropriate existing measures, the aim of the present study was to develop, and undertake preliminary validation of the APS, a comprehensive psychosocial survey for use in talent development systems. By necessity, the traditional principles of measurement development and analysis (e.g., factor analytic approaches), were not applied to the development of the APS. Given our aim of including only two items per scale, this analysis may not have provided us with useful information. Using a novel approach, I was able to get an accurate assessment of the psychometric properties of the APS and, combined with its practical application, the results of this study show the APS to be a valid and reliable measurement tool warranting inclusion within talent development systems.

The robust methodology and systematic approach to developing a user-friendly survey utilised best-practice suggestions whilst also maintaining practical utility and subsequently ensured

the rigor of our study. We used literature based methods to firstly develop the APS items by following guidelines outlined by (Rust & Golombok, 2009). Within the first two studies I also used an analytical approach adopted from Gosling et al. (2003) to replicate support for the survey's internal reliability and convergent / predictive validity. In Study 3, I provided support for the measure's predictive validity by utilising a contemporary and sophisticated pattern recognition approach (Güllich et al., 2019; Jones et al., 2019) that enabled us to model the complex interactions outlined within talent development systems. I further ensured rigor by employing a stringent inclusion criterion across the studies whereby we removed participants that may have provided dubious data. Our elite pathway sample also replicates the target population for the APS lending additional support (Marquart, 2017). The usefulness of the APS is also highlighted through its ability to predict high level athletes in comparison to previous existing measures (Hill et al., 2019). On this note, one must consider that using a narrow Likert scale (i.e., 5-point) may have influenced the ability of the APS to distinguish between the two groups and using a broader range scale may have allowed for more distintion. Leung (2011) identified that an 11-point Likert scale increases the sensitivity of a scale and looking to validate the APS on a broader Likert scale may be beneficial.

The constructs within the APS encompass a large majority of the talent development literature emphasising psychosocial constructs (e.g. Collins & MacNamara, 2012; Gould et al., 2002; Hardy et al., 2017) with the sections of life experiences, personality, and training behaviours. There are additional psychosocial components within the literature that were not included for example coach-athlete relationship (Jowett & Ntoumanis, 2004) and psychological skills (Hill et al., 2019) however an additional survey is being developed within the Pathway 2 Podium project which is inclusive of these. This chapter builds upon previous measurement development research such as the PCDEQ (Macnamara & Collins, 2011) and PCDEQ-2 (Hill et al., 2019) by incorporating multiple constructs relevant to talent development, however moves beyond these questionnaires by including even more factors of relevance. It also builds upon findings from Gosling et al. (2003) by utilising their methodology to develop two-item questionnaires. Compared to other longer, singlular construct questionnaires we do not have the same level of understanding of the factor structures. Neverthesless, due to the rigourous, three-study appraoch that we have taken, we can still be confident in the psychometric properties of the APS.

3.6.1 Practical Considerations

Traditionally, there may be some stigma associated with brief questionnaires (possibly due to unknown psychometric properties), yet despite this, short form questionnaires are likely the preferred option for most practitioners due to their practical utility. This short form measure offers coaches and practitioners the opportunity to gain insight into a variety of the assessed constructs and initiates the further exploration of factors of interest (e.g., via qualitative interviews or

administering a focused psychometric tool). The APS is practical and informative for gaining insight into a large number of constructs across large groups of developing athletes and diminishes the need for time consuming assessments limited in practicality.

Whilst the predictive accuracy was greater with a specific selection of variables, this does not take away from the key influence of other APS variables on the development of an athlete. The full APS can be used as a screening tool to provide coaches and practitioners with a broad overview of individuals entering a pathway, which in turn can be used to enhance their development. The specific features identified within the final model can then direct a focus within the pathway for further athlete progression (e.g., developing aspects that have been shown to be key influencers). It is also important to note that variables not identified in our final model may be commonalities not discriminators between the groups and pertinent for the development of hockey players across all expertise levels.

Whilst I am advocating for the predictive validity of the APS, I am not suggesting it should be used to predict performance and consequent selection into programmes. The main problem in TID approaches is the one-dimensional approach that is frequently adopted (Güllich & Cobley, 2017), which consequently results in low athlete progression to elite level (Ackerman, 2013). Using the APS as a standalone performance predictor, would simply compound the problem, conflicting with our initial rationale for the development of a psychosocial measure. Instead, the APS should be used as part of a multidisciplinary approach to capture and assess constructs of developing athletes and consequently used to inform best practice for coaches and practitioners. To ensure that the APS is not used inappropriately (e.g., as a means of identification), recommendations are made that the APS is used as a starting point only and then followed up with additional exploration. Coaches and organisations are encouraged to investigate any constructs of interest identified through the APS with more detailed methodology, for example qualitative inquiry or the completion of longer more detailed questionnaire. Administering the APS to an athlete at the point of entry to a programme would also enable management to make more informed and bespoke decisions surrounding the athlete to enhance their progression through the pathway. For example, literature has highlighted a compensatory effect where coaches, for example, can compensate for a value that an athlete may not experience within their family environment. To illustrate this, Gaudreau et al. (2016) found support for their compensatory-protective interaction hypothesis by identifying that when an athlete had low parental autonomy support there was a positive relationship between coach autonomy support and sport motivation, need satisfaction, and athletic success. This suggested that the role of a coach can compensate for experiences that are identified as missing. This has strong implications for use of the APS, as coaches and practitioners can identify areas that were lacking in the athlete's family environment and subsequently tailor the support that they are providing.

3.6.2 Limitations

A main limitation of this Chapter was that the constructs identified were drawn directly from the GBM psychosocial interviews (Hardy et al., 2017) and other research was not considered. Whilst this study does provide some breadth in the constructs covered, it may also have precluded the inclusion of characteristics not included within this research. Undertaking a systematic review of the talent literature prior to instrument construction and item generation would have increased the range of topics considered for inclusion. However, due to time limitations and a necessity to have the APS finished prior to Pathway 2 Podium data collection, this was not possible. Additionally, there were eight subscales which did not have a directly corresponding element and subsequently only the predictive and not convergent validity was established. This means for these constructs the psychometric properties were not confirmed as thoroughly and one should be mindful of the interpretation of these constructs until further validation can take place. Furthermore, whilst the methodological procedure was rigorous and provided initial confirmation of the psychometric properties of the APS, I did not explore its factor structure (i.e., undertaking structural equation modelling). A CFA would enable us to test the relationship between the observed variables and their underlying latent constructs, adding additional support for the strength of our measure. The aim of the present study was to develop a measure with practical utility and so exploring the factor structure would not necessarily provide us with useful information. Further research investigating the factor structure of the APS would be beneficial to confirm its psychometric properties. A final limitation of this chapter is that it only considers psychosocial construct pertinent to talent development and precludes the capturing of other multidisciplinary factors. Whilst this was necessary to develop a measure that could be used in multidisciplinary research, one should be mindful of utilising the variables outlined in this study alone. Future research should go on to use the APS as part of a multidisciplinary investigation within individual sports to move beyond a unidimensional approach and capture a wide range of multidisciplinary factors relevant to the sport in question.

3.6.3 Summary

Across the three studies, I was able to provide strong support for the psychometric properties and practical utility of the APS. The results were in line with previous literature emphasising the relevance of the APS constructs (which are informed by some relatively complex constructs) within the high-performance environment. The practicality of this measure means that coaches and practitioners can gauge many psychosocial constructs pertinent to athlete development and readily incorporate them into their talent development programmes. This in turn aids the progression of talent development systems by enabling the integration of multiple perspectives alongside greater athlete insight for coaches and practitioners than what is currently available.

Chapter 4:

A Prospective and Longitudinal Investigation of the Multidisciplinary Factors Influential to Canoe Sprint Pathway Athletes

4.1 Abstract

Despite elite sport development a multidisciplinary (Gagné, 2009) and non-linear (Gibbs et al., 2012) process, most expertise development research utilises cross sectional measurement to examine unidimensional constructs in isolation (see Johnston et al., 2018 for review). Recent research (Güllich et al., 2019) has attempted to rectify this although is limited by retrospective recall and heterogenous athlete samples. The present study adopted a multidisciplinary, longitudinal, and prospective approach to examining and identifying the key determinants of expertise in canoe sprint pathway athletes ($n_{male} = 3$, $n_{female} = 4$, $M_{age} = 21.57$). Data was collected over a period of 18 months and analysed using state of the art machine learning analysis. Our results identified that an interaction of multidisciplinary variables could discriminate between high- and low- potential athletes with 79% accuracy. Specifically, we identified an athlete's early developmental experiences, the microstructure of practice, and their ability to cope with challenge as particularly influential. Our findings have clear implications for the developmental environments needed to enhance the progression of canoe sprint athletes whilst also highlighting the importance of taking a multidisciplinary, longitudinal, and prospective approach to talent identification and development.

4.2 Introduction

Expertise development within sport is a multidisciplinary and interactive process involving numerous components throughout an athlete's long-term development (Gagné, 2009). However, most research and applied practice neglects to consider this and instead focusses upon unidimensional and cross-sectional measurements (see Johnston et al., 2018 for review). Recent research in talent identification and development (TID) has started to adopt a multidisciplinary approach, with The Great British Medallists Project (GBM; Güllich et al., 2019) identifying an interaction of demographic, psychosocial, coach and family relationship, practice and training, and performance factors as discriminators between super-elite and elite athletes. The multidisciplinary and interactive nature of this study enhanced our understanding of the processes underpinning athlete development and the comparison between elite- and super- elite athletes was novel and a particular strength of the research. However, despite the advancements this study offered to the talent development field, it is not without flaws and the authors acknowledged that the retrospective nature of this research is problematic. Whilst they protected against some limitations (e.g., use of a matched pairs design and triangulation of athletes, parents, and coaches), comparing athletes based upon achievement whilst also using a retrospective design could be an area for concern. Bahrick et al. (1996) highlighted that level of achievement can affect accuracy of recall, with positive achievement associated with greater recall accuracy. The broad-brush approach across multiple sports, also neglects to consider sport specific demands and practice structures (see Jones et al.,

2019) that will ultimately have long-term development implications for individual sports. The present study aims to address previous limitations in the talent development literature and be the first study to prospectively examine the multidisciplinary factors relevant to athlete development within canoe sprint.

4.2.1 Athlete Availability

Athlete availability has been highlighted as salient in the development of elite athletes due to the influence it has upon training. It has been shown to be shaped by a variety of factors such as training load (Jones et al., 2017), sleep (Fullagar et al., 2015), and athlete mental health (Drew et al., 2017). This is relevant as at the most recent 2016 Olympic Games, of the injuries and illnesses that occurred, 40% of injuries and 18% of illnesses were severe enough that they lead to an absence from either training or competition (Soligard et al., 2017). A longitudinal study by Raysmith and Drew (2016), highlighted that a loss of training time due to injury or illness was a determining factor regarding whether track and field athletes performing at international level achieved their goals. They found that there was a 26% reduction in the odds of an athlete achieving goal success for each week they had to modify[2] their training due to injury or illness. However, the authors did acknowledge that there were additional components that may have had an influence, for example race tactics and field conditions. Whilst there are a multitude of studies highlighting the impact of injury on athlete performance (e.g., Drew et al., 2017), there are few studies investigating the effect of modified training on performance when considering both injury and illness.

4.2.2 Practice and Training Factors

As well as being available to practice, the type of practice an athlete undertakes is also influential to their progression. Whilst volume of training is generally assumed to be important to performance (Baker & Young, 2014; Ericsson et al., 1993), recent literature is starting to indicate that it is important to consider the nature of this practice (Farrow & Robertson, 2017). Varied practice refers to practice where there are frequent changes (e.g., paddling on choppy waters versus calm waters creates variation in the environment) which subsequently presents an individual with multiple versions of a task (Schmidt, 1975). Despite initial performance being weaker, the long-term retention benefits of varied practice have been shown to be superior (Shea & Morgan, 1979). Jones et al. (2020) explored the microstructure of practice in elite and super-elite cricketers and found support for this notion within a high-performance sporting environment, identifying that super-elites spin bowlers took part in more varied practice in comparison to their elite counterparts. This may occur as a function of contextual interference, whereby the presence of interference during practice enhances learning (Battig, 1966; Shea & Morgan, 1979). Nevertheless, there are

[2] Modified training defined by Raysmith and Drew (2016) as: "Any reduction or restriction to an athlete's participation in training or competition, as planned by coaching staff for greater than 24 h." (p. 2)

very few studies that examine the variability of practice outside of a laboratory setting and so is an issue that warrants further investigation especially in the context of elite sport.

An additional component of the microstructure of practice relating to expertise development is the specificity of practice principle (Henry, 1958), which states that practice conditions should mimic target conditions to enhance optimal learning. Previous research investigating the microstructure of practice within a talent development environment found that undertaking practice similar to the competition environment resulted in superior athlete development (Rothwell et al., 2017). Oudejans and Pijpers (2009) also found support for this principle and identified that practicing under conditions of anxiety enhanced performance under pressure in both a basketball free throw and dark throwing task. With competition performance the end goal for competitive sport, it is reasonable to assume that training under conditions of anxiety that mimic the competition environment (e.g., race simulation) would enhance overall athlete performance.

4.2.3 Psychosocial and Socio-Demographic Factors

Psychosocial factors are regularly identified as important within the talent development literature with personality (Gould et al., 2002), early developmental experiences (Hardy et al., 2017), and lifestyle factors (Burns et al., 2019) all influential. Socio-demographic factors also come into play, for example an athlete's age in relation to their peers (Cobley et al., 2009) and their homeplace during their development. There has been research indicating that the size of the city where an athlete spends their developmental years, influences their early sporting experiences and subsequent progression within their sport. Baker et al. (2009) found that Great Britain Olympians were more likely to have originated from small settlements ranging from populations of 10,000 to 29,000. The benefit of originating from a smaller location could be due to a number of influences; for example, the opportunity for greater sport diversification (Côté et al., 2006), better social support (MacDonald et al., 2009), and the increased access to open play spaces (Sallis et al., 1993).

The influence of family dynamics is also significant to athlete development (Rouquette et al., 2020). A mastery focus is regularly associated with positive adaptations in sport and exposure within the family has been identified as beneficial to development. Knight et al. (2016) identified a family task-involving climate as having a positive influence on motivation, perceptions of pressure, confidence, and pre-race anxiety. In line with Sabatier and Lannegrand-Willems (2005), a mastery focus within the family is also likely influence an athlete's propensity to adopt this themselves. This in turn would aid them in their development as by understanding the processes behind performance, the athletes would become fully committed to training and preparation (Hardy et al., 2017).

4.2.4 Limitations Associated with Previous Research

Within the sport of canoe sprint, there has been a plethora of studies investigating the impact of physiological factors on athlete development. Ackland et al. (2003) examined the morphological characteristics of a cohort of Olympic paddlers, finding that they possessed characteristics inconsistent with the general population (e.g., proportionally large upper body girths). Whilst the sample of Olympic athletes is a strength of their study, the non-linear environment in elite sport (Gibbs et al., 2012) means that the cross-sectional nature of the research limits its value. López-Plaza et al. (2019) extended this body of research by exploring the evolution of these morphological characteristics longitudinally over three years. However, they did not measure any additional factors outside of this domain (e.g., psychosocial variables) and so the conclusions we take from this paper are limited. With physiological characteristics alone being poor predictors of performance (e.g., Lidor et al., 2005 found no differences in the physiological and anthropometric tests between selected and non-selected handball players), it is crucial to examine all elements influential to athlete performance, for example athlete health, wellbeing and recovery, practice and training, and psychosocial factors. Whilst recent research has gone on to highlight the role of psychology within the development of canoe sprint athletes (Yasin et al., 2020), to our knowledge there are no studies that examine the multidisciplinary spread of factors relevant to athlete development in a longitudinal and prospective manner.

4.2.5 Study Aims and Hypotheses

In summary, the aim of this study was to take a multidisciplinary, longitudinal, and prospective approach to examining the key determinants of expertise within the sport of canoe sprint. The chapter builds upon Chapter 3 by utilising the APS showing how the APS can be used as part of a multidisciplinary investigation. This study was part of a wider project, the Pathway 2 Podium project, which aimed to prospectively examine athletes on their journey from development through to podium across a variety of Olympic sports. In line with previous research (cf. Güllich et al., 2019), it was hypothesised that there would be an interaction between multiple domains (e.g., psychosocial and practice and training factors). With new research highlighting the importance of the microstructure of practice (Jones et al., 2019), we expected that specific components of an athlete's training (mainly the variability of practice) would emerge as influential. Due to the prominent influence of the early environment upon athlete development (Hardy et al., 2017) there was also an expectation that these experiences would be relevant. Considered collectively, the results from the present study were likely to have practical value for canoe sprint coaches and support staff by highlighting variables of importance to target within an athlete's development.

4.3 Method

4.3.1 Participants

I invited 16 centralised British canoe sprint pathway athletes to take part in the study. Overall, five declined, three withdrew from the study, and one left the sport, leaving us with a sample of seven athletes ($n_{male} = 3$, $n_{female} = 4$, $M_{age} = 22.28$, $SD = 1.39$, $M_{hours\ training\ per\ week} = 11.99$, $SD = 2.03$; $M_{years'\ experience} = 4.71$, $SD = 2.59$). Two of these athletes were podium potential funded and four were talent transfer athletes. Three of these athletes were deemed high-potential ($n_{male} = 1$, $n_{female} = 2$, $M_{age} = 21.66$, $SD = 1.69$, $M_{hours\ training\ per\ week} = 12.86$, $SD = 2.11$; $M_{years'\ experience} = 4.50$, $SD = 1.87$) and were split across three different training groups while four were deemed low potential ($n_{male} = 2$, $n_{female} = 2$, $M_{age} = 22.75$, $SD = 0.82$, $M_{hours\ training\ per\ week} = 12.86$, $SD = 2.11$; $M_{years'\ experience} = 4.89$, $SD = 3.01$) and were split across two training groups. Initially four coaches of these athletes were involved in the study. The transition of athletes across different coaching groups meant that two coaches stopped participating and an additional coach joined the project. All coaches were national coaches.

4.3.2 Measures

To ensure the multidisciplinary nature of our study I collected variables that encompassed: athlete health, wellbeing, and recovery; practice and training; and athlete and coach psychosocial components. These variables were included following consultation with the Research Action Group (RAG) comprised of experts across numerous fields related to athlete development from Bangor University and UK Sport. Whilst this study is referred to as multidisciplinary due to it capturing variables across multiple disciplines, it is important to acknowledge that there are additional factors relevant to athlete development that have not been included.

Athlete Health, Wellbeing, and Recovery.

Athlete Monitoring Questionnaire (AMQ). The AMQ is a weekly athlete monitoring system developed as part of the Pathway 2 Podium Project. It is comprised of validated questionnaires measuring athlete health, wellbeing, and recovery factors influential to athlete development. In this instance, wellbeing referred to a subjective quality of life based upon vitality, general interest, and positive mood (WHO Regional Office for Europe, 1998). It encompasses: readiness to train (Pruscino et al., 2013), perceived recovery (Perceived Recovery Scale; Laurent et al., 2011), perceived rating of exertion (Percevied Exertion Scale; Borg, 1998), training hours and races, perceived stress (Perceived Stress Scale; Cohen et al., 1983), perceived wellbeing (WHO-5; WHO Regional Office for Europe, 1998), chronic versus acute illness (symptoms) and injury (area) and the effect on training and performance (Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; Clarsen et al., 2013), and sleep hours, quality, and latency (Pittsburgh Sleep Quality

Index; Buysse et al., 1989 & Athlete Sleep Screening Questionnaire). In total athletes completed 39 items. Ongoing validity work is currently being undertaken as a separate part of the P2P project. Whilst we do not report the results of this here, preliminary data identifies it to be a valid measure with strong practical utility. For instance, data from the measure were able to differentiate between athletes of varying competitive standards and predict elite swimmers' availability to train over an extended period (Lowery, 2021).

AER (Availability, Effort and Recovery) Monitoring App. The AER App forms part of the Performance Data Management System (English Institute of Sport, 2015), a bespoke health surveillance system implemented by the English Institute of Sport. It is tailored to individual World Class Programmes and monitors athlete availability, effort, and recovery daily.

Practice and Training.

Athlete Practice and Training Interview Schedule. The quantitative athlete practice and training interview schedule was developed based upon work by Jones et al. (2019), that explored the microstructure of practice in elite spin-bowlers, and tailored towards canoe sprint practice activities. For a full interview schedule please see Appendix E. The interview was structured into four sections examining practice activities relevant to athlete development:

1. Demographic and family information (e.g., homeplace and education throughout development).
2. Activities throughout the lifespan (e.g., sports throughout development).
3. Developmental milestones, performance indicators, and maturation (e.g., age at specialization).
4. Practice activities (e.g., microstructure of practice).

Psychosocial.

Athlete Psychosocial Survey (APS). The APS measures 33 psychosocial factors relevant to TID. It was developed as part of the Pathway 2 Podium project with validation work currently ongoing. For a full list of constructs and definitions please see Chapter 3. I also measured an additional three constructs examining the relative importance of the different components of need satisfaction (Deci & Ryan, 1985) to provide some immediate feedback for use within the sport to enhance engagement. Because I was asking for a large commitment to the sport, we wanted to provide feedback immediately after initial data capture. I felt that this was a variable that would provide useful feedback quickly that could be utilised within the programmes.

Coach Psychosocial Survey. The coach psychosocial survey measured 21 personality characteristics adapted from the APS alongside a brief validated measure of attachment style (The Relationship Questionnaire; Bartholomew & Horowitz, 1991). For a full version of the questionnaire, please see Appendix F.

Prospective Athlete Survey. The prospective athlete survey was developed as part of the Pathway 2 Podium project and measures an additional 50 psychosocial constructs pertinent to athlete development. Whilst the APS focused upon athlete early development experiences, the Prospective Athlete Survey examined the athletes' experiences in the sport, their relationships with coaches, support staff and their national governing body, support available to them, and their view on life. These sections encompassed: need satisfaction in sport (Basic Need Satisfaction in Sport Scale; Ng et al., 2011), need supportive behaviours (Markland & Tobin, 2010), mental toughness (Mental Toughness Inventory; Gucciardi et al., 2015), psychological characteristics of developing excellence (Psychological Characteristics of Developing Excellence Questionnaire 2; Hill et al., 2019), self-esteem (Rosenberg Self-Esteem Scale; Rosenberg, 1965); transformational leadership (Differentiated Transformational Leadership Inventory; Callow et al., 2009), coach-athlete relationship (Coach-Athlete Relationship Questionnaire; Jowett & Ntoumanis, 2004), motivation (Sport Motivation Scale II; Pelletier et al., 2013), responsiveness (Reis et al., 2008), coaching behaviours (Measurement of Coaching Behaviors; Wagstaff et al., 2017), support from social media (Facebook Measure of Social Support; McCloskey et al., 2015), organisational support (Survey of Perceived Organizational Support; Eisenberger et al., 1986), social support (Perceived Available Support in Sport Questionnaire; Freeman et al., 2011), and sense of coherence (Sense of Coherence Scale; Antonovsky, 1993). Similar to the APS, we developed short form versions of full length questionnaires with two items per construct utilising a method outlined by Costa and McCrae (1992) where we took the items with the highest factor loadings for each subfactor of the overall factor as well as considering item relevance to reduce the length of the full questionnaire. For a full version of this questionnaire, please see Appendix G.

4.3.3 Procedures

Following institutional ethical approval, I consulted with British Canoeing national coaches before inviting pathway athletes and their coaches to participate in the study. On invitation to take part they were given an information sheet and the opportunity to provide consent. Data were collected from January 2019 – August 2020. However due to the potential confounding influence of COVID-19 lockdown restrictions, only data collected before this was included within this study.

Initial Data Capture (January 2019). Athletes and coaches completed the APS and the coach psychosocial survey respectively, independently, and under quiet conditions. Trained researchers were available to answer any questions and ensure the accuracy of the questionnaire completion. Athletes were also interviewed in a quiet location by the main researcher using the athlete practice and training interview schedule. The fourth section of this interview was done with reference to the year before the athlete joined the centralised pathway system to provide us with a

point of comparison. Where talent transfer athletes were involved, the interview schedule was amended in line with their main sport before joining this pathway.

Prospective Data Capture (January 2019 – August 2020).

Athlete Health, Wellbeing, and Recovery Factors. Athletes completed the AMQ for 57 weeks (February 2019 – March 2020) using a commercially available software system (Qualtrics, 2019). Each participant received an individualised link to the questionnaire weekly via an email and / or text depending on their personal communication preference. On entry of the first week's data, researchers supervised the participants to address any questions and ensure accurate completion. A 72-hour completion window prohibited data from one week altering responses from another. A reminder was sent out if no attempt was made to start the questionnaire within 48-hours with a further reminder at 69-hours. To ensure adherence, athletes, coaches, and support staff all received weekly reports summarising the data. Adherence was calculated as the percentage of fully completed AMQs per week across the 57 weeks. The adherence to full AMQ competition for canoe sprint athletes was 87%. Three athletes were regularly completing the AER App prior to commencing the study. To reduce replication and burden on the athletes, these athletes did not complete the AMQ but instead completed the AER App as normal alongside additional perceived stress and wellbeing questions from the AMQ. Prior to analysis, we standardised the variables across these two questionnaires so that we could combine common variables.

Practice and Training Factors. Both athletes and coaches met with the lead researcher over 12 timepoints and undertook section four of the athlete practice and training interview schedule. This took approximately 20 minutes per participant. To ensure prospective data capture, the questions were framed with regards to the previous three weeks. As they are generally considered to be more stable in nature and to reduce athlete burden, we captured the constructs of feedback, focus of attention, and vicarious experiences at three timepoints instead of 12.

Psychosocial Factors. Six months into the study, the athletes completed the prospective athlete survey independently and under quiet conditions. The lead researcher was available to answer any questions and ensure the accuracy of the questionnaire completion.

4.3.4 Analysis

Previous research has neglected to consider the interaction of multiple components when examining the development of canoe sprint athletes. Güllich et al. (2019) and Jones et al. (2019) provide a novel solution to this with the introduction of a pattern recognition analytical strategy; a machine learning process that uses algorithms to mirror the complex non-linear interactions in talent development systems. Pattern recognition generates a model of interactive variables that

predict group membership, and in this instance, variables that discriminate between high- and low-potential canoe sprint athletes. To determine these two groups, I consulted with British Canoeing national coaches (i.e., expert raters) who made informed decisions on whether an athlete was deemed by the programme as high- or low-potential based upon their experiences in the sport, training sessions, competition results, progression, commitment, and attitude.

All data from coaches and athletes were compiled into one dataset using the "Tidyverse" (Wickham et al., 2019) and "dplyr" (Wickham et al., 2020) packages in R studio. As pattern recognition cannot run with missing data, I employed a strategy of averaging across time points where necessary to generate a dataset of 808 variables (55 health and wellbeing, 140 socio-demographic and psychosocial, and 613 practice and training variables). For a summary of features collected and entered into the analysis, please see Appendix H. Next, I normalised the variables so that the values lay between 0 and 1, meaning that all our variables were on a common scale aiding interpretation of the findings. I then undertook a pattern recognition analysis comprised of feature selection and classification processes; for a more detailed outline of this procedure please see Chapter 3 section 3.5.1. To provide a more thorough examination of the full holistic dataset, I also ran a pattern recognition analysis on each individual group of variables (health, wellbeing, and recovery; psychosocial and demographic; and practice and training). Whilst I am advocating for taking a multidisciplinary approach, this enables the consideration of additional variables that were not strong enough to come out in the full model but may still be relevant within TID.

4.4 Results

The results section is comprised of four sub-sections, each with the results from both the feature selection and classification processes. The first section outlines a full model of discriminatory factors between the high and low potential groups. This was generated with the full multidisciplinary dataset where all variables measured were entered into the analysis. The following three sub-sections outline the findings from the analysis of each discipline separately (e.g., psychosocial). The full results of all classification processes can be found in Table 4.1.

4.4.1 Multidisciplinary Approach has Strongest Classification

Feature selection for the full set of variables identified a model of eleven interacting factors as being of high relative importance in discriminating between the two groups. The high-potential group was more likely to have had a high Mastery Focus within their family and to have come from Homeplace with a greater relative population during their development. At the timepoint 11th February – 3rd March 2019, they did more Technical Practice, training under Race Specific Conditions, and Varied Whole Practice (the whole stroke with variation e.g., on choppy waters). They did less Constant Part Practice (the stroke broken down with no variation e.g., performing just

the catch of the stroke on an ergo) from the 28th Oct – 19th Nov 2019 and had a greater amount of Individualised Practice from the 1st January 2020 – 17th February 2020. They also found practice less Technically Challenging across four time points in comparison to the low-potential group. For a visual representation of the feature selection please see Figure 4.1.

Classification on the multidisciplinary model, revealed that it was possible to predict group membership with an average accuracy of 79%. The average sensitivity parameter of .58, identified that 58% of our high-potential sample were classified correctly whilst the average specificity parameter was .94, suggesting that 94% of our low-potential sample could be correctly classified.

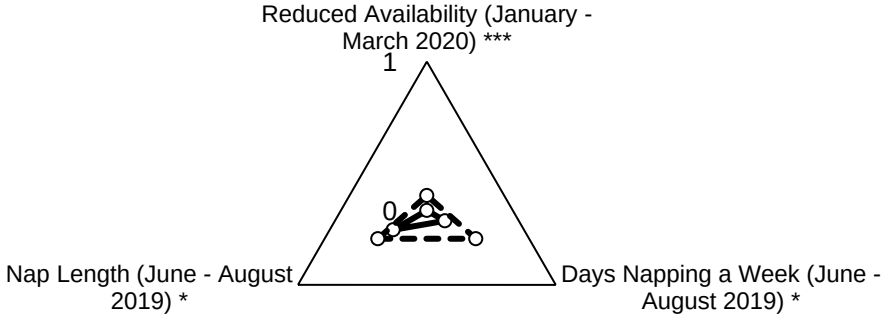
4.4.2 Athlete Health, Wellbeing, and Recovery Factors

Feature selection of the athlete health, wellbeing, and recovery factors identified three factors that could discriminate between the high- and low-potential groups. The high-potential group were more likely to Nap and for a longer length of time in June – August 2019. They also had reduced Availability to train from January to March 2020. For a visual representation of the feature selection please see Figure 4.2.

Classification of the health, wellbeing, and recovery factors alone revealed that it was possible to predict group membership with an average accuracy of 64%. The average sensitivity parameter of .33, identified that 33% of our high-potential sample were classified correctly, whilst the average sensitivity parameter was .88, suggesting that 88% of our low-potential sample could be correctly classified.

Figure 4.2

Athlete Health, Wellbeing, and Recovery Model Discriminating Between High- and Low-Potential Canoe Sprint Pathway Athletes



Note. Data points reflect the normalised mean values for each group. Points closer to 1 indicate that the group mean was higher whilst points closer to 0 indicate it was lower. * indicates feature appeared in two algorithms, ** indicates feature appeared in three algorithms, and *** indicates feature appeared in all four algorithms.

Table 4.1

Summary of Classification Algorithms

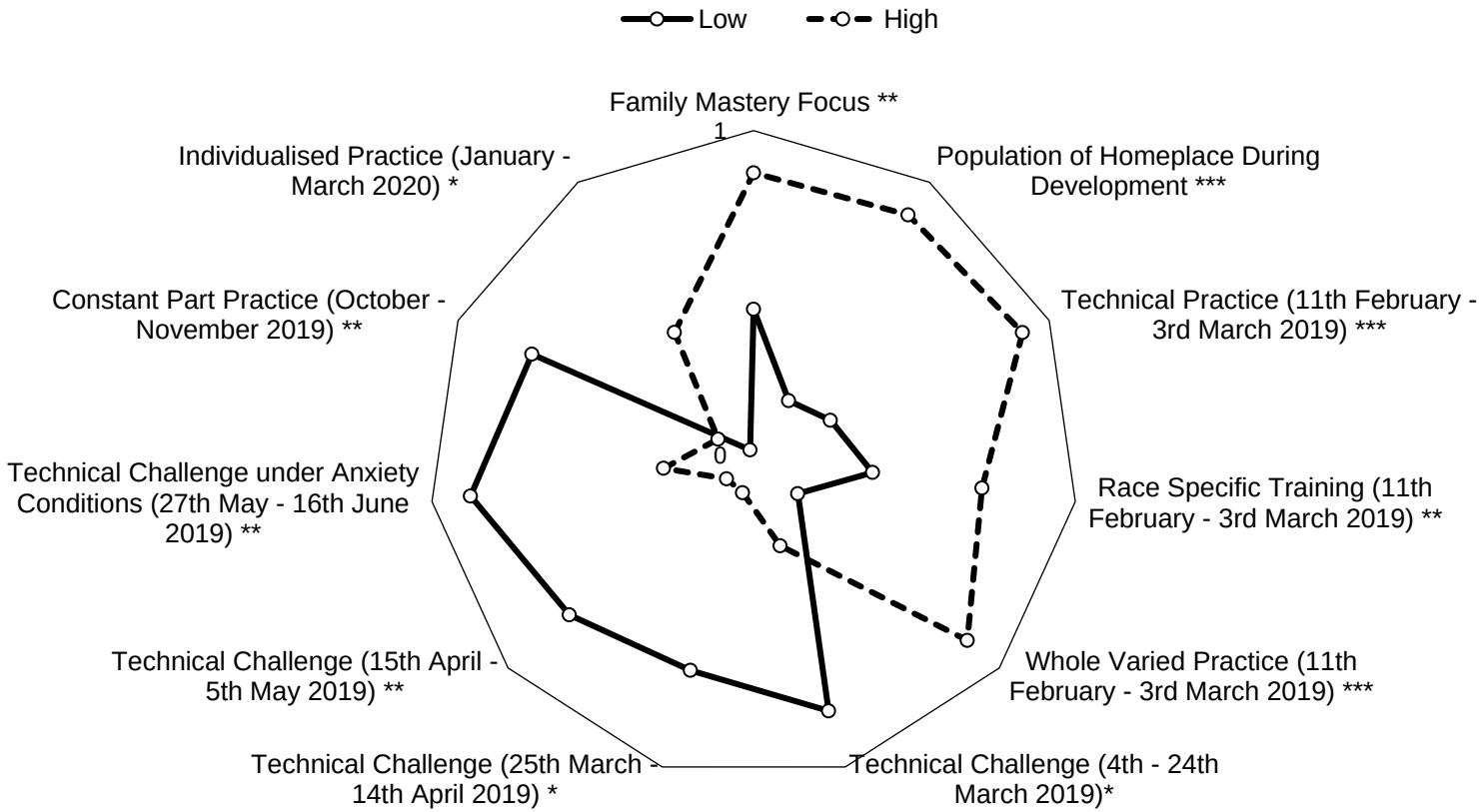
Classifier	Accuracy (%)	Sensitivity	Specificity	Average Area under ROC Curve
		Full Model		
Naïve Bayes	57.14	.33	.75	.60
Support vector machine	100.00	1.00	1.00	1.00
J48 decision tree	100.00	1.00	1.00	1.00
K-nearest neighbour	57.14	0.00	1.00	0.00
All classifiers	78.57	.58	.94	.65
		Health, Wellbeing, and Recovery		
Naïve Bayes	71.43	.67	.75	.92
Support vector machine	71.43	.33	1.00	.67
J48 decision tree	57.14	.33	.75	.25
K-nearest neighbour	57.14	0.00	1.00	0.00
All classifiers	64.29	.33	.88	.46
		Practice and Training		
Naïve Bayes	85.00	.67	1.00	.92
Support vector machine	100.00	1.00	1.00	1.00
J48 decision tree	42.86	.33	.50	.42
K-nearest neighbour	57.14	0.00	1.00	0.00
All classifiers	71.25	.50	.87	.59

Classifier	Accuracy (%)	Sensitivity	Specificity	Average Area under ROC Curve
		Psychosocial and Demographic		
Naïve Bayes	28.57	0.00	.50	.17
Support vector machine	100	1.00	1.00	1.00
J48 decision tree	100	1.00	1.00	1.00
K-nearest neighbour	57.14	0.00	1.00	0.00
All classifiers	71.43	.50	.88	.54

Note. Accuracy = percentage of correctly classified observations. Sensitivity = 1 – false positive rate. Specificity = 1 – false negative rate. ROC = Receiving operating characteristic. Area under ROC curve is a measure of how well the model can correctly distinguish between the two groups.

Figure 4.1

Multidisciplinary Model Discriminating Between High- and Low-Potential Canoe Sprint Pathway Athletes



Note. Data points reflect the normalised mean values for each group. Points closer to 1 indicate that the group mean was higher whilst points closer to 0 indicate it was lower. * indicates feature appeared in two algorithms, ** indicates feature appeared in three algorithms, and *** indicates feature appeared in all four algorithms.

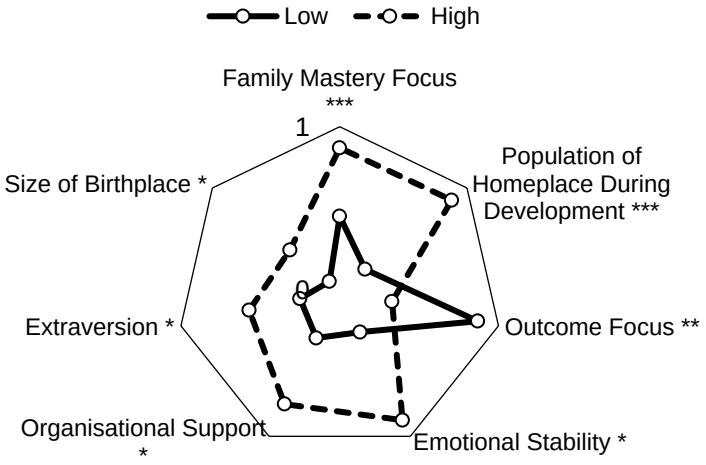
4.4.3 Psychosocial and Demographic Factors

Feature selection on the psychosocial and demographic factors individually identified a model of seven interacting factors. For a visual representation of the feature selection please see Figure 4.3. Like the multidisciplinary model, the high-potential group was more likely to have had a high Mastery Focus within their family and to have come from Homeplace with a greater relative population during their development. Alongside this, they were more likely to have a Birthplace with a greater relative population and hold a lower Outcome Focus than the low-potential group. Furthermore, the model identified that high- potential athletes had higher levels of Emotional Stability, Extraversion, and Organisational Support.

Classification of the psychosocial and demographic factors alone revealed that it was possible to predict group membership with an average accuracy of 71%. The average sensitivity parameter of .50, identified that 50% of our high-potential sample were classified correctly, whilst the average specificity parameter was .88, suggesting that 88% of our low-potential sample could be correctly classified.

Figure 4.3

Psychosocial and Socio-Demographic Model Discriminating Between High- and Low-Potential Canoe Sprint Pathway Athletes



Note. Data points reflect the normalised mean values for each group. Points closer to 1 indicate that the group mean was higher whilst points closer to 0 indicate it was lower. * indicates feature appeared in two algorithms, ** indicates feature appeared in three algorithms, and *** indicates feature appeared in all four algorithms.

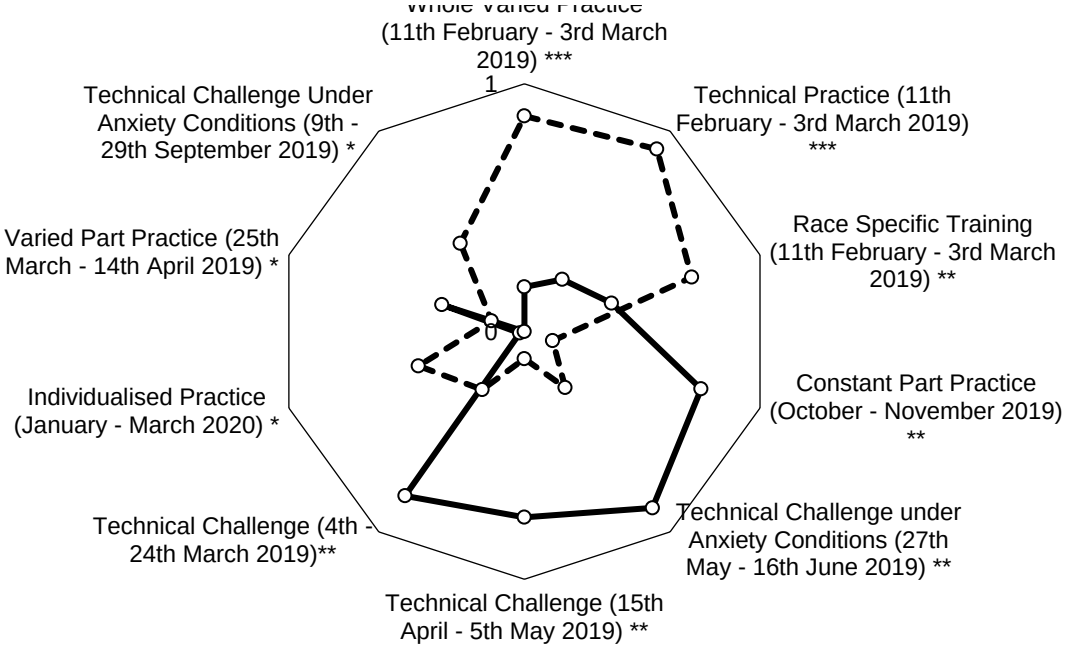
4.4.4 *Practice and Training Factors*

Due to the prevalence of these features in the multidisciplinary model, feature selection of the practice and training factors returned similar results. In addition to the variables already outlined, the high potential group were also taking part in less Varied Part practice from the 25th March – 14th April 2019 and less Challenging Practice when under conditions of anxiety from the 9th – 29th September 2019. For a visual representation of the feature selection please see Figure 4.4.

Classification of the practice and training factors alone revealed that it was possible to predict group membership with an average accuracy of 71%. The average sensitivity parameter of .50, identified that 50% of our high-potential sample were classified correctly, whilst the average specificity parameter was .87, suggesting that 87% of our low-potential sample could be correctly classified.

Figure 4.4

Practice and Training Model Discriminating Between High- and Low-Potential Canoe Sprint Pathway Athletes



Note. Data points reflect the normalised mean values for each group. Points closer to 1 indicate that the group mean was higher whilst points closer to 0 indicate it was lower. * indicates feature appeared in two algorithms, ** indicates feature appeared in three algorithms, and *** indicates feature appeared in all four algorithms.

4.5 Discussion

The aim of this study was to take a multidisciplinary, longitudinal, and prospective approach to examining and identifying the key determinants of expertise within canoe sprint. Relationships between variables in an elite sporting environment are rarely simple or linear in nature and so our approach enabled us to take this into account. To my knowledge, this is the first study to explore all multidisciplinary factors relevant to talent development in a longitudinal and prospective manner. In line with the hypothesis, I found that an interaction of variables spanning psychology, socio-demographic, and skill acquisition variables could discriminate between our two groups with 79% accuracy. As well as this, the interaction between early developmental experiences of the athletes and the microstructure of practice was very prevalent within our model, subsequently supporting our hypothesis that these domains would have a particular influence. I also ran analysis on individual subsets of our overall dataset (athlete health wellbeing and recovery; psychosocial and demographic, and practice and training factors). Whilst the classification was higher in the multidisciplinary dataset (providing evidence for why we should be taking a multidisciplinary approach), these subsets provided us with additional variables that support our full model and may also be of some interest to practitioners.

4.5.1 Athlete Health, Wellbeing, and Recovery Factors

Attributes that did not come up in our full multidisciplinary model as discriminating between the two groups were that of the athlete health, wellbeing, and recovery. Given the influence of these variables upon athlete availability and subsequent training, it is somewhat of a surprise that none of these variables came out as influential. However, it is important to note that the analytical strategy utilised, highlighted discriminators between the groups and not commonalities (i.e. variables that are essential for all groups to reach this level). Raysmith and Drew (2016) identified a 20% benchmark, explaining that if 20% or more of total training sessions had to be modified due to injury or illness, athletes were less likely to achieve their performance goal. Throughout the course of the study, none of our athletes experienced any significant injuries or illnesses that had a long-term impact upon their training. Bearing this in mind, this lack of long-term injury / illness prevalence, may suggest that this is a key commonality between the groups and essential to have made it onto the pathway in the first place.

When we analysed this subset of variables individually, we did however find that the high-potential group had lower Availability during January – March 2020 in comparison to the low-potential group. In depth discussions of these findings with national coaches and support staff led us to believe that this was a result of higher training intensity that subsequently led to minor injuries / illnesses. In line with Raysmith and Drew's (2016) 20% benchmark, this reduced availability may

not have had an overall detrimental effect on the paddlers because it covered less than 20% of the total training time. The implication of this that modifying training over short periods of time to enable recovery is potentially beneficial rather than detrimental to performance. Within this subset, Napping also came out as a discriminator between the high- and low-potential groups supporting previous research that highlights the beneficial effect of napping due to its impact upon recovery and performance enhancement (O'Donnell et al., 2018).

4.5.2 Practice and Training Factors

In line with Jones et al. (2020), the microstructure of practice was a key discriminator in the development of high- and low-potential canoe sprint athletes, with the high-potential group undertaking more Varied and less Constant Practice. These findings are consistent with the long-term learning benefit associated with practice that is high in contextual interference (Shea & Morgan, 1979), and adds additional support to this literature base due to its applied setting. This position also supports challenge point framework (Guadagnoli & Lee, 2004), which states that learning is most robust when there is an increase in task difficulty to the point of optimal challenge. In this case, task difficulty has occurred as a function of the additional interference present in practice because of 'variation', benefitting the high-potential group. For four out of the five factors relating to challenge, the low-potential group reported finding their training more challenging, indicating that in line with challenge point framework, they had gone beyond the point of optimal challenge and the subsequent learning benefit had decreased. It is worth noting that these athletes did not undertake more challenging practice (evidenced by participation in more constant and less varied practice), but it was their perception of challenge that was higher. This indicates that this group of athletes may not have developed the coping strategies needed to cope with challenge (e.g., experiencing failure due to task difficulty), and so are less able to undertake challenging practice where there is an additional learning benefit. Being able to reappraise and cope with both chronic and acute stressors would be of benefit to their overall development and performance (Schinke et al., 2012). The combination of additional stressors (e.g., university demands and selection races) around the time points where challenge was perceived as highest, may also be worth considering (Tenenbaum et al., 2003).

The results regarding the microstructure of practice also provided support for the specificity of practice principle (Henry, 1958), with the high-potential group undertaking more practice that mimicked the target race conditions (e.g., Race Specific Training, more Whole and less Part Practice) than in the low-potential group. The high-potential group also took part in more Technical Practice with a directed focus upon the technical elements of their paddling. This adds further support to the importance of technique on paddling efficiency and subsequent effect on athlete development and performance (Michael et al., 2009). It is important to also acknowledge the

interaction between these variables at this time point. The prevalence of variables from 11th February – 3rd March 2019 highlights it as being a key periodisation point where additional training components will be introduced (e.g., training under conditions of anxiety). Whilst on average, Technical Practice was higher for the high-potential group across the majority of timepoints, it was only strong enough to come out as a discriminator from 11th February – 3rd March 2019. It is likely that there was a particular emphasis in maintaining technique at this timepoint due to the inclusion of variation and race specific conditions that may disrupt the technical elements of paddling.

4.5.3 Psychosocial and Demographic Factors

The finding regarding both the size of the athlete's Birthplace and Homeplace during development was perhaps unexpected, with previous research placing emphasis upon the benefit of smaller populations in Great Britain for athlete development (Baker et al., 2009). This may, however, be a variable of specific influence solely to canoe sprint highlighting the value of taking a sport-specific approach to this research. Increased access to competition throughout the athlete's development could be enhanced by greater variety in the population, subsequently enhancing the athletes' developmental experiences. Greater opportunities within the sport (e.g., access to national coaches and training facilities) may also be increased. Pennell et al. (2017) found that whilst living in a small town was beneficial to the development of New Zealand "Touch" rugby players, the proximity of this town to large cities was also a key factor. The authors noted that these athletes were able to easily access resources alongside having a choice in clubs and facilities, something those living in more remote towns were not able to do. From this we might infer that athletes growing up in places where there were smaller populations were disadvantaged by limited access to additional resources.

The high-potential group also had a greater exposure to Mastery Focus within their family during development, consistent with previous research within canoeing (Knight et al., 2016). This may also provide an explanation for the emergence of a lower Outcome Focus in the high-potential group when examining this subset of psychosocial and demographic variables individually. Exposure to a Mastery Focus during development likely had an impact upon the high-potential athletes' ability to frame challenge positively (Stout & Dasgupta, 2013) explaining why the high-potential athletes had a lower perception of challenge and were thus able to engage in more challenging practice. The higher levels of Emotional Stability and Organisation Support identified within our analysis of the subset of psychosocial and demographic variables would also be influential in enabling these athletes to cope with higher levels of challenge.

Previous multidisciplinary research has highlighted the prominent influence of psychosocial factors (c.f. Güllich et al., 2019). In contrast however, the findings from this study place a strong

emphasis upon practice and training factors (as part of a multidisciplinary approach) as the most influential components within athlete development. Because types of training are more likely to differ across sports, examining sports together would likely lead to a wash out effect whereby any differences between sports cancels each other out. Performing this analysis on a singular sport enabled these nuances to come to fruition. Within this study there were also differing variables of importance within the psychosocial factors in comparison to previous research. For example, Hardy et al. (2017) identified relative importance of the sport as a discriminator between elite and super-elite athletes, however this was not a discriminator within this study. With the centralised system at British Canoeing linked up with the local University, and an emphasis on taking part in other opportunities, these differing findings are likely a result of sport specific differences across sports with different variables being influential dependent on the sport. This work has extended the field by adding to the body of work in canoe sprint, which has previously focussed solely on anthropometric factors (López-Plaza et al., 2019), and instead providing a greater breadth of factors that can be utilised in the development of canoe sprint athletes.

4.5.4 Limitations

The value of collecting sport-specific data from a nuanced population comes with a sacrifice to the statistical power and possible generalisations we can make from the data. The nature of the study meant that a large commitment was required of the athletes to enable us to undertake multidisciplinary and longitudinal research. To be confident in the accuracy of the data, I could only collect and analyse data from athletes who committed to full engagement in the study. Due to the fact there were only seven participants overall (and pattern recognition analysis usually works with larger samples), there is a need to be cautious in relation to data interpretation. Providing firm recommendations to coaches and practitioners based on a small sample would be irresponsible and looking to replicate these findings within a larger pool of athletes would be the next step. Due to the sample size, I was unable to run a confirmation of the model using unseen participants' data (c.f. Jones et al., 2019). However, to account for this I undertook a leave-one-out cross validation procedure which was employed across both the feature selection and classification processes. The sample size also provides some explanation for the classification accuracy of our models being lower than previous studies (Güllich et al., 2019; Jones et al., 2019). The predictive nature of our group split may mean that we have not correctly identified whether an athlete is high- or low-potential. Due to the smaller sample, there was less margin for error on this and an athlete placed incorrectly may have a greater impact on the classification rates. With very few athletes making it to top elite levels, it may be that not all paddlers in the high-potential group will go on to perform at a level higher than what they are currently. Subsequently, they may fit a low-potential athlete profile better providing an explanation for the lower classification accuracies of the high potential

group. As this study is part of the longer-term Pathway 2 Podium project, the analysis of these data as part of a larger dataset alongside group classification based upon final, objective career trajectories means it is not believed any of these potential limitations to be of concern. It is also worth considering that I utilised four different classification methods within our study, each relying on different algorithms that together strengthened the confidence in the data. Whilst using only one of these (e.g., support vector machine or J48 decision tree) would have given a higher group classification accuracy, the fact there is some discrepancy highlights the rigor in our methodology and subsequent strength of the research. A final limitation is that whilst this study captured a plethora of variables shown to be influential to athlete development, I did not capture all variables of importance. For example, (López-Plaza et al., 2019) has shown body dimensions to be relevant to the development of canoe sprint athletes however within this study we did not capture any anthropometric variables.

It is important to acknowledge reasons for drop out to provide some applied implications for similar work to aid future researchers in engaging with a larger sample. For athletes who were full time University students or also in employment, completing a weekly questionnaire alongside regularly meeting with a researcher posed a large time commitment. Furthermore, the use of a measure developed in cricket posed some problems for canoeists due to the large differences in practice types between the sports. This meant some athletes found completing the interviews challenging and not enjoyable, leading to less engagement. Having a longer set-up time in the sport, and athlete input into reviewing the measures used for similar research would help provide a solution to this.

4.5.5 Implications for Research and Application

Overall, this study has highlighted the importance in taking a multidisciplinary, longitudinal, and prospective approach to talent development with a variety of factors coming out as influential across multiple domains. The practice and training findings support those from Jones et al. (2019) and continues to emphasise the relevance of the microstructure of practice in expertise development. Further talent development research should consider this and not solely rely on measuring the number of hours an athlete undertakes (Ericsson et al., 1993). In terms of athlete development there are clear implications to come out of this, mainly the incorporation of variable practice as a means of enhancing long-term athlete progression. As well as this, it is important for coaches and practitioners to consider the specificity of practice principle and to structure and design training with consideration of the long-term performance outcomes.

A key implication to come out of the present study is the importance of ensuring athletes are equipped with the coping mechanisms needed for them to thrive on challenge throughout the

developmental stages of the pathway. If more athletes can cope with challenge, then more will be able to undertake challenging practice important for long-term development (e.g., variable practice) and cope with demands present at higher levels. Subsequently, this would lead to a greater number of athletes achieving potential higher levels in the sport. Collins and MacNamara (2012) emphasised that to develop athletes that can cope with challenging situations, you need to create an environment throughout the pathway where challenge, alongside accompanying support to deal with this challenge, is prevalent. Identifying and targeting young athletes and implementing interventions (e.g. Bell et al's., 2013 mental toughness intervention) proactively is also beneficial to long-term athlete development and does not just rely on this ability occurring by chance.

Finally, there are additional implications regarding the psychosocial and socio-demographic factors that came out as influential in this study. I emphasise the importance of ensuring all athletes along the pathway have opportunities to access variation in competition and training / coaching resources. Ensuring athletes experience an espoused mastery focus throughout their development is also key and it is worth considering that there may be other domains that enable an athlete to experience this (e.g. their school and training environment). Gano-Overway and Ewing (2004) provide practical recommendations on encouraging an environment that supports a mastery focus (e.g., working with others on a skill development task). Further research should examine how these strategies could be utilised as an intervention within training and competition environments to enhance elite athlete development.

Future research should also look to continue following these athletes all the way to the peak of their careers to enable the capturing of additional variables throughout their development. Whilst this study is novel in that it measures variables longitudinally assuming that the timeframe measured within this study is the only one of influence, is naïve and the addition of further timepoints to the research would be very beneficial. Furthermore, including athletes into the study as they come onto the pathway and then continuing to follow their journeys would provide a greater sample and enable the confident confirmation of these results. Finally, exploring some of the variables of interest that came out in this study (for example, challenge and a family mastery focus) in more depth would allow further insight which would then have more application for pathway structures and additional athlete support.

4.5.6 Conclusion

Overall, I identified an 11-factor multidisciplinary predictive model (encompassing socio-demographic, psychosocial, and practice and training domains) that was successful in discriminating between high and low potential canoe sprint athletes. I also identified additional variables of influence (e.g., Napping and Organisational Support) within our subset analysis which

added depth to our findings. This study has implications for the development of canoe sprint athletes and highlights how considering the microstructure of practice and the developmental experiences that an athlete has can aid in their progression. I also emphasise the importance of creating an environment that enhances an athlete's ability to deal with challenge. The present study has highlighted why researchers should be taking a multidisciplinary, longitudinal, and prospective approach to talent development and provides evidence of how this can be undertaken. To my knowledge, this is the first study to have done this and serves as a steppingstone for future research to build off these findings.

Chapter 5:

Examining the developmental life stories of Great Britain Canoe Slalom Pathway Athletes

5.1 Abstract

Psychosocial factors and experiences underpin a large majority of the multidisciplinary factors influential to talent identification and development (Bienenfeld, 2006). Despite playing a key role within an athlete's developmental journey (MacNamara et al., 2010a, 2010b), they are often neglected in favour of cross-sectional physiological measures (see Johnston et al., 2018 for review). Previous qualitative investigations into the perspectives influencing athlete development (e.g. Hardy et al., 2017), have added greatly to the literature base. However, these findings are foreshadowed by an inability to identify causality due to the length of time between retirement and interview. This study built upon this whilst also following on from a multidisciplinary investigation of canoe slalom pathway athletes as part of the Pathway 2 Podium Project. I undertook a qualitative exploration to enable us to get added depth and context to previous findings from this project. Taking a critical realist perspective, we adapted the semi-structured interview schedule from the Great British Medallist's Project (Hardy et al., 2017) and undertook four qualitative interviews with canoe slalom pathway athletes. Seven themes constructed from our data were influential to athlete progression. Specifically: (a) early developmental experiences, (b) relationship with sport, (c) personality, (d) ongoing developmental experiences, (e) athlete behaviors, (f) support networks, and (g) pressure zone and emotion regulation. These findings add to the broader knowledge base surrounding the psychosocial processes underpinning the development of elite athletes whilst also providing important implications for applied practice.

5.2 Introduction

Research into the journeys of elite athletes seeks to understand the influences behind their success. Despite often being neglected within TID systems (see Johnston et al., 2018 for review), literature highlights the key role psychosocial characteristics play on the elite performer's developmental journey (Gould et al., 2002). In line with psychodynamic theory (Bienenfeld, 2006), an athletes' psychosocial characteristics and experiences also underpin a large majority of factors that influence athlete progression. For instance, the prevalence of adverse experiences in early foundational years can increase propensity for illness (Sonu et al., 2019) and subsequently training availability, whilst the values of a family can contribute to how a child engages in sport (Strandbu et al., 2020). Subsequently, it is crucial for sporting organisations to acknowledge and examine the influence of psychosocial factors on athlete development and utilise these to enhance the progression of their athletes. The present study follows on from Hardy et al.'s (2017) investigation of the psychosocial biographies of elite and super-elite athletes and looks to build upon their findings within a sport-specific sample. The aim of this study was to explore the journeys of Great British canoe slalom pathway athletes to gain insight into the psychosocial processes that shaped their development.

5.2.1 Athlete Experiences

Studies have shown the prevalence of a culture of striving within elite and super elite samples (Wilson et al., 2019). Within Hardy et al.'s (2017) study, this was manifested through combinations of an environment of expectation and achievement, a strong work ethic, a highly competitive home environment, and a high value placed upon mastery and / or outcome. The authors stipulated that exposure to this culture of striving fostered traits that benefitted athletes' progression in sport. For example, an environment of expectation and achievement nurtured the belief that excellence was not extraordinary rather it was expected. This finding is consistent with research from Wilson et al. (2019) who identified an overrepresentation of elite athletes' parents also reaching elite levels of sport. In addition, a relationship between adversity and talent development has been evidenced by Sarkar et al. (2015), who identified the presence of sport and non-sport related adversities in the lives of Olympic champions and the positive impact this had on their motivation. Collins and MacNamara (2012) also suggested that athletes needed adversity within a pathway to facilitate high level performance. They emphasised that the skills gained from overcoming these situations (e.g., resilience and coping skills) transfer to the sporting domain and provide athletes with an adaptation that was beneficial to their long-term development.

5.2.2 Athlete Characteristics

Athletes' psychosocial characteristics are also influential with substantial evidence highlighting the impact of personality on athlete progression and development. Gould et al.'s research (2002) paved the way for psychosocial investigation into elite athletes and identified psychosocial traits that were pertinent to their development (e.g., conscientious, perfectionistic, competitive, and being able to cope with and control anxiety). Hardy et al. (2017) also identified that super-elite athletes engaged in higher levels of preparation which underpinned their ability to perform well under pressure. This is in line with research that has highlighted being able to perform well under pressure as key to an athlete achieving success (MacNamara et al., 2010a) and is likely underpinned by a variety of psychological processes, such as a counterphobic attitude (Hardy et al., 2017), high levels of mental toughness (Bell et al., 2013), and regular exposure to competition (Burns et al., 2019).

5.2.3 Athlete Support

An athlete's support network have also been identified as influential to sport performance (Knight et al., 2018), with coach and family relationships highlighted as particularly important (Gould et al., 2002). Freeman and Rees (2009) examined the benefit of perceived support upon sports performance and found the provision of support, specifically esteem support, supported performance. This was attributed to the role esteem support played in athletes' appraisal of competition as being less of a threat for them. Burns et al.'s (2019) qualitative investigation of

Olympic, Paralympic, and world champions also identified the importance of interpersonal relationships (e.g., the right support team and an effective coach-athlete relationship) in empowering athletes, facilitating their needs and subsequent wellbeing and performance.

5.2.4 Study Rationale and Aims

Given the contribution of psychosocial factors to the talent development process, incorporating psychosocial aspects as part of a multidisciplinary approach is key. Previous qualitative explorations (Gould et al., 2002; Hardy et al., 2017) have added to the talent development literature by identifying more nuanced evidence of the components underpinning development. However, these potential important findings and associated implications are foreshadowed by the substantial length of time between retirement and interview alongside the heterogenous nature of the samples, which neglect to recognise sport specific factors. Undertaking interviews with an exclusive focus on a group of developing athletes from a single sport would provide a solution to these limitations offering long-term athlete development implications. Chapter 4 of this thesis built on from previous literature by undertaking a multidisciplinary investigation of prospective factors influential to athlete development within a single sport. However, the depth of these findings was limited and exploring psychosocial factors in greater detail is a crucial next step for this chapter. Qualitative research provides more in-depth insights into variables of interest and subsequently a methodology that will be adopted for this chapter. Undertaking research in a singular sport (contrasting to previous qualitative investigations) would also aid in the construction of sport specific nuances that overall will have more application for talent development. In summary, the aim of the present study was to elicit an in-depth understanding of the findings constructed from quantitative investigation of Great British canoe slalom pathway athletes to gain further insight into the psychosocial processes that shape their development. The research question was: can we confirm or refute some of the major findings of the Great British Medallist's (GBM) project psychosocial biographies (Hardy et al., 2017) regarding successful progression? Specifically, how does the early environment impact upon an athlete's progression in their sport, and what long term influence does key positive and negative foundational events have on an athlete. Critically, the findings have the potential to inform the sporting body's policy with regards to elite athlete development and support programme provision[3].

[3] This study was part of a wider project, the Pathway 2 Podium project, which aimed to prospectively examine athletes from their development through to podium across a variety of sports. In this instance, the present study dovetailed with the results of previous data collected for

5.3 Method

5.3.1 Philosophical Standpoint

This chapter was grounded in a post-positivism paradigm (Guba & Lincoln, 2005) underpinned by a critical realist ontology and an objectivism epistemology. Post-positivism moves away from the objective positivist stance instead emphasising the subjectivity of reality. It maintains that reality exists, but that knowledge is socially constructed and not everything is completely knowable (Krauss, 2005). Reality can only be known imperfectly (Alvesson & Skoldberg, 2017) and is influenced by prior knowledge, experience, and researcher values etc. This had implications for the methodological decisions for example choice of method (e.g., a semi-structured interview), data analysis (e.g., a majority deductive approach), and ensuring rigour (e.g., involvement with critical friends). The adopted philosophical standpoint also has implications for interpretation of the results by acknowledging that the research findings are contextually bound and not universally generalisable but instead relevant to those of similar cases. Instead, it is accepted that the results are value laden and influenced by the researcher's own values, knowledge and previous experience.

5.3.2 Participants

I undertook critical case sampling to select participants that we anticipated would provide the most meaningful insights for coaches and support staff at British Canoeing. To identify these critical cases, I consulted with British Canoeing coaches and support staff to determine which athletes they felt were most suitable to participate (e.g., athletes that were transitioning on or off funding). British Canoeing guided the selection due to wanting additional insight into certain athletes, which they felt could then be used to enhance their development (outlined within the participant penned portraits). For example, they wanted to gain insight into one athlete because they felt she had the potential to be a top GB athlete and that this may be useful for supporting her journey whilst also looking at her experiences and how this may help other athletes. The male participant was included within this study to ensure that there were participants of both genders however British Canoeing guided the selection for which male participant, due to developmental experiences they wanted further insight into (specifically the relationship and expectations from his father). The four current British Canoeing athletes (n_{female} = 3, n_{male} = 1; M_{age} = 19.5, SD = 0.60; $M_{\text{years' experience}}$ = 10.75, SD = 1.64; $M_{\text{years' competing}}$ = 10.12, SD = 1.29) were invited to take part in a semi-structured psychosocial interview were participating in the Pathway 2 Podium study; a

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this project (e.g., completion of the Athlete Psychosocial Survey) and enabled us to add more depth and context to our findings.

multidisciplinary, prospective study tracking Great British pathway athletes over time. Three of the participants were UK Sport Podium or Podium Potential funded athletes and one of them was transitioning off Podium Potential funding. We provide penned portraits of these athletes to provide contextual information and subsequently add meaning to our findings. Athletes' age is referred to in quartiles. Whilst Chapter 2 of this thesis highlights the importance of looking at birth weeks rather than quartiles, coaches and practitioners within the sport were more used to seeing dates of birth referred to in quartiles and so presenting it in this way enabled them to understand the findings quicker and easier.

Athlete 1. Athlete 1 was born in May in a town with a population of 51,735. This placed her in the second quarter for the calendar and competitive year. She attended a state primary school and then a state secondary that was also a specialist sport school. She grew up as the youngest of three sisters in a two-parent household. She started canoeing age 12 following selection for the sport's talent identification program. She took part in three other sports outside of canoeing with one other main competitive sport. She continued this sport until age 14 when she specialised in canoeing. She started competing at age 12 and progressed from Division 4 to Premier in two years. She first started competing internationally at 15 years old, becoming a funded athlete the year after, following those competition results. She made her senior international debut at 16 years old also qualifying for senior international finals. At the time of the interview, she was training as a full-time athlete at the main centralised training centre. This athlete was selected to participate in the study to explore the journey of a TID athlete who was part of the first cohort of TID athletes to have come through the system. She was also identified by coaches as an athlete who they felt had potential to become a top GB athlete.

Athlete 2. Athlete 2 was born in August in a town with a population of 7,933. This placed her in the third quarter for the calendar and competitive year. She attended a state primary school and then a state secondary school. She grew up with an older brother and a non-identical twin sister in a two-parent household. She started canoeing age eight with her twin sister at an after-school club. She took part in four other sports outside of canoeing and specialised at age 18. She started competing at age 10 and progressed from Division 4 to Premier in four years. She initially trained as part of a home nations programme, however, became coached by volunteer coaches following a fallout in the program. She first started competing internationally for Great Britain at 16 years old, becoming a funded athlete the year after following those competition results. Despite relocating to the main centralised training centre, she did not regain her funding until she qualified for the senior team and international finals later that year. She made her senior debut at age 19. At the time of the interview, she was training as a full-time athlete at the main centralised training centre and working a part time job. This athlete was selected to participate in the study to explore how being dropped

from funding could have influenced her motivations and behaviours, especially considering the results she achieved the following year.

Athlete 3. Athlete 3 was born in June in a town with a population of 154,600. This placed him in the second quarter for the calendar and competitive year. At age five his family relocated to a small town where he attended a state primary and then secondary school. He grew up with an older sister in a two-parent household. He started canoeing age nine with his father and sister. He took part in three other sports outside of canoeing and specialised at age 12. He started competing at age nine and progressed from Division 4 to Premier in three years. He was initially coached by his father before joining a local club and then becoming part of a home nations programme. Following a fallout, he returned to his local club and was also coached by his father again. He first started competing internationally for Great Britain at 17 years old, becoming a funded athlete the year after following his competition results. He relocated to the main centralised training centre a year later and was awarded one additional year of funding before losing his place the year after. At the time of the interview, he was training as a full-time athlete at the main centralised training centre, whilst undertaking a part-time university degree and working a part-time job. This athlete was selected to participate in the study to ensure that we had representation from a male athlete and also to capture additional insights of his journey (specifically the relationship and expectations from his father) that coaches and support staff thought would be beneficial.

Athlete 4. Athlete 4 was born in August in a town with a population of 58,135. This placed her in the third quarter for the calendar and competitive year. She attended a state primary and a state secondary school that was also a specialist sport school. She grew up as an only child in a two-parent household but had two half-brothers that were older and lived away. Due to parental involvement in the sport she was immersed in the sport since birth with her parents coaching her in her early foundational years. She started competing at age eight and progressed from Division 4 to Premier in five years. She took part in three other sports outside of canoeing, with one other sport counting as a main sport she was competitive in. She continued this until age 13 when she specialised in canoeing. At 14 she and her family relocated, and she moved schools. She first started competing internationally at 17 years old becoming a funded athlete the year after following those competition results. At the time of the interview, she was training away from the main centralised training centre whilst undertaking a full-time university degree at the same time. This athlete was selected to participate in the study following interesting values on the Athlete Psychosocial Survey (a comprehensive measure of psychosocial factors pertinent to athlete development), specifically a low relative importance score, which coaches and support staff wanted to explore further. Also, as the athlete was the only funded athlete in university full-time, we wanted to explore this and see if there were any additional insights, that would be relevant to the program.

5.3.3 Procedures

Consistent with a critical realist perspective, I examined pre-existing theories and literature surrounding talent development to inform our research question and subsequent data collection. The research was guided by psychodynamic theory, which explains how human feelings, behaviours, and motives are influenced by early experiences, and ultimately shape adult personality (Bienenfeld, 2006). This afforded he opportunity to explore the early developmental experiences of the athletes and examine how these experiences impacted upon their personality, behaviour, and subsequent progression in their sport. In line with a critical realist perspective, where appropriate, I was conscious to consider other theories that could provide value to our findings, for example, post-traumatic growth theory; the idea that a positive psychological change can occur due to a traumatic event (Tedeschi & Calhoun, 2004).

Interview Schedule. I adapted Hardy et al.'s (2017) semi-structured interview schedule (see Appendix I) for this study as it allowed us to further explore findings from previous literature that have been shown to be influential in the progression of elite performers. The semi-structured nature of the interview schedule was important to encourage the development of new ideas that may appear due to our sport specific sample. It also facilitated prospective as well as retrospective insights to be gleaned. The interview guide was structured into six sections based on the six main GBM interview schedule themes (Hardy et al., 2017): critical developmental experiences; relationship with their sport; pressure zone and emotional regulation; personality; relationships with family and coaches; and career turning points and other experiences. As the study was guided by psychodynamic theory, the interview guide and process explored childhood experiences and relationships and then followed up on the possible influence of these on the athlete's development as both a person and an athlete. Probes were weaved in throughout to elicit how participants' experiences might have influenced their feelings (e.g., "Which had the greatest (emotional) impact on you, winning or losing?") and behaviours (e.g., "To what extent were you supportive of your teammates?") up to the present day. Participants were also encouraged to speak around the topics and give additional information about that topic that they thought was relevant to their development. The last section of the interview script also provided them with opportunity to provide additional insights into their development beyond that which was specified in the interview schedule.

Interview Procedure. Prior to the interview, I, had been working with each of the athletes for at least a year. This period of prolonged engagement involved meeting monthly whilst conducting semi-structured interviews and collecting questionnaire data regarding their training experiences and personality. This was done in line with Ronkainen and Wiltshire's (2019) suggestions to enhance the accuracy of the data collected. Having a prolonged engagement guarded

against the limitations of our data collection techniques (e.g., reduced responses due to lack of trust between participant and interviewer). On invitation to take part in this study, the participants were provided with an overview of the six main themes. The interviews took place in the off-season at a time and place that was convenient to the participant. Each interview began by reminding the participant about the nature of the interview and that whilst the results would be used as part of a report for the sport, they could choose to anonymise their data, and had a right to withdraw at any time. I explained that I was interested in the athlete's whole life story to the present day, and that although I would like them to speak freely and about anything the participant thought was important, I was going to be exploring six themes: critical developmental experiences; relationship with their sport; pressure zone and emotional regulation; personality; relationships with family and coaches; and career turning points and other experiences. The interview started with the critical developmental experiences section, which explored early childhood experiences and relationships, with the remaining themes following in a logical order. I allowed for flexibility across the themes to enhance the flow of the interview to enhance the depth and meaningfulness of the information. Questions specific to the themes were weaved throughout the conversation and probes were used to get a more detailed description of the participants experiences and insights (e.g., "What did it feel like to work with this coach? How did this coach make you feel emotionally?"). This enhanced the quality of the interview process and the data elicited. At the end of the interview, athletes were offered the opportunity to elaborate or add to what had been said and then thanked for their time. All participants were provided with a transcript of their interview for them to check for adequacy and accuracy before any analysis took place (Ronkainen & Wiltshire, 2019). They were asked to highlight any passages that they were uncomfortable with or felt did not accurately represent their views. This was followed up with a phone conversation where the passages were either amended, kept but with instruction not to use as direct quotes, or removed from the transcripts completely. The length of the interviews ranged from 106 to 110 minutes.

5.3.4 Data Analysis

The interviews were transcribed verbatim by professional transcribers and then read several times over by the interviewer until they were fully immersed in the data. Next, NVivo 10 qualitative data analysis software (Nvivo, 2012) was used to analyse the data. A primarily, deductive approach aligned best with the philosophical standpoint so utilised a directed content analysis based on the principles outlined by Hsieh and Shannon (2005). I, initially coded the data in NVivo into the six pre-determined interview themes on a line-by-line basis until all the text was coded. Any data that could not be categorised was identified and coded into a seventh open-ended theme. Next, I examined the quotes within the themes to construct first- and second-order sub-themes. I acknowledged that the codes might change and consequently codes were added, deleted, or changed

dependent on the data. These themes were then used to provide perspectives around the contributing influence of a range of factors to athlete development.

I, the lead researcher who conducted the interviews and analysis, presented my findings to four critical friends who were experienced qualitative researchers and experts in the subject field. Any discrepancies between the interpretation of the data were addressed by returning to the original transcripts and discussing the different explanations for the findings until there was full agreement across all researchers. The results were then narrated as a group summary of the overall findings. Following this, the athletes were provided with an additional opportunity for member reflection to give their perspective on our interpretation of the findings. Where our interpretation did not fully resonate with the participants, I revisited and amended the narrative accordingly. This stage of the analysis ensured that we safeguarded the quality, representativeness and meaningfulness of the exposé and where necessary engaged with alternate explanations to enhance the representativeness of the expose and where necessary engaged with alternative explanations to enhance the rigour of the process and the meaningfulness of the findings (Ronkainen & Wiltshire 2019).

5.3.5 Ontological Plausibility, Empirical Accuracy, and Practical Utility

Recommendations for ensuring trustworthiness or 'rigour' within qualitative research are often grounded in a relativist ontology (Smith & McGannon, 2018). Ronkainen and Wiltshire (2019) recently proposed alternate approaches of: ontological plausibility, using theories that are plausible to describe events; empirical accuracy, whether there is accurate and sufficient data gathered to support the conclusions drawn; and practical utility, research that is pragmatic whilst also rooted in theory that explains events. These principles guided the research due to their strong alignment with a post-positivistic standpoint. Ronkainen and Wiltshire (2019) recommended researchers use Maxwell's (2017) typology of descriptive, interpretive, and theoretical validity to ensure these three principles and the subsequent rigour of our study. Descriptive validity refers to how factually accurate the research account is, and we ensured this through prolonged engagement (e.g., the researcher undertaking the interviews had already been working with the participants for over a year), in-dwelling (the researcher had been embedded within the sport for over a year), and participant response verification (through transcription checking). This safeguarded the adequacy and accuracy of the data, its interpretation, and the final report writing. This ensured the quality of the study by making sure the observations and conclusions accurately reflected real world events (Ronkainen & Wiltshire, 2019). Interpretive validity refers to the consideration of participants interpretations which we ensured through member reflections (whereby participants were given the opportunity to critique and discuss the researcher's interpretation of the data). I also engaged with critical friends and undertook disputative conversations (whereby the researcher who had undertaken the interviews and analysis reported their interpretation to other members of the

research team) which encouraged us to consider alternate explanations of the data. This enhanced the quality of the study by ensuring that the interpretations of the data accurately reflect those of the participants (Ronkainen & Wiltshire, 2019). Finally, theoretical validity refers to how well the identified theory explains the phenomena. This was ensured, and the consequent rigour of our study by drawing on existing theory to make sure our research account engaged with theoretical explanations of the empirical evidence. This enhanced the quality of the study by ensuring real world events and participants experiences of them could be explained by theory (Ronkainen & Wiltshire, 2019). In conclusion, the rigour of our study was reached through drawing on existing theory; prolonged engagement with the participants; data in-dwelling; transcription checking; critical friends; disputative conversations; and by utilising member reflections.

5.4 Results and Discussion

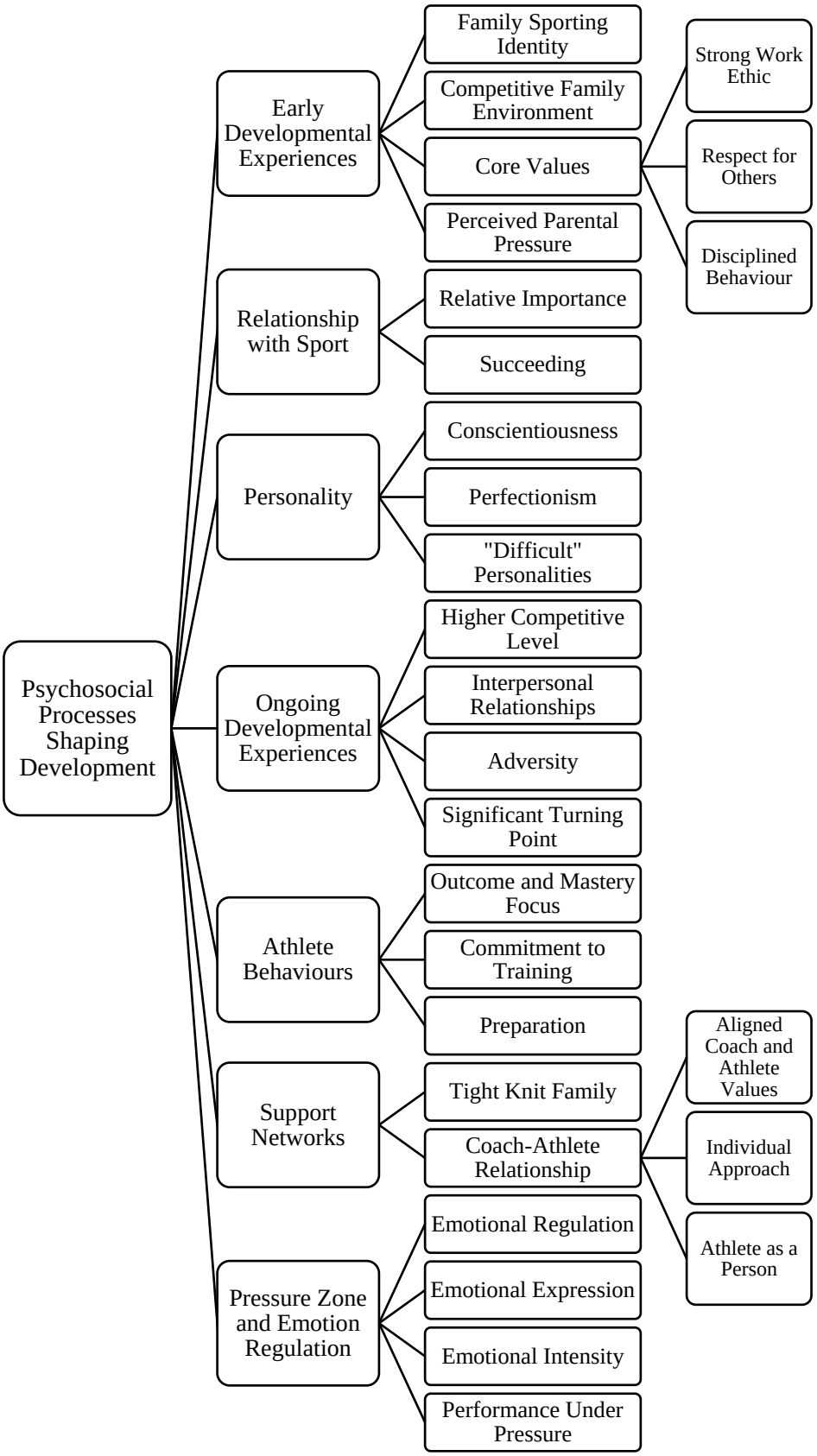
Our results are presented in seven sections: (a) Early Developmental Experiences, (b) Relationship with Sport, (c) Personality, (d) Ongoing Developmental Experiences, (e) Athlete Behaviours, (f) Support Networks, and (g) Pressure Zone and Emotion Regulation. For a schematic diagram of this framework, see Figure 5.1.

5.4.1 Early Developmental Experiences

Family Sporting Identity. All our athletes experienced an active childhood where participation in sport was inherent to family life. They all referenced both parental and sibling involvement and so it was of no surprise that our athletes also engaged in sport (Strandbu et al., 2020). Athlete 1 explained: “Both my sisters have always done sport … we’ve always been a sporty family, again my mum coached netball, my dad was a mountain biker, so I was always quite active, I guess, always on the go, doing something.” This is consistent with research that shows how individuals often identify with the family narrative and align their identity with that of the collective (Cooper & Ewing, 2020). This in turn can strengthen the bonds within a family, which was exhibited by the close-knit nature of all our athlete’s families. For Athlete 4, canoeing specifically was integral to family life and underpinned her participation in the sport: “My parents did paddling before I was born, so then I grew up in the sport. So, then I was introduced into paddling. The first time I went to a slalom, I was six months old.”

Figure 5.1

Psychosocial Processes Shaping the Development of Elite Athletes



Competitive Family Environment. Three of the four athletes grew up within a Competitive Family Environment with all these athletes participating in the same sport as their siblings throughout their development. For Athlete 1, a competitive environment extended across her whole family and to a variety of contexts, not just a sporting one: "So, every year we have this card game that we do at Christmas, and it's literally the worst game ever, but everyone is so competitive we end up in arguments over it." Athlete 1 went on to show high levels of competitiveness herself, exhibited through a high Outcome Focus and Need to Succeed.

For Athletes 2 and 3, exposure to a Competitive Family Environment was primarily through a friendly sibling rivalry. Athlete 2 explained how being in direct competition with her twin sister provided her with drive and motivation to push herself further.

> I always say I wouldn't be where I am if it wasn't for her because if she did something, I would do it. If she's going to training, well I'm going training with her. It was really positive rivalry, friendly rivalry, but we both helped each other.

This attitude is consistent with previous research examining the potential underpinnings of the relationship between twins and talent development. Taylor et al. (2020) found a positive rivalry enhanced athlete motivation within their sample of twins competing in the Great Britain hockey pathway. Competition within families has also been shown to prompt an increase in training workload, effort during competition, and increased use of mental skills (Davis & Meyer, 2008); all of which would be beneficial for athlete progression and development. However, it is worth noting that athletes often report an increased level of perceived pressure when competing against their siblings (Davis & Meyer, 2008).

As the only athlete not to grow up with her siblings, Athlete 4 did not experience a sibling rivalry. However, being immersed in the sport since birth meant that she attended competitions frequently from an early age, getting exposure to the competitive environment. She was also part of a sport specialist school where sporting excellence was perceived as the norm and regularly participated in school sports competitions. As previous literature has indicated (Hardy et al., 2017), growing up in an environment where there is exposure to competition can aid athletes in identifying skills and strategies to help perform under pressure and thus, these early developmental experiences were likely to have multiple benefits.

Core Values. All our athletes experienced Core Values at home. This was manifested through varying combinations of: A Strong Work Ethic where the athletes witnessed their parents and siblings working hard to achieve their goals with an expectation that they would do the same; Respect For Others (in and outside the family); and Disciplined Behaviour where the athletes were

expected to hold themselves to a high standard. Consistent with Sabatier and Lannegrand-Willems (2005), these values influenced the athletes' behaviours both in and outside of their sport. Athlete 3, in particular, was exposed to a family culture where there was a noticeable emphasis on Disciplined Behaviour:

> I don't want to say strict, but they were disciplined, like good table manners, speaking properly, being polite. Mum always used to say her friends were impressed with how polite we were at the dinner table… No knives and forks on the table or on the plate, when you're done, put them together, and then we'd clear up and make sure everything is tidy.

Athlete 3 showed these behaviours himself in his high levels of Commitment to Training and Total Preparation. The fact that the family values influenced athlete behaviour is consistent with social learning theory (Bandura, 1977), which suggests that behaviour is learnt through observation and imitation. The athlete observes these behaviours within their family and then imitates them within their sporting environment.

Perceived Parental Pressure. It is widely acknowledged that parents play a pivotal role in a child's sporting experiences (Knight, 2019), with parental pressure (e.g., placing extreme expectations and overstepping the parental role in the sport) shown to have a negative impact on the need satisfaction and subsequent motivation of child athletes (Amado et al., 2015). One athlete felt a very high internalised pressure because of their parents' sacrifices. However, through discussion with them was able to develop a better understanding of their position. This is in line with Dorsch et al. (2016) who found that a child may perceive supportive parental behaviours as pressure despite this not being the intention.

Whilst for Athlete 3 the main emphasis from his parents was the enjoyment of the sport, there was also a subtle emphasis on behaviours and achievement that stemmed from his father as a coach:

> He was critical of me, but I was critical of myself. So, he was not actually saying anything that I didn't agree with. … And critical if I ever didn't try or if I gave up. … Or if I didn't warm up properly or didn't eat before a session. … He wanted me to do it everywhere I could. Probably beyond the level I was at. … I don't know if it was the fact it was winter training when he was coaching me as well. … But probably for a while until I got used to being super thorough with everything and it probably did take the enjoyment out of it.

Other research investigating parent – coach / child – athlete relationships has also identified that higher expectations placed upon the children of coaches can reduce their enjoyment and motivation in the activity (Amado et al., 2015). However, Athlete 3 also recognised that his father's values and

expectations were beneficial to his progression, and he set his own expectations in line with this (Sabatier & Lannegrand-Willems, 2005): “Now, that’s probably one of the bits of canoeing I enjoy the most. Being really thorough, looking back through it and my preparation and stuff.”

Summary. Family identity is governed by a set of shared values (Cooper & Ewing, 2020) portrayed by the parent and often accepted by the offspring (Sabatier & Lannegrand-Willems, 2005). These general and sport specific values that underpin a family’s culture and identity can impact upon a child’s propensity and participation within sport (Wheeler, 2012). This was shown by our athletes who all aligned with their family’s sporting identity and developed their own values in line those. All our athletes were also exposed to a highly Competitive Family Environment throughout their development albeit the sources of this varied.

Relationship with Sport

Relative Importance. For all the athletes, their sport was an integral part of their life and they were willing to make sacrifices to enhance their progress. However, this did not mean that sport held the highest Relative Importance for them and three of the athletes placed importance on other areas of their life (e.g., future careers and interpersonal relationships). For Athlete 2, however, canoeing was the *most* important thing to her with other domains holding less attraction than they did for the other athletes:

> I know I can go and drink, but I don’t want to because I want to be the best athlete. It comes with sport. It comes with being an athlete. Everyone knows. I think everyone is aware of this when they become a full-time athlete – that there’s stuff you have to give up. Some people see it as a sacrifice. I see it as, “Well, it’s one step closer to becoming a better athlete for me.”

This attitude is reflective of other super elite athletes from the who also did not view prioritising their sport as a sacrifice (Hardy et al., 2017). Athlete 4 on the other hand, despite canoeing being very important to her, placed low Relative Importance upon the sport. From a young age, Athlete 4’s parents placed a high importance on her education as well as having a balance in her life which influenced her own perceptions:

> As much as I want to make it in canoeing, it’s not the be all and end all. … They [my parents] want me to have another life. They don’t want it to just be canoeing. As much as they want me to make it, you’ve got to have something to fall back on. They’re really supportive of my canoeing and very conscious they want me to have a good education as well.

By pursuing other additional educational opportunities, Athlete 4 was at a potential disadvantage due to her reduced access to centralised training. However, her high levels of Conscientiousness

combined with strong parental support at home (also identified as beneficial by other canoe slalom athletes; (Knight et al., 2016) have so far enabled her to achieve high levels in both domains. Previous research (e.g. Knight et al., 2018) has also identified the importance of an athlete's support network in aiding the maintenance of school and elite sport. Athlete 4's motivation to perform well in both sport and education is consistent with previous research that has also highlighted student-athletes as having high motivation to maintain a dual-career (Lupo et al., 2015).

Succeeding. All the athletes were driven by achievement and success which they utilised as a driving force in both training and competition. For Athlete 1, however, achieving success seemed to go beyond just a want to succeed but instead presented itself as an inherent need.

> I think you either have that want to win or you don't. And I think that helps me in some senses to hold on, and even in a race, or when I don't want to train, or I don't want to do it because I'm scared. I'll still do it because I *have* [emphasis added] to [win]. … There was senior world champs. … I was one of the youngest. … When people were speaking to me about it they said, "Oh are you just going to enjoy it?" I said, "No, I go to win."

The inherent need to succeed may be explained by attachment theory (Bowlby, 1982). An initial experience of loss creates an unconscious need to avoid experiencing loss again causing the development of an unconscious drive towards achieving success and avoiding failure. Speaking about an experience where she could have left the sport following a negative event within it, Athlete 1 demonstrated the need to have this outlet for her to succeed in: "I'm just competitive, I didn't have another sport to fall back on. … So, I tried to stick at it. … I'm too competitive to give it up."

A need to win as a means of Succeeding was likely exacerbated by Athlete 1's dichotomous thinking, a tendency to think in terms of polar opposites, for example "all or nothing" and "black and white" (Oshio, 2009). This way of thinking provides a clear distinction between a win and anything else, and so provides some explanation for why this need was so strong and clear cut. Dichotomous thinking was also exhibited across other domains in Athlete 1's life for example her preference for relationships with others who present themselves as "black and white" and with regards to the expression of her emotions which were very clear cut.

Summary. There was variation in the relative importance of their sport to the athletes with some of them identifying other domains that were also important to them. One athlete exhibited an inherent need for success which underpinned her motivations within the sport. Although the other athletes were driven by success this presented itself as a want more than a deep-seated need.

5.4.2 Personality

Conscientiousness. All the athletes exhibited elements of Conscientiousness by either being organised and thorough, working to the best of their ability, and / or holding a strong work ethic. Athletes 2 and 3 showed high levels of Conscientiousness if they could see the benefit or rationale for doing something:

> If someone said to me, "If you do this, this is what's going to happen. If you do it with all your effort. …" I'll think, "That's a good idea." … If you explained it to me, and in my head, I'm going "That's not going to work. That's not going to benefit me." I'm not going to give it my all. [Athlete 2].

This is consistent with the theory of reasoned action (Fishbein & Ajzen, 1975), which suggests an individual will consider the consequence of a behaviour before executing it. Athlete 4 on the other hand, showed high levels of Conscientiousness across all domains of her life. This stemmed from parental expectations for her to work hard across all domains in her early developmental years and was instrumental in enabling her to balance both university and sport.

Perfectionism. To integrate different conceptualisations of Perfectionism, researchers have subsumed the fundamental components into two higher order factors: Perfectionistic Strivings and Perfectionistic Concerns (Stoeber & Otto, 2006). Athlete 3 exhibited only a modest amount of Perfectionistic Striving, and like his Conscientiousness this was dependent on his perception of the situation: "If there's something I know I'm not very good at and I don't do it perfectly, I'm ok. … I wouldn't say I'm full-on perfectionist, but I'm definitely on like that half of the range". However, he presented higher levels of Perfectionistic Concerns with regards to his negative reactions to something he perceived he could do well at. He also experienced elements of socially prescribed perfectionism that stemmed from his father as a coach. Unlike Athlete 3, the other athletes showed a more balanced profile between Perfectionistic Strivings and Concerns. For Athlete 4 this was consistent across all aspects of her life, enabling her to achieve success in multiple domains.

Difficult Personalities. Two of the athletes exhibited traits of Ruthlessness, a willingness to be disliked in an attempt to achieve targets, and Selfishness, a willingness to put oneself first in an attempt to achieve targets. Whilst interpersonal relationships were important to Athlete 2, she recognised that this was not the goal of her participation in the pathway: "The problem is everyone tries to act as best friends with each other, but behind each other's back, we're not best friends; we're competitors. … people have to understand that – that not everyone is good mates." Athlete 3 identified how he was able to utilise these traits when it was appropriate and beneficial:

> I feel like I'm quite good at getting my way where it suits me. … Around races and stuff, there's things you might want to do. You might not want to go to demos and if you can manipulate the coach or support staff to sort out a way that you don't have to go to demos or you can go to training at a different time, then it's beneficial. … I don't feel I'm manipulating people to do what I want all the time, but if I've got something I want to do, I can put my reasons across.

These traits are consistent with Machiavellianism (Paulhus & Williams, 2002), a personality trait reflective of selfish, manipulative, and ruthless behaviours. Machiavellianism has been shown to be a predictor of sport performance (Vaughan & Madigan, 2020) indicating that acting ruthlessly and selfishly is potentially necessary to secure one's targets and interests. It is worth considering that as these characteristics are less socially desirable, other athletes may be less likely to admit that they possess them and behave in these ways. Whilst Athletes 1 and 4 did not display the traits of Ruthlessness and Selfishness they did exhibit some stubborn and argumentative behaviours indicating a low flexibility facet on the trait of Agreeableness (Lee & Ashton, 2004).

Summary. Personality has been shown to both directly, and indirectly influence sporting performance and progression (Gould et al., 2002). Among the plethora of personality traits shown to be relevant, Conscientiousness and Perfectionism are consistently shown to be prominent among elite level athletes (Gould et al., 2002), so it is unsurprising that both were prevalent among our sample. The influence of non-socially desirable traits also came to the forefront and adds to the growing literature base that explores these "Difficult" Personalities with reference to sport performance (Vaughan & Madigan, 2020). Consistent with other research exploring personality profiles of elite athletes (Allen et al., 2013), none of our athletes exhibited the same profile but displayed varying combinations and levels of each trait.

5.4.3 Ongoing Developmental Experiences

Higher Competitive Level. In their development both Athletes 2 and 4 were regularly exposed to athletes who were training at a higher level than them. This came from training in groups with older athletes and alongside boys, who were faster and stronger. Athlete 4 experienced both: "We had a Wednesday night session, a girls' session, and there were usually quite a few older people that were a bit better than me, and I got to train with them. That brought me on." Alongside training with people of a higher level, Athlete 4 was also smaller than her peers which she recognised as a positive development opportunity that impacted upon her progression: "I was never strong as a kid, I was always small. The only way I'd win a race was from my lines being fast, but now I'm obviously stronger. I've got the best of both worlds." These experiences are reflective of the underdog hypothesis where the challenge experienced by smaller / less advanced athletes may

enhance the development of core psychological, technical, and/or tactical skills that are needed to succeed at the highest levels (Gibbs et al., 2012). The implication is that by being an "underdog" in their development, our athletes developed skills that aided their future development. In the case of Athletes 1 and 3, the experience of a Higher Competitive Level occurred later once they had become funded athletes. For Athlete 1, it was the opportunity to train and compete at a senior level, whilst for Athlete 3 it was in his day-to-day training environment. Athlete 1 referred to the lessons she learnt from being in a senior environment and how this prepared her for future races:

> To be put in that situation where it's the older guys, how they cope with it; I learnt so much from watching them properly prepare … which is why I struggled in 2019, when I came back to the junior environment. … That was when I realised the level of preparation. That's probably when I learnt so much about myself.

Interpersonal Relationships. All the athletes referenced feeling different from other peers and that sport was where they found like-minded people. This was more noticeable in the three female athletes who often referred to being involved in friendship groups at school but not feeling a true sense of belonging. The athletes found that their friends in sport understood them more than friends in school and other areas of life, an attitude reflected by Athlete 1:

> My friends aren't sporty at all, we're literally complete opposites, and they've never really understood elite sport. … I feel like sport is one of those things that you have to be in that environment to know what it's like and see what people put in.

This feeling that school friends did not fully understand the athlete lifestyle was reflected by all of the athletes and is unsurprising given that athletes spend a larger amount of time with teammates and have more similar experiences with other athletes than school peers (Hawley et al., 2014). Athlete 2 found that she struggled to fit in with peer groups at her school:

> As we went through school, I was in the shadows. … I had a few really good mates but didn't really have many good mates because it was all the dance academy. … I think since high school, I've stood out from them.

She did however build strong relationships with coaches, teammates, and support staff in her sport, which enhanced her experiences and promoted a sense of community, something that was crucial to her development. Having strong interpersonal relationships within sport has been highlighted as influential among World, Olympic, and Paralympic Champions (Burns et al., 2019), and likely satisfied the athletes' need for relatedness (Deci & Ryan, 1985) benefiting their motivation and subsequent progress in the sport.

Adversity. All our athletes experienced Adversity at some point throughout their development, either within their sport or home environment. Examples include: a breakdown of relationships; dissolution of squads; lack of squad selection; and de-selection. Athlete 2 spoke of the experience of being dropped from funding and the initial negative impact this had on her:

> Up to Christmas, no one quite knew what was going on with me. I was very quiet. They didn't really see this, but obviously inside I was distraught. For two weeks straight, I cried myself to sleep. … I was like "I want to be this elite athlete and I've just been kicked off the elite program. What am I going to do?"

The experience of Adversity is likely influential in the development of elite athletes as it provides opportunities to develop characteristics necessary to excel (e.g., resilient and mental toughness) alongside an unconscious need to avoid loss in the future (Bowlby, 1982). Although Van Yperen (2009) found that there was a greater divorce rate among families of successful academy soccer players, experiencing Adversity can also be associated with mal-adaptive outcomes (Phillips et al., 2005). Hardy et al. (2017) found that experiencing a positive significant event in close temporal proximity to a negative experience could buffer maladaptive outcomes associated with negative events. Both Athlete 2 and 4 experienced a positive competition shortly before or after a momentous adverse experience. The combination of these experiences enhanced the athletes' motivation going forward and formed the basis of a Significant Turning Point.

Significant Turning Point. Athletes 2 and 4 expressed how despite following Adversity in their sport they experienced a noticeable decrease in motivation and loss of love for the sport they were able to use this as a driver going forward, and in Athlete 2's case, enhanced motivation and self-belief:

> I just wanted to come back and prove to myself that I was good enough. … That actually made me believe in myself. For all the grief that I had last year, I'm so grateful I got kicked off because I'm a better person, I'm more confident, and I'm a better paddler. I understand things a lot more why everything happens. … It's not going to be a straight high. You're going to have ups and downs, and I'm aware that's going to happen now.

For Athlete 4, Adversity increased her motivation and understanding of what was needed to achieve:

> They say they don't believe champions are made unless you've been through a tough time and I agree with it. … I think it makes you work harder. You know what you've got to do to get places and you don't take things for granted. It's just hard, but you work harder for it, so I think you get further in life.

Both these experiences are consistent with posttraumatic growth (PTG), which suggests that for positive psychological change, a form of emotional distress needs to happen (Tedeschi & Calhoun, 2004). Being able to reflect and evaluate on the adverse experiences is an important aspect of the growth process and was mirrored through our athletes' interpretation of the events. This finding is consistent with other research proposing that athletes need to experience PTG to reach the highest levels of performance in their sport (Fletcher & Sarkar, 2012).

Summary. Our results indicated that there were a variety of different environments that provided the opportunity for progression throughout the athletes' development. Noticeably, all our athletes experienced environments that created challenge. This is consistent with research from Collins and MacNamara (2012) that maintained experiencing challenge or a 'rocky road' during a sporting career can aid in facilitating high level performance. These experiences can elicit increased effort and motivation (Sarkar et al., 2015); develop skills such as resilience and mental toughness that are crucial to navigating the talent development environment (Collins & MacNamara, 2012).

5.4.4 Athlete Behaviours

Outcome and Mastery Focus. All the athletes exhibited elements of both an Outcome and Mastery Focus, expressing a want to win and beat people, but also a desire to perform to the best of their ability with winning on its own not enough. Athletes 1, 3, and 4 leant more towards an outcome focus with this being a primary motivator for them. Athlete 3 recognised being outcome focused from a young age with his outcome focus extending into his training environment as well as competition:

> I just want to win. I quite enjoy racing if I think I can win as well. You bring that into training … "I could win this session today and beat [teammates]." That makes you feel good for the next week or so. Then, "If I start beating them now, maybe I can beat them at selection."

Previous research (Hardy et al., 2017) has shown that having a dual Outcome and Mastery Focus can aid an athlete in performing under pressure by enabling the athletes to focus upon their mastery goals in high pressure situations. A dual focus also encouraged a strong link between process and outcome, with super-elite athletes exhibiting a long-term view on the purpose of training and competition. This was reflected by Athlete 2 who, whilst having an Outcome Focus, also identified that a sole focus on this resulted in poor performances. She recognised that combining her drive to win alongside aiming to perform to the best of her ability, was important in enabling her to enjoy the sport and perform well under pressure:

> I felt like I was racing the year before to have to get a result to stay on program. I felt really

> nervous. I felt there was a lot of pressure on me. … Last year was very much, "My motto is 'always learning'," and I was very in touch with that. I was very in touch with, "I'm going to do these races and I'm going to learn from them." … If someone puts their run [race] down, you've just got to do the best you can do.

Commitment to Training. All the athletes exhibited a high Commitment to Training. This was evidenced through investing significant amounts of effort into training, working to the best of their ability each session, travelling long distances to attend training, and frustration during injury. For Athletes 2 and 3 their developmental experiences increased their appreciation of their current opportunities as they both had to travel long distances and train in less than ideal conditions in comparison to other athletes who had better access to centralised bases. Athlete 2 recognised that working hard offset this potential disadvantage and gave her a realisation of the opportunities she had now:

> Even people in [Home Nation] don't have all the opportunities we have, and it's making those people aware that it is possible, and it doesn't matter. Just because these kids down here [centralised base] have the access to all this stuff, it doesn't mean you can't be just as good by working harder.

Preparation. Three of the athletes showed high levels of Preparation reflected by their attitudes towards being fully physically and mentally prepared. This was especially true of Athlete 3 who's exposure to strong Core Values in his developmental years, influenced his own perceptions and attitudes for example, in relation to his Preparation on his performance under pressure:

> If I'm happy with everything I'm doing, the nerves start to go away. … I'll go out and go canoeing the way I know how to go canoeing on this course that I've looked through. I know every stroke. I'll just do it on autopilot now. … Whereas if your somewhere you don't know. … The nerves come in, the doubts come in, and then it starts to affect you a bit.

This mimics the attitudes of the super elite athletes from the GBM study (Hardy et al., 2017) who perceived that by having high levels of Total Preparation and "leaving no stone unturned" they could maintain performance under pressure. Without this however, the pressure could become overwhelming and detrimentally effect their performance, which was also referenced by Athlete 3. Gould et al.'s (2002) findings Olympic champions had a high ability to plan and prepare which in turn influence successful performance.

Athlete 1 expressed a preference for being more laid back across training and everyday life: "I am literally last minute; I don't plan. Any time I try to organise myself, everything just gets a bit scrambled. … I'm very easy with just turning up, not knowing what's going on." Despite this,

Athlete 1 expressed a preference for higher levels of Preparation during competitions, and acknowledged from her experience of a senior environment, the importance of being mentally prepared: “More so as I’ve experienced the senior setup, have I realised the benefit of knowing what’s coming and being able to prepare yourself for that, if it’s a big race … thinking about how you can pre-empt it.” The emphasis upon good mental preparation was also shown by Athlete 4 who explained how this aided her in performing well under pressure situations. This is consistent with literature in other elite athletes, which found that utilising mental skills and strategies enhanced performance under pressure (Maher et al., 2020).

Summary. Our results identified behaviours the athletes adopted that aided them in progressing in their sport. Consistent with psychodynamic theory (Bienenfeld, 2006), the majority of these behaviours stemmed from values that were prevalent during their early environment, for example a high expectation of Disciplined Behaviour resulting in high levels of Preparation. The athletes also showed a recognition and understanding of the importance of developing these behaviours and appreciated how they enabled them to progress further in their sport.

5.4.5 Support Networks

Tight Knit Family. All athletes experienced a close relationship with both parents and siblings. This afforded them the opportunity to have varying levels of ongoing support throughout their development and when coping with adversity. Specifically, the athletes referred to having high levels of Emotional Support; the extent to which someone would be there for comfort and security, and Tangible Support; the extent to which someone would provide instrumental assistance (Freeman et al., 2011). Athlete 2 also identified high levels of Esteem Support from her family, which was instrumental in helping her bounce back following Adversity. The support received by the athletes was beneficial to their development as social support has been shown to be an important resource for athletes and is associated with positive outcomes for example increased levels of motivation (Sheridan et al., 2014). Athlete 1 experienced high levels of Emotional Support from her family but identified difficulties with being away from them due to a lack of trust in people outside her family. Perceived injustices concerning peers and authority figures throughout her development influenced Athlete 1’s perception of others:

> I’m really close to my mum, like I trust her with anything, and I’d always go – if I had an issue, I’d go to her. But I feel like I’ve always struggled with her not being there, to replace that person who I could go to.

This is consistent with research which explains that children initially develop trust with parental figures based upon experiences and interactions. Their perceptions about trust are only extended to others if their behaviour is also shown to be reliable and credible (Szczesniak et al., 2012).

Coach-Athlete Relationship.

Aligned Coach and Athlete Values. All the athletes expressed the importance that their coaches coached in a way that aligned with their core beliefs. This was especially true for Athlete 3 who held strong values with regards to discipline and preparation that stemmed from his early developmental experiences and worked best with coaches who operate according to these values:

> So, with [Coach 1], he was the first professional coach I had. … I actually, worked well with him because he was super tough on discipline, we'd be five minutes late and he would make you do 15 pushups. Being so well planned. I feel like it just worked really well with me.

This is consistent with other research (e.g., Andrew, 2009) and the congruence hypothesis (Yukl, 1971) which specifies that the smaller the discrepancy between followers preferred behaviour and leaders actual behaviour, the more positive the athlete outcomes (e.g., increased satisfaction and performance).

Individual Approach. Their coach taking the time to understand them as an individual and consequently knowing how to get the best out of them was also important to the athletes. Athlete 1 spoke about a coach who understood her motivation and used this to help her progress:

> We just worked, he got me straight away. I'm the type of person that would be like, "I don't want to do it; I'm not doing it, I don't want to, I'm scared." And he would just turn around and go, "Okay, that's fine, but you can sit there and watch everyone else do it." As much as I'll say I won't do it, I will end up doing it, I'm too competitive not to. He got me straight away; he knew how I worked.

This is consistent with Newland et al. (2015) who explored transformational leadership in female athletes and found that a coach had a positive impact by pushing the athletes further than they would themselves. This type of approach is reflective of the inspirational motivation component of transformational leadership where a coach motivates athletes by providing meaning or, as in our case, challenge in their work (Bass, 1985).

Athlete 3 put less emphasis than the other athletes on having a coach that knew how to get the best out of him. This may be down to Athlete 3's ability to "manipulate" a situation to his advantage: "You learn to get the best out of a coach for what you want. So, they might not be the best for how you work but if you can work with them in the right ways, I feel pretty good."

Athlete as a Person. A final area of importance in the coach - athlete relationship was the extent to which the coach cared about the Athlete as a Person, beyond their sporting identity. This was especially true for Athlete 4 who felt it was important to have a strong, personal relationship

with her coach:

> Other people are fine if they don't have a good connection with their coach but, to me, in order for it to work, we have to be close and work well, otherwise I don't have trust in you and I'm not going to commit.

This is in line with Fisher et al.'s (2019) heuristic of the relationship between caring coaching and athlete performance, which explains that the more an athlete perceives care the more effort they put in, and the greater their holistic development. This in turn increases the athlete's performance, which was mirrored in Athlete 4's experiences. Having a coach that cares about the person beyond that of an athlete was perceived to be crucial to Athlete 4's development due to her being lower in Emotional Stability and Regulation.

> Coaches always struggle with me because I'm a bit emotional. Me and [Coach] get on really well. He's quite soft and he's really optimistic. … He coached me a bit when I was really young, sat with me when I was crying and wouldn't go down the course.

There is evidence to suggest that a close relationship between an athlete and a coach can aid the athlete's regulation of their own emotions (Braun & Tamminen, 2019). Athlete 4 gave examples of where her coaches helped her with controlling emotions, nerves, and fears, which explains why a close coach-athlete relationship was especially influential in her case.

Summary. Our results highlighted the importance of the athletes' relationships with their family, coaches, and support network with regards to their progression in the sport. This is consistent with Baker et al. (2003), which identified the role of parental support via the provision of emotional and financial resources in the expertise development of athletes. This was shown in our athletes through the provision of Emotional and Tangible Support and for one athlete additional Esteem Support. A strong and complementary coach-athlete relationship was also identified as key to athlete development and progression (Jowett, 2017). Taken together, it seems clear that the extended sporting community support experienced by some could provide additional benefit to our athletes, aiding them in their progression.

5.5 Pressure Zone and Emotion Regulation

Emotion Regulation. Emotion Regulation refers to the use of strategies to either deliberately or unconsciously initiate, maintain, modify or display emotions (Gross & Thompson, 2007). As a means of regulating her emotions throughout her development, Athlete 1 developed strategies that she used to avoid the feelings of negative emotions:

> I'd have to normally say goodbye to my mum before school … my mum wasn't allowed to stay and wave me off because I would just cry. … I'd always have to say bye before I got to the gates and then I could just walk straight in and not look back.

This is reflective of situation selection, an antecedent-focused strategy from the process model of emotion regulation where an individual chooses whether to avoid or approach an emotionally relevant situation (Gross, 1998). In this case Athlete 1 used an avoidance coping strategy to decrease the likelihood of experiencing a negative emotion. Whilst avoidance coping strategies can reduce the short-term negative emotions, it can be associated with long-term negative emotional and motivational outcomes (Carver et al., 1989). It may be worth considering, that Athlete 1's need for success came about through avoidance coping. Whilst it presented itself as a need to succeed, the underlying mechanisms may stem from a need to avoid failure in line with her avoidance coping strategies.

Athlete 2 expressed difficultly with regulating negative emotions. This could potentially have been detrimental to Athlete 2 as being able to control emotions is a trait that underpins Olympic champions (Gould et al., 2002):

> I don't like when I'm angry and doing stuff that I shouldn't do. At the end of a run, I've punched my boat. … In the moment, if it's rage, it's rage. It's coming out as rage and that's it. I'm getting better at trying to maintain it or trying to figure out how, if I'm angry, "How do we turn that anger into positivity and happiness?"

However, Athlete 2 was also able to recognise that this was not beneficial to her progression and thus there was a need for greater regulation of her emotions. Athlete 2 exhibited a growth mindset with regards to multiple areas of her development and an understanding of the importance of her personal development with regards to her progress in sport. Athlete 2's relationship with her coach also aided her in this through co-regulation (Collins & Durand-Bush, 2014) by encouraging her to let go of mistakes.

Emotional Expression. All athletes spoke about intentionally reducing Emotional Expression within their sport, for example not overly celebrating when winning or not emphasising frustration when they did not perform well. Athlete 2 exhibited a specific difficulty with Emotional Expression evidenced by putting up a front instead of expressing extreme emotions:

> For many years, I didn't like showing my emotions, and I'm still like that. I don't like people seeing if I'm unhappy. I don't want people to see I'm overly happy. If I'm sad, I don't want people to know I'm sad. If it's something affecting me or if someone is affecting me, I don't want them to know they're affecting me. … I'm getting better at pulling it down,

> but I put this front up and I bottle all my emotions. Then, something happens, and they all just come out. It comes out upset or comes out very angry.

This lack of expression of her emotions could provide some explanation for why Athlete 2 struggled with Emotional Regulation; holding the emotions in increased the intensity of them subsequently making regulation harder. A lack of expression of negative emotions also resonated with Athlete 3 with both athletes identifying that they avoided showing negative emotions to prevent themselves coming across as weak: "It's like if I'm angry when I was training with [teammates] and I was like 'I don't want to show them I'm struggling.' I don't know if it's almost a fear to show weakness or something."

Athlete 1 also avoided Emotional Expression acknowledging that she was more expressive with her family due to a lack of trust external to them. However, the development of good relationships with coaches and support staff aided her in expressing emotions to them to help her cope with stressors. This is consistent with research from (Tamminen & Holt, 2012) who found that parents and coaches can facilitate the development of coping strategies by offering a supportive context where an athlete feels at ease to discuss them.

Emotional Intensity. Athlete 4 expressed a noticeable intensity when experiencing emotion: "I get really nervous really easily. … I feel things. Part of me being empathetic, I feel things really badly, which is why I think when I do lose it hurts a lot." Athlete 4 showed elements of reduced emotional stability through high levels of perfectionism and a propensity to get nervous or upset. Low emotional stability has been associated with increased intensity of negative emotions (Eysenck & Eysenck, 1985) providing an explanation for why Athlete 4 experienced intense emotions.

In contrast, Athlete 2 referred to experiencing few emotions in day to day life however emotions of a heightened intensity when participating in her sport:

> I do get emotional about family, but a lot of other things don't affect me. I think it's quite hard at times. My emotions outside of canoeing… I clearly don't have much stuff going on outside of canoeing. … My life is filled with canoeing and most of my emotions have come from people in canoeing. … There's so much raw emotion on the water. For me, paddling is so powerful because you can be so connected with the sport and connected with yourself.

Athlete 2's emotional experiences are reminiscent of elements of an Alexithymic profile (cf. Barlow et al., 2013) where in everyday life she does not experience high levels of emotions but identifies an emotional connection with the sport. Canoeing provides an outlet for her to experience and express emotions likely linking in with her high Relative Importance of the sport.

Performance Under Pressure. Both Athletes 1 and 4 referred to a specific dislike of nerves and subsequently at times struggled with Performance Under Pressure. Athlete 1 explained how the intensity of emotions surrounding competition combined with her strong Outcome Focus and need to win meant that she struggled to perform well under pressure.

> Normally my nerves are through the roof, like massively; I'm normally really nervous, feel sick. There's always something [winning] in the back of my mind … it's not even in the back of my mind it's literally in the front. Sometimes, I get so set on that, I kind of lose my way. … Anyone who enjoys being nervous is literally a mad man.

This is consistent with research that highlights the importance of mastery goals on performance under pressure (Hill et al., 2010). Whilst Athlete 1 did have elements of a Mastery Focus, a sole focus on outcome in a competition could be detrimental to her Performance Under Pressure.

During her development, Athlete 4 also struggled with nerves in competition however with psychological support and help from an influential coach, became able to identify and regulate the intensity of her emotions at competition which she attributed to improved Performance Under Pressure as she got older:

> I used to panic when my heart started racing on the start line. … But now I see that as it's just an adrenaline rush. All it means is that I'm ready to go. My body is ready to now perform what I want it to do.

This example is in line with the biopsychosocial model of challenge and threat (Blascovich & Tomaka, 1996). A threat state is where an individual does not believe they have the resources to cope with a task and so perceives the situation as a threat. A challenge state on the other hand, relates to when an individual does believe they have the personal resources to deal with a situation and see it as an opportunity for example to gain mastery or personal growth. In Athlete 4's case, the support from psychologists and coaches equipped her with personal resources that enabled her to move from a threat to a challenge state and subsequently perform better under pressure.

Athletes 2 and 3 both suggested that nerves could facilitate their Performance Under Pressure. For Athlete 3 the combination of excitement along with nerves was beneficial to him and enabled him to perform well. This is consistent with literature that has shown a reduced intensity of cognitive and somatic anxiety in a group of excited athletes (Jones & Uphill, 2004). This research also identified that excitement enhanced the perception of somatic symptoms, something that was again reflected by Athlete 3:

> When it's bad nerves, I can feel like I'm a bit rigid. So, you can feel it in your warmup, the boat's not flowing very much into your movements. And you're just not open, whereas I can

> feel like when I'm excited, it's like you can just get so much more energy. Like, ready to go. And I'd be like, "I can do anything."

Athlete 2 referred to initially thriving on nerves and the emotional intensity of competition however, later in her development, doubts around her performance often led to her underperforming under pressure:

> I loved the thrill of being on the start line. … I loved the nerves, and as I got a bit older, I despised it. It was too much. When I was 17 to 19, I wanted to go racing, but when I get there, I didn't really want to do it because what if it went wrong? "If this goes wrong, what am I going to feel like?" Again, that's not why we do it. We do it because we love it.

This again is in line with a challenge versus threat appraisal but in this sense the reverse has occurred with Athlete 2 going from an initial challenge state to a threat state. This was potentially due to the increased pressures associated with achieving matrix results to achieve funding. Her reference to enjoying nerves and the thrill of being on the start line is like the counterphobic attitude displayed by super elite athletes in the GBM study (Hardy et al., 2017) where one is drawn to the intense emotions that competition elicits.

Summary. Our results indicated that our athletes' emotional experience could both enhance or become detrimental to their progression in the sport. Emotional Regulation has been shown to enhance Performance Under Pressure (Balk et al., 2013) and our athletes gave examples of how regulating their emotions had helped them in competition situations. Our athletes varied with regards to Emotional Expression and Intensity, however all athletes recognised the influence these had on them and their performance.

5.6 General Discussion

Taking a critical realist standpoint, I used a qualitative method and analysis to explore the wide range of psychosocial processes that shape the development of four Great British canoe slalom pathway athletes. Our findings confirm the critical role of psychosocial factors on athlete development with seven key themes being influential: (a) early developmental experiences, (b) relationship with sport, (c) personality, (d) ongoing developmental experiences, (e) athlete behaviours, (f) support networks, and (g) pressure zone and emotion regulation.

The findings from this study identified variation among the experiences of the athletes. No athlete presented the same as another across any of the themes with regards to the amount of that trait or experience they possessed or the combination of them. This is in line with the findings from the GBM psychosocial biographies (Hardy et al., 2017), which highlighted that whilst super-elite and elite groups tended to share similar experiences / traits with each other in their group there were

also exceptions. This is also consistent with Allen et al. (2013) and emphasises the importance of taking an individual approach to athlete development and not disregarding an athlete from a talent programme because they are missing or have a different developmental experience/ psychosocial trait to what is the norm. There were also similarities among the athletes namely their early developmental experiences and the importance of positive coach-athlete relationships with were consistent among the cohort. The early developmental experiences of these athletes were also consistent with the experiences of both super-elite and elite athletes (Hardy et al., 2017). The prevalence of adversity related experiences also support previous research (Sarkar et al., 2015). Support from coach-athlete relationships was also highlighted as important by Burns et al. (2019) who emphasised the relevance of inter-personal, relational, and technical coaching support for talent development. This chapter built on from Chapter 4 by continuing to take a sport specific approach whilst also gathering data with depth not just breadth. It has expanded upon the literature by taking a sport specific approach without examining topics that are overly narrow. This chapter is this first study to date that has gathered insight into the psychosocial developmental experiences (inclusive of the early developmental environment, personality, and training behaviours) of canoe slalom athletes.

5.6.1 Applied Implications

These findings have several implications for applied practice, particularly when considering developing athletes on talent development programs. In line with psychodynamic theory (Bienenfeld, 2006), the results identified that the early environment an athlete is exposed to is important to their progression. For example, a competitive family environment positively influencing drive and motivation. It is crucial therefore to identify athletes who may lack the identified early developmental experiences and look to provide other similar developmental opportunities and exposure to these environments (e.g., greater exposure to competition scenarios; Burns et al., 2019).

Individual stories were constructed within the data reinforcing the recommendation to recognise an athlete's relationship with their sport and take an individual approach to tailoring support. Sports should be mindful that an athlete placing high relative importance upon their sport or utilising it as a domain to succeed in, may be more adversely affected by set-backs such as deselection or injury (Brown & Potrac, 2009). Support staff (specifically psychologists) should seek to provide such athletes with appropriate coping mechanisms and support to enable them to overcome and ideally grow from these adversities. This has potential benefits of aiding transition and post-transition periods following athlete retirement or deselection. Sports should also ensure that athletes who hold a lower relative importance for their sport and are balancing their sporting

career with other opportunities (e.g., education), are also equipped with the resources that enable them to strive. Performance lifestyle advisors should look to encourage the development of time management strategies and the use of support networks to enable this to be possible.

A finding with important implications was the influence of challenge upon the athletes' development. The results are consistent with Collins and MacNamara's (2012) theorising that talented performers need challenge to facilitate performance. Our data indicated that being an underdog / experiencing adversity could enhance both the technical and motivational development of an athlete and subsequently enhance their long-term progression. The implications from this are that it is crucial that an athlete is taught and given the opportunity to practice skills on how to cope with challenge (e.g., mental preparation strategies such as imagery techniques and self-talk) to enable it to have a positive impact upon their development. Challenge should then be integrated into the developmental process using transformational delivery enabling the practicing and refinement of coping skills in a meaningful context (cf. Bell et al., 2013). Athletes should also have the opportunity to experience positive critical events (Hardy et al., 2017) during their time on the pathway such as meeting inspirational teammates or coaches and being selected onto a new squad. Collins and MacNamara (2012) emphasised the importance of strong social support for coping with challenge, with our results concurring esteem support as being particularly salient at aiding an athlete with overcoming adversity. Our results also identified tangible and instrumental support as important for athletes' development and are therefore worthwhile monitoring to identify when additional support strategies might be prudent to implement.

5.6.2 Limitations and Future Research Directions

This study is not without its limitations and the nature of our research meant that I did have to capture some elements retrospectively. Triangulation of experiences with parents and coaches could have protected against the potential problems regarding accuracy of recall, however due to the breadth and depth of data collected in the Pathway 2 Podium project, taking this approach would not have been practical. The retrospective elements of our study (e.g., early developmental experiences) were necessary for us to fully capture an athlete's journey and covers a shorter period of time than previous research (Gould et al., 2002; Hardy et al., 2017). However, the structured interview approach and deductive analysis used within this study meant that the opportunity for new insights beyond that of examining previous findings was reduced and there may be key areas not explored because of this. The one-off nature of these interviews is also worth considering given that by doing so we have only captured up until that time point in the athletes' journeys and neglects to acknowledge the influence of other experiences yet to occur.

Furthermore, only having a sample of four participants meant that data saturation may not have been achieved. Fugard and Potts (2015) outlined sample size requirements for data saturation based upon population theme prevalence and desired number of theme instances. Within this study, a greater sample would have been needed to achieve saturation alongside increasing the generalisability of the results. Additionally, the use of critical case sampling has potential flaws as whilst the findings from the data will provide in depth individual insight, these participants may not be representative of other canoe slalom pathway athletes and so the findings may not be generalisable.

Further research should continue to prospectively interview these athletes throughout their career, which will enable examination of the full extent of their journey without it being potentially clouded by memory decay and recall bias. These findings also suggest that future research should continue to examine psychosocial factors alongside more commonly measured traits (e.g., physiological characteristics), due to the influence they have upon the developmental process. It is also important to acknowledge that the findings are potentially influenced by my own values, beliefs, and perspectives (Maxwell, 2012). However, due to the engagement with critical friends and member reflections in addition to consulting with experienced researchers independent of the project, I do not believe the interpretations of this data to be a concern.

5.6.3 Conclusion

In summary, this study added to the broader knowledge base surrounding the psychosocial processes underpinning the development of elite athletes specifically, the influence of the early environment, differences in an athletes' relative importance of a sport, and the importance of challenge throughout development. The representative sample of developing athletes gives confidence in the application of these findings as a means to inform talent development programs. The results highlight the importance of taking an individualised approach and being aware of specific athlete characteristics. Sports should look to develop and refine their scouting processes (e.g., on entry interviews) to tailor programmes to best meet the needs of athletes. Further research should continue to prospectively explore the psychosocial factors influencing the development of these athletes as part of a multidisciplinary investigation, enabling us to capture the nuanced factors underpinning their development.

Chapter 6:

General Discussion

6.1 Summary of Results

The aim of this thesis was to highlight problems associated with identification in talent systems and seek to understand the differences in psychosocial, practice and training, and health and wellbeing components of athlete progression across sports. This thesis looked at prospectively identifying influential components that contributed to overall athlete development.. Over four chapters, I expanded upon previous research in the field by taking a sport-specific approach to examining multidisciplinary factors relevant to TID. Chapter 2 first examined the inter- and intra-sport differences in the RAE and, contrary to most of the research in this area (Cobley et al., 2009), found no RAE in the full sample, highlighting the importance of practitioners taking a sport-specific approach to understand this phenomenon. Importantly, when adopting an in-depth nuanced approach to our analysis of the data I found a reversal effect when the sample was broken down into apparatus specialism. Chapter 2 raised some important psychological mechanisms highlighting the need for further consideration of psychological processes within talent development research whilst also highlighting issues surrounding identification in talent systems. Within Chapter 3, I developed and validated a survey capturing psychosocial constructs relevant to talent development and then used this within Chapter 4 to take a longitudinal, prospective, and multidisciplinary approach to exploring expertise development. In Chapter 4 I utilised machine learning techniques to better replicate the complex interactions of multiple variables pertinent to athlete development. The qualitative inquiry in Chapter 5 followed on from the quantitative methodologies and afforded the opportunity to gain greater insight into the psychosocial processes shaping the development of elite athletes. The studies as a collective addressed the thesis aims by firstly highlighting how identification on physical characteristics alone can lead to bias in cohorts of athletes. The thesis then went onto develop ways to undertake multidisciplinary research and used this to gain insight into sport specific nuances in the development of athletes taking a multidisciplinary, mixed method and prospective approach. The main findings of this thesis will be presented below and are contextualised within the current literature and relevance for TID practitioners.

6.1.1 Relative Age Effect and the Consideration of Inter- and Intra- Sport Differences

The findings from Chapter 2 add considerably to the current RAE knowledge base due to our examination of a relatively neglected sport and expertise level within the research literature. Whilst much of the RAE research exploring team sports identifies an overrepresentation of relatively older athletes (Cobley et al., 2009), these findings showed that within a sample of elite gymnasts, no RAE was present. This indicated that in sports where there is a bias towards delayed maturation, being bigger is not necessarily better. I also found evidence of a reversed RAE when we considered different apparatus specialisms (specifically beam and vault), lending support to the impact of both self-fulfilling prophecy (Merton, 1948) and the underdog hypothesis (Gibbs et al.,

2012) upon the RAE. These results continue to emphasise the importance of exploring the RAE in early specialisation sports, such as gymnastics, and that examining individual differences within the sport (e.g., positional and apparatus differences) gives an additional insight and depth to findings.

The results of Chapter 2 also framed the direction of this thesis as I saw the value in taking a sport specific approach to my research and subsequently examined factors specific to the sports involved. Sport specific differences were evident across both Chapter 3 and 4 with differing psychosocial factors emerging between hockey and canoe sprint. For example, selfishness appeared in the hockey and not the canoe sprint model. This may be down to the differences between team and individual sports and the need to be selfish to stand out among other members of a team. This has important implications for talent development programmes and emphasises the relevance of taking an individual approach due to differences in sport specific demands. Sports should seek to develop their own individualised talent programmes instead of relying upon one size fits all approaches. They should first identify key characteristics pertinent to athlete development (by undertaking multidisciplinary investigatory research), and then look to implement and encourage the emergence of these traits within their programmes. For traits and experiences that are not malleable, sports should look to provide additional support to increase exposure in other ways and enhance the development of strategies that enable these athletes to succeed. Whereby literature within these sports does not exist and undertaking this research is not possible, drawing from findings of other sports with similar developmental patterns and performance characteristics (e.g., gymnastics and figure skating) would provide a sporting point.

6.1.2 Development of the Athlete Psychosocial Survey

As a means of identifying psychosocial characteristics of an athlete (and identify key psychosocial characteristics of relevance specific to the sport), sports could use the Athlete Psychosocial Survey; a comprehensive and practical measure developed within Chapter 3. The APS fits well within the literature and encompasses a multitude of psychosocial factors relevant to the high-performance environment. It combats the problem that there was not previously a measure that did this and circumnavigates the issue of excessive questionnaire length due to its short form nature. We used literature-based methods to identify constructs and items that made up the APS and provided support for the measure's reliability and validity across all three studies. I used both traditional and contemporary analytical approaches, which resulted in a rigorous methodology and a measure with strong practical utility for the target population.

The development of the APS has implications as the practicality of the measure means that it can be incorporated alongside other factors aiding the progression of talent development systems. This was highlighted within Chapter 4 where I was able to undertake multidisciplinary research and

capture many psychosocial constructs pertinent to athlete development without increasing athlete burden. Sports should continue to use the APS in this manner to enable them to move past the over reliance on measures biased towards understanding an athlete's physical capabilities (Gullich & Cobley, 2017), and instead consider a wider range of factors. Due to the relevance of psychosocial attributes across all four of the PhD chapters, administering the APS to an athlete at the point of entry to a programme would enable management (e.g., coaches, psychologists, and lifestyle advisors) to make more informed and bespoke decisions surrounding the athlete to enhance their progression through the pathway. It is worth a note of caution that the APS is not recommended as a method for talent identification but instead should be used as part of a talent development approach to capture and assess constructs of developing athletes and consequently used to inform best practice for coaches and practitioners.

6.1.3 Multidisciplinary Approach to Talent Development

Alongside psychosocial factors, I also identified a variety of multidisciplinary variables that interacted together to influence athlete progression. The multidisciplinary approach and analysis adopted in Chapter 4 highlighted the importance of considering all disciplines and not just individual domains. Throughout this thesis, many variables emerged as influential, specifically the early environment, practice structure, and challenge, which we examine in further detail.

Early Environment. In line with Côté (1999), I identified the importance of the early environment for an athlete's development. Exposure to specific situations shaped the behaviours and motivations of the athletes, which in turn influenced their progression in the sport. Interpretation of the findings from Chapter 4 indicated that being exposed to a mastery focus gave an athlete a focus upon the process, further supporting Knight et al.'s (2016) findings that a task-involving climate had a positive influence on athlete development. The early environment also emerged as influential in our findings in Chapter 5, specifically an athlete's exposure to competitive and disciplined environments. For example, all athletes were exposed to a competitive environment through either their family or their school, which positively influenced their drive and motivation. The noticeable emphasis upon disciplined behaviour in one athlete's early development was also instrumental in the development of his own perceptions and attitudes.

Taking into consideration the relevance of the athletes' early environments upon their progression, it is important to recognise individuals who may lack exposure to the identified experiences and seek to provide other opportunities for them to be exposed to these environments. For example, emphasis upon both mental and physical preparation within an athlete's training and competition environments will likely aid the emergence of an athlete's own preparation behaviours if this was not a value emphasised within their family environment. Gano-Overway and Ewing

(2004) also provided applied recommendations for encouraging a mastery focus (e.g., promoting and supporting goal setting), which would be of practical use for athletes whose families did not place an emphasis on this. To aid an athlete who potentially lacked a competitive environment, pathway managers should look to provide the opportunity for increased participation in competition and race scenarios to all athletes across all levels of the pathway. Coaches should also look to create anxiety-specific training conditions (Oudejans & Pijpers, 2009) which mimic the competition environment (for example training with a crowd watching). Anxiety specific training was also a variable that came out as a discriminator between the high- and low-potential groups within Chapter 4 highlighting that it is of particular relevance.

Microstructure of Practice. Consideration of what training "looked" like was a key finding throughout this thesis that reinforces Farrow and Robertson's (2017) recommendation that expertise development literature takes into account the microstructure of practice. Across both Chapters 2 and 4, I found that emphasis upon technical development within training had a beneficial impact upon athlete progression. Following the results from Chapter 2 we speculated that by spending more practice time in the developmental stages where optimum learning and motor skill development takes place (Kirk, 2005), gymnasts developed superior technical foundations which, in line with Bradshaw (2004), enhanced overall performance and subsequent long-term progression. The results from Chapter 4 also found that the high-potential group were undertaking more technical practice supporting previous literature that has highlighted it's importance within canoeing (Michael et al., 2009). Further examination of the interactive effects of the variables in Chapter 4, identified technical practice as important due to the addition of other components of the microstructure of practice, specifically anxiety specific and variable practice. Anxiety specific practice is likely to improve competition performance (Oudejans & Pijpers, 2010), whilst practice that is high in variation impacts upon skill development due to its association with high contextual interference and subsequent long-term learning benefit (Shea & Morgan, 1979). These findings emphasising the importance of the microstructure of practice counter the previously accepted 10,000-hour rule of deliberate practice (Ericsson et al., 1993) in favour of a more nuanced approach to expertise development.

The investigation of differing components of the microstructure of practice within this thesis gives a much-needed depth to the literature by going beyond looking at practice as simply number of hours but instead examining what it contains. In terms of research implications, it reinforces the need for a closer examination of practice structure and not relying on models (e.g. the long-term athlete development model; Balyi & Hamilton, 2004) that propose practice as a singular construct. There are also strong athlete development implications which highlight the importance of coaches looking at the mechanisms behind the training they design. Specifically, and in line with Jones et al.

(2020), the results from this thesis would recommend incorporating varied and anxiety specific practice into an athlete's training programme. Coaches should also place strong emphasis upon the technical development of an athlete within their training to ensure technique is maintained even in a challenging environment.

Challenge. A commonality among many components of the microstructure of practice was the implementation of challenge into practice (e.g., by adding variation or conditions of anxiety to training). This is consistent with challenge point framework (Guadagnoli & Lee, 2004), which states that learning is most robust when there is an increase in task difficulty to the point of optimal challenge and explains why it is a variable of importance for talent development. Alongside the technical challenges associated with these elements of the microstructure of practice, both Chapters 2 and 5 highlighted how experiencing physical challenge (potentially due to delayed maturation) provided athletes with a long-term performance benefit. For example, in Chapter 2, I theorised that younger gymnasts may struggle with performance on vault due to the physical disadvantages associated with being relatively smaller. I felt that these gymnasts could not rely on height, weight, speed, and power and so would have to develop strong technical foundations to succeed. This was also evidenced within Chapter 5, where one athlete was noticeably smaller than her peers and only succeeded due to strong technical prowess. This fits with our previous comment regarding technical development whilst also providing support for the underdog hypothesis (Gibbs et al., 2012). The challenge experienced by athletes due to being physically disadvantaged promotes a focus upon technique, which aids the athletes in excelling once they had also matured and developed strength. Alongside the technical and physical challenge identified within Chapters 2 and 4, Chapter 5 also emphasised the importance of psychological challenge (e.g. being dropped from funding) throughout an athlete's development as a means to elicit increased effort and motivation (Sarkar et al., 2015).

The findings from Chapter 4 emphasised that lower-potential athletes reported finding their training more challenging, indicating that this group of athletes may not have developed the coping strategies needed. A main implication from this finding is that it is crucial that an athlete is taught and given the opportunity to practice skills on how to cope with challenge (e.g., mental preparation strategies such as imagery techniques and self-talk) to enable challenge to have a positive impact upon their development. Challenge within the microstructure of practice alongside both physical and psychological challenge should then be integrated into the pathway using transformational delivery enabling the practicing and refinement of coping skills in a meaningful context (cf. Bell et al., 2013). In line with Hardy et al. (2017), and as identified in Chapter 5, the opportunity for significant moments (such as selection to a squad, chances to train with higher level athletes) should also be readily prevalent. Chapter 5 further highlighted the importance of social support for an

athlete to cope with challenge and subsequently is worthwhile monitoring to identify when additional support strategies might be prudent to implement.

6.2 Relationship with Previous Literature

Previous literature has taken a generalised approach to talent development. Sport specific nuances are often not identified, with research taking an approach whereby sports are grouped together (Güllich et al., 2019). This is also the case for talent development models and approaches. For example, the theory of deliberate practice (Ericsson et al., 1993), LTAD model (Balyi & Hamilton, 2004), and the DMSP (Côté et al., 2007) take an approach whereby practice is given a very generalised term (e.g., not moving beyond simply deliberate practice or play) and there is no consideration of additional multidisciplinary factors that are relevant. This thesis highlighted differences between developing athletes across sports and disciplines emphasising the importance of developing sport specific models considering a multitude of factors and practice structures. Findings from this thesis (specifically Chapters 2 and 4) emphasise the role of the microstructure of practice in developing athletes and again the need for a sport specific model that identifies what these practice structures are.

The findings from this thesis do however sit well with the DMGT (Gagné, 2009) in that there is a multidisciplinary focus to the findings emphasising the role of more than one component (e.g., practice alone as identified by the previous models) in talent development. Specifically, these findings sit well with the interpersonal and environmental features outlined in the DMGT (Gagné, 2009) but go beyond this by specifying what this looks like in separate sports as well as outlining some of the developmental processes needed to get there. This is particularly prevalent within Chapter 4 whereby a multidisciplinary investigation was undertaken and so did not just consider single disciplines. The findings from this thesis also sit well with the main factors influential to development outlined within the literature review (microstructure of practice, RAE, challenge, and psychosocial factors). For example, Chapter 2 identified the presence of the RAE and how components of the microstructure of practice may have contributed to that. Other elements of the microstructure of practice were also emphasised across Chapters 4 and 5 particularly with reference to challenge within the practice. Throughout the entirety of the thesis, the relevance of psychosocial variables was prudent and confirmed the findings of previous literature whilst also highlighting those that were specifically relevant to different sports.

6.3 Implications

There are conceptual implications to come out of this thesis, specifically regarding how talent is perceived. Some previous literature has taken the approach that talent is something that can be identified early on, and predicts future success (Brown, 2001; Cobley et al., 2012) whereby others

have emphasised talent as something that can be developed and influenced by a variety of factors (Davids et al., 2017; Gagné, 2005). The findings from this thesis support that view that talent is something that can be developed over time and not something that simply exists in the first place. This is particularly evidenced through findings within this thesis that emphasise the role of both the early environment and differing practice structures emphasising that success is not achieved through superior "ability" or preferential personality traits alone. It has expanded the work around these areas by looking at talent development prospectively and longitudinally and so moving beyond single timepoint analysis used in previous research and encouraging a move away from identification towards a development perspective. This subsequently has implications for how talent is framed both within research and an applied setting.

The findings from this thesis have methodological implications and highlight the importance of considering a multitude of factors influential to talent development within future methodology. Findings also highlight the usefulness of taking a mixed method approach as it enabled the capturing of a large amount of data whilst also gathering in depth insight into other variables of interest and is a beneficial methodology to use going forward. This thesis also provided methodological consideration for utilising analysis that is less well known in favour of one that is more suited to the field of investigation (for example, regression of multiple weeks as opposed to χ^2 with quartiles or machine learning that considers the interaction between factors as opposed to a DFA). This thesis has expanded the talent development work in these areas as previously research was rarely utilising analytical methods that captured the complexity of interactions in talent development or the full range of ages in RAE analysis.

A final implication of this thesis is that of the applied implications and how the research can be used to inform how coaches and practitioners develop athletes. The findings emphasise the need for sports to look to develop their own individual sport specific development structures and models. Throughout the thesis, different variables of influence emerged across the chapters, likely a result of the relative importance of a variable dependent on the sport. This thesis also provides applied implications by specifying variables of influence for use within current systems. For example, variables of influence have been identified for gymnastics, hockey, canoe sprint, and canoe slalom and so can be utilised by coaches and practitioners to aid the development of their athletes. Some variables (e.g., challenge) came out across sports and so from this it can be inferred that this is a variable that coaches and practitioners should look to be developed regardless of sport. There is very little research that takes a multidisciplinary approach, limiting the application of previous findings. This thesis moves beyond this and has expanded the talent development work by doing so.

6.4 Limitations and Future Research Directions

This thesis is not without its limitations and despite the multidisciplinary nature of the research I did not measure any of the athletes' anthropometric profiles. Given the breadth and depth of the research, which captured over 8000 variables across multiple sports, also administering physical tests would not have been practical. As anthropometric measures currently make up a large proportion of the current TID literature, but fail to predict skill level (Dugdale et al., 2021), the project team did not feel measuring additional physical components was a priority within Chapter 4. However, utilising physical markers already captured within the sport (e.g., maximum back squat, height, and weight) would have allowed confirmation of this and is something that future research should consider. This is particularly relevant within a sport like canoeing where there is an implicit belief among coaches that physical prowess is beneficial to progression.

Capturing maturation data within Chapter 2 would have been of specific benefit to confirm the theorising surrounding the effect of maturation on the RAE. To test the underdog hypothesis, Cumming et al. (2018) examined the interactive effects of maturation and psychological characteristics upon the RAE in professional soccer academy players. Taking a similar approach in this research would have added additional strength to the second chapter and enabled confirmation of the speculation regarding self-fulfilling prophecy and the underdog hypothesis. To further the research, one should look to conduct a study measuring maturation status alongside coach expectations to provide support for self-fulfilling prophecy as a mechanism for the reversal effect within beam finalists. Gathering objective competition score data (specifically execution scores) for the current sample, alongside an additional sample of gymnasts who did not reach vault finals would also give a measure of technical ability enabling confirmation of thoughts regarding the superior technical ability of relatively younger vault specialists. Taking a prospective approach like in Chapter 4 would further enable the capturing of this data over time and to examine the different components of the RAE and its associated factors across multiple age groups.

One might argue that whilst the unique natures of the samples throughout were a strength of this thesis, Chapter 4 was somewhat limited in size for a quantitative study. However, the nature of TID research means that samples are likely to be small due to the small proportion of athletes that make it to this point in a sport's pathway (Ackerman, 2013). Furthermore, at the start of the study we had over 60% of the total pathway population for the sport and so despite being a small sample, is representative of the cohort we are targeting. Nevertheless, we should be mindful of this when interpreting and disseminating these results and further research should look to replicate these findings in an additional, larger sample for us to have true confidence in our findings. By also capturing data from multiple cohorts along the pathway, this avoids the problem associated with

smaller pools of athletes whilst also capturing data across a longer timeframe. Whilst it may reduce the sample further, future research examining different discipline specialisms (e.g., C1 vs K1 paddlers where there is an implicit belief within the sport surrounding the differences in physicality) would also give added value to future research.

In relation to the thesis as a whole there are some additional limitations. This thesis placed more emphasis upon the development side of sports systems rather than identification. Whilst I did highlight problems that may arise with identification in talent systems, I did not specifically explore these within the sports systems I was working in. Doing so, might have provided additional insight into the impact this had on the development within those sports.. Furthermore, due to the applied nature of this PhD and the data collection constraints, there is a lack of continuality across the chapters due to each chapter investigating a separate sport and subsequently it was meant there was not additional follow up on sport specific nuances in the next chapter. Whilst I was able to capture information on each of the sports, utilising the same sport within each of the chapters might have provided greater insight and addressed the thesis aims more thoroughly.

Considering this, future research should look into the methods of identification used within specific sports and subsequently investigate what problems may be arising in the sport. Future research should then look to address any issues identified. For example, RAE analysis within a sport would investigate whether an athlete's time of birth within a year had an influence upon their identification into a system; this could then be addressed, and solutions put in place to reduce bias. Research undertaken in this thesis should also take place throughout a single sport to enable a greater depth of insight and continuality throughout research. For example, following relative age effect analysis within gymnastics, future research should look to explore the psychometric properties of the APS within a gymnastics sample and then use the APS to identify gymnastics specific nuances to provide more psychosocial insight for the sport. Additional multidisciplinary research within gymnastics should then be undertaken to examine factors across the multiple disciplines shown to be influential. The measures for this research should be designed with the sport in mind to enable the capturing of differences in practice structure. Following the findings of multidisciplinary investigation, qualitative analysis of the same sample of gymnasts should be used to investigate any variables of interest further. Furthermore, following the psychosocial constructs identified in hockey in Chapter 3, multidisciplinary and subsequent qualitative investigation should also take place to glean greater insight from the data. This is something that is ongoing as part of the Pathway 2 Podium project. To further advance the findings from Chapter 4, as British Canoeing athletes are added onto the programme future research could also start to capture their experiences to ensure that there is a bigger sample of athletes to add to both the multidisciplinary and qualitative investigations.

6.5 Thesis Conclusions

This thesis has added noticeably to the expertise development literature by identifying factors influential to athlete progression across four different sports. I took a longitudinal, prospective, and multidisciplinary approach to our research, which negated previous concerns with regards to recall ability (Hardy et al., 2017) and the reliance upon unidimensional measures (Johnston et al., 2018). The development, validation, and subsequent application of the APS provided me with the opportunity to capture multiple psychosocial variables alongside other multidisciplinary factors, moving away from the unidimensional methods typically used within TID. The multidisciplinary examination of sports at an individual level is novel and provides greater depth to the findings increasing the possible implications to come from this research. Utilising a machine learning approach within this thesis enabled me to analyse and interpret the vast number of multidisciplinary factors pertinent to athlete development and warrants further use within talent development research and development. The additional qualitative analysis added depth to the findings and enabled me to gain greater insight into processes of relevance. With many factors across different disciplines emerging as influential, a main implication of this thesis is that taking a multidisciplinary approach is crucial to develop effective and efficient talent development programmes.

The dissemination and discussion of our findings with experts from within the sports, gave a truer understanding of the meaning and application of these results and how they could be used to inform bespoke TID decisions. Multidisciplinary, longitudinal, and prospective investigation within a sport, like I undertook throughout this thesis, should be used to highlight crucial factors that are relevant within each individual sport specifically. Instead of focussing resources on identifying and developing athletes from an early age, sports should then look to develop environments that promote the emergence of the identified factors influential to talent development among larger pools of developing athletes. This would move away from the current unidimensional and cross-sectional approaches subsequently increasing the efficiency of TID programmes.

6.6 PhD Reflections

Starting my PhD, I really wasn't sure what to expect. I spent a lot of my first year feeling quite lost and not sure what "doing a PhD" really meant. Up until this point in my life, my tasks had been directed by others and I would be told what I needed to have done by when. I felt pressure to be in the office working 9-5 as this was what a lot of the other PhD students were doing, but at the same time didn't know what I was supposed to be filling this time with. A delay in the project starting up and thus no data collection for the foreseeable future probably didn't help this. I spent a lot of my time trying, and failing, to read papers day in and day out and realise now that this was

probably never something that would be achievable for someone that can't sit still for longer than five minutes. I didn't realise that this time could be used to upskill myself and that the work I was doing didn't need to be solely related to the PhD project. Throughout my PhD I spent a lot of my time using R, looking back I wish I had spent more of my first year learning how to use this properly. Getting involved in other PhD projects (e.g., helping with VO2 max tests) would also have been a good experience and perhaps also helped provide me with some structure to a day. Not having any concrete goals within this first year was something I found difficult and, despite the car crash that was my nine-month verbal proposal, I enjoyed having a goal to focus upon. From this I have learnt the importance of setting myself small goals – this massively helped with the write up of my PhD which at times can seem like it is never ending. I also realise now that I am more task directed than time directed, and I work better in an environment where the goal is to finish a task not just work the whole day on that task. Give me a task and I will get it done in a couple of hours, tell me I must work 9-5 on it and I will stretch it out the whole day!

I was very fortunate to have had the opportunities to work in an applied setting, across multiple sports, and alongside external stakeholders. Spending time with so many different people, from different backgrounds, and with different values is so valuable and has opened my eyes further to the world of elite sport. It has helped me develop skills such as leadership, persuasion, and empathy as well as being able to jump into a situation that is unknown and I'm unsure of; something I found really daunting beforehand. In addition to this my PhD involved a large amount of regular travelling which can be exhausting. Whilst at times I resented this, my driving skills are 10 times better than they were before (even if I do occasionally drive into things) and I know all the tricks of the trade with getting the cheapest and shortest train journeys! I now know that whilst I don't mind a bit of travel, I don't think I want a job that involves as much as I did throughout my PhD. Both governing bodies and stakeholders have different goals to that of your overall PhD and trying to balance these can result in a lot of additional work that doesn't always feel that beneficial to you. Whilst it definitely is beneficial, it can be hard to see this at the time when you have lots of other things on your plate. I learn that speaking up when you don't think things are working was important but that there was a time and a place for this and how you responded could influence your working relationship with those people. I also found that it was important to pick your battles in these kinds of situations and complaining about something that was a minor inconvenience to you probably wasn't going to be helpful when you then needed to complain about something that was a real issue. I learnt that it was important to be accountable for my own actions as whilst I couldn't control what other people were doing my own way of responding was something that I could be accountable for. It's hard to look back and acknowledge that you are being difficult, but in the long run it always works out better. I also found that being accountable for my own development really

helped me as a researcher. Up until a few years ago I could not present in front of an audience and recognised that this was going to be detrimental the further I went along my career. I decided to do as many presentations as possible and whilst I did not enjoy it one bit, I can now present confidently and without shaking like a jelly and sometimes come out of them saying it I enjoyed it. This is probably my proudest moment from my PhD.

Being in both elite sport and academia meant that I was working in a male dominated field. I found it challenging often being interrupted, overlooked, patronised, and not seeing representation within my field of work. For someone that has been brought up being told that I can accomplish whatever I want despite my sex or gender, it is frustrating that this was not reflected within the environments that I was in. However, by being immersed in a culture of everyday sexism I have learnt more than ever how to use my voice. Whilst before I would have stayed silent, I now make an effort to call out behaviour and I hope that by doing this it has even the smallest impact. I try to share my values with the girls that I coach, and I hope that this has an impact on the adults that they turn out to be.

When I look back through my time as a PhD researcher, I don't always think about it fondly. I think finishing a PhD in a pandemic has an impact on this as you don't get to have the everyday moments (such as coffee in the staffroom with friends or an impromptu game of frisbee outside) that balance out the lows. Having your friends in the department to pick you up when things get hard or celebrating together when someone has finished their viva are among the little things that come with making a PhD what it is, and without that it's different. I'm still not sure if a PhD was the right path for me to take but at the end of the day it has shaped who I am as both a person and a researcher. I hope that in years to come I will be able to look back and be proud of what I achieved. For now, this is just a part of my story.

> *There's something so special about a woman who dominates in a man's world. It takes a certain grace, strength, intelligence, fearlessness, and the nerve to never take no for an answer.*
>
> *-Rhianna*

Chapter 7:

PhD Impact and Dissemination

7.1 Summary

This PhD was part of the wider Pathway 2 Podium project and required continuous involvement within British Canoeing. Due to the longitudinal nature of this project and the fast-moving nature of elite sport, it was important to us that the findings from this project were disseminated to the sport in an easily accessible and timely manner. Dissemination has been ongoing from the start of the project and mainly involved reports and presentations with discussions of what these findings meant for the sport. Below I report evidence of the dissemination, implementation, and impact of this PhD within canoe sprint and slalom.

7.1.1 Weekly Athlete Monitoring Reports [February 2019 – August 2020]

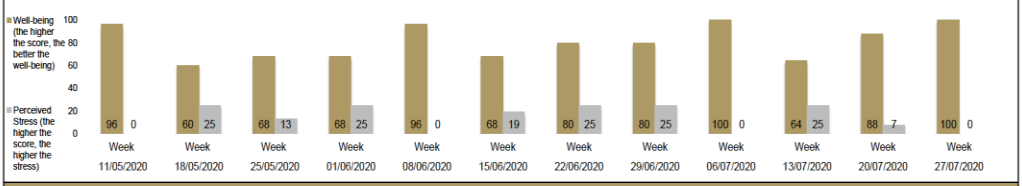
Athlete monitoring reports were sent out to canoe sprint and slalom athletes, coaches, and support staff on a weekly basis based on data collected in the Athlete Monitoring Questionnaire, an example report is shown below. Following this I worked with psychologists and a lifestyle advisor from British Canoeing to enhance the effectiveness of how this information could be used. This led to the development of a feedback loop whereby I flagged any data meeting a set of principles to coaches and the support staff which was then followed up in the sport. These principles were:

- Noticeable drop of wellbeing / increase in stress compared to athletes previous reported values.
- Downward trajectory to below 50 on wellbeing/ upward trajectory in stress.
- Wellbeing score of less than 50.
- Stress score being higher than wellbeing score.
- No other reasons in the data that would explain the score (e.g., illness causing lower wellbeing than normal).

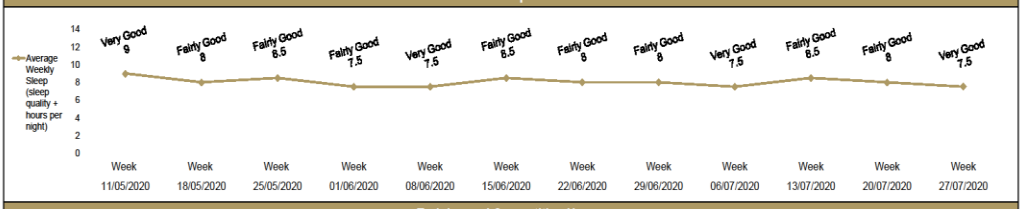
Athlete Monitoring Summary

Athlete:

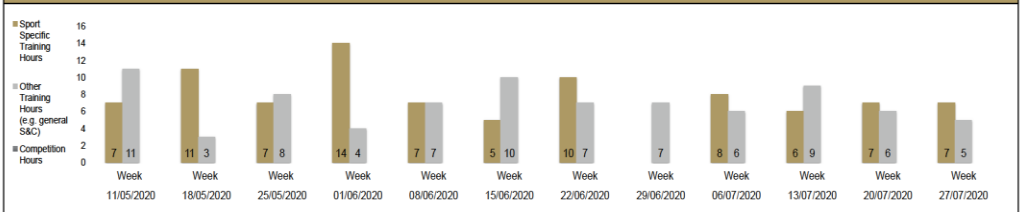
Well-being and Perceived Stress



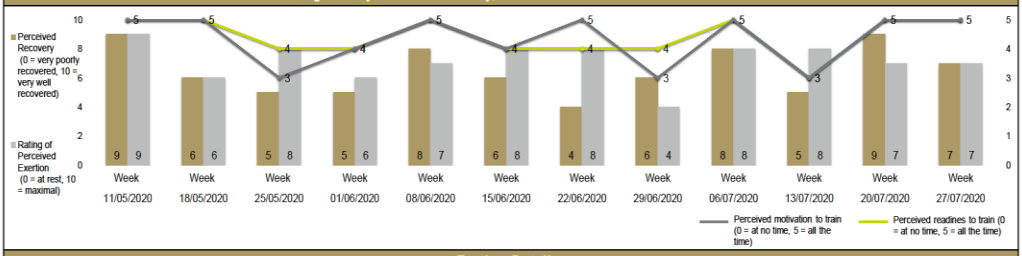
Sleep



Training and Competition Hours



Average Weekly Perceived Recovery, Readiness to train and Perceived Exertion



Further Detail...

Any sleeping troubles?

	Week 11/05/2020	Week 18/05/2020	Week 25/05/2020	Week 01/06/2020	Week 08/06/2020	Week 15/06/2020	Week 22/06/2020	Week 29/06/2020	Week 06/07/2020	Week 13/07/2020	Week 20/07/2020	Week 27/07/2020
I cannot get to sleep within 30 minutes...	Not during the past week	Once or twice a week	Less than once a week	Three or more times a week	Not during the past week	Less than once a week	Not during the past week	Less than once a week	Not during the past week	Less than once a week	Less than once a week	Not during the past week
I wake up in the middle of the night or early morning...	Not during the past week	Once or twice a week	Once or twice a week	Once or twice a week	Not during the past week	Less than once a week	Three or more times a week	Not during the past week	Not during the past week	Once or twice a week	Less than once a week	Not during the past week

Additional Sleep

	Week 11/05/2020	Week 18/05/2020	Week 25/05/2020	Week 01/06/2020	Week 08/06/2020	Week 15/06/2020	Week 22/06/2020	Week 29/06/2020	Week 06/07/2020	Week 13/07/2020	Week 20/07/2020	Week 27/07/2020
Number of days where I napped...			3	1	4	4	3	1	5	5		4
Average number of hours I spent napping during the day...			Greater than 0.5 but less than 1 hour	Greater than 1.5 but less than 2 hours	Greater than 0.5 but less than 1 hour	Greater than 1 but less than 1.5 hours	Greater than 1 but less than 1.5 hours	Less than 0.5 hour	Greater than 0.5 but less than 1 hour	Greater than 1 but less than 1.5 hours		Less than 0.5 hour

Injury and Illness

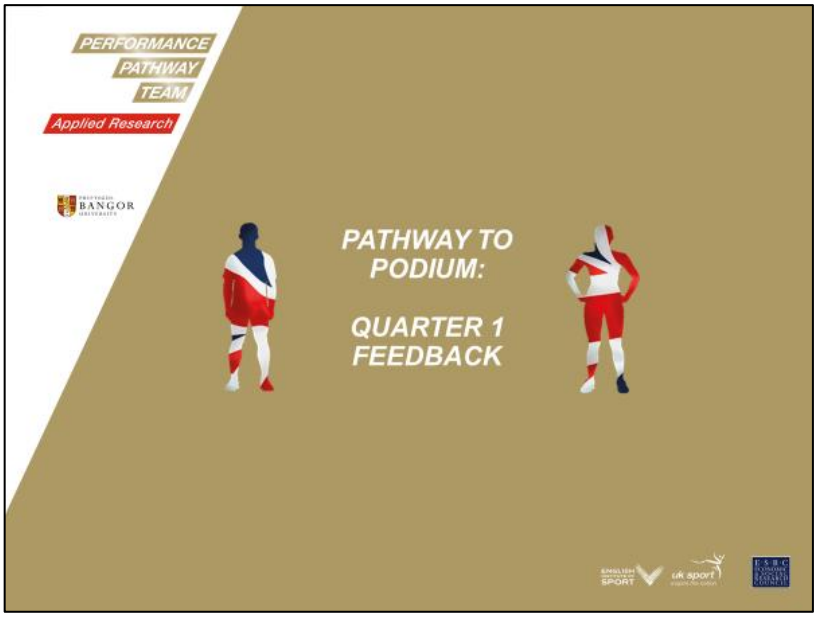
	Week 11/05/2020	Week 18/05/2020	Week 25/05/2020	Week 01/06/2020	Week 08/06/2020	Week 15/06/2020	Week 22/06/2020	Week 29/06/2020	Week 06/07/2020	Week 13/07/2020	Week 20/07/2020	Week 27/07/2020
Training Days Missed												
Injury		Lower limbs,		Upper Limbs,							Torso,	
Illness												

Competition Details

	Week 11/05/2020	Week 18/05/2020	Week 25/05/2020	Week 01/06/2020	Week 08/06/2020	Week 15/06/2020	Week 22/06/2020	Week 29/06/2020	Week 06/07/2020	Week 13/07/2020	Week 20/07/2020	Week 27/07/2020
Days of Competitions												
Number of races / competitions												

7.1.2 Canoe Slalom Quarter 1 Feedback Session [April 2019]

I ran a feedback session with canoe slalom national coaches and support staff to disseminate descriptive findings following the start-up of data collection in the sport. The psychosocial subsection of slides from this session are shown below. The session involved unpacking the psychosocial profiles of the athletes, exploring past training histories, and a brief description of the first few months of athlete monitoring data.



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Q1 Psychosocial Inventory

Canoe Slalom

Background

16 Elite

16 Super Elite

What We Measured

10

2

What We Measured

What We Measured

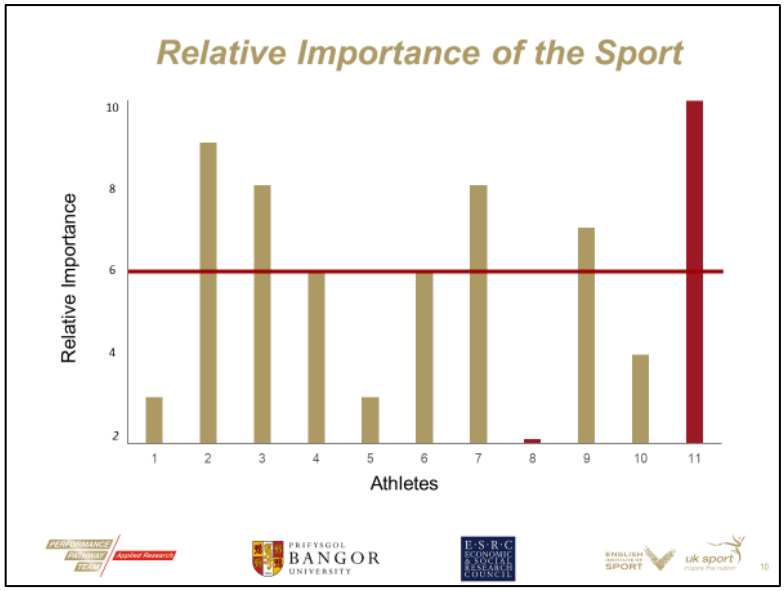
1. Relationship with their Sport
2. Approach to Training
3. Approach to Competition

1. Relationship with their Sport

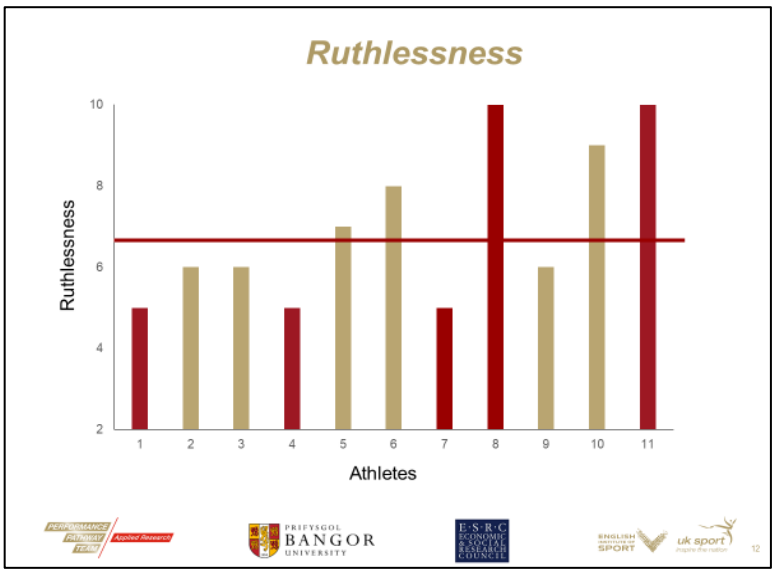
RELATIVE IMPORTANCE OF CANOE SLALOM

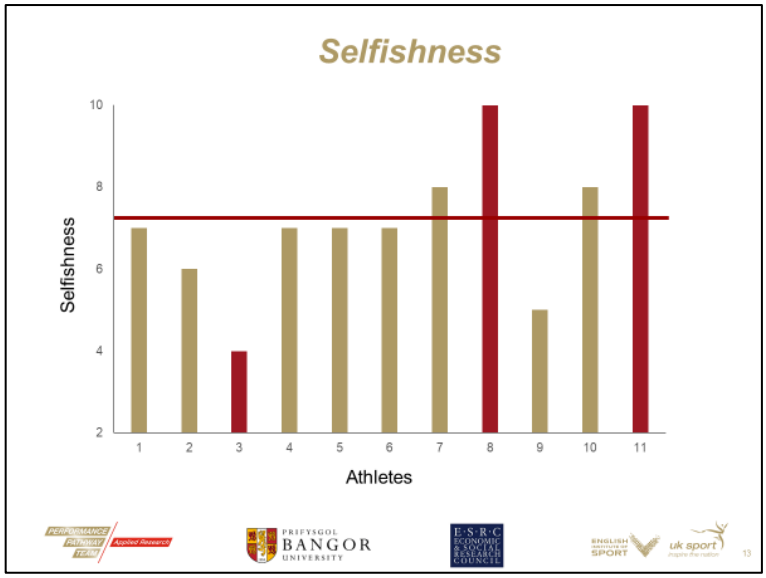
- Attraction of everyday life
- Competing influences
- Drawn away

1. *My sport is the most important thing in my life.*
2. *My sport offers me more than anything else in life (e.g. friends, family, relationships, money).*


Relative Importance of the Sport
Relative Importance
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10 11
Athletes


2. Approach to Training
RUTHLESSNESS AND SELFISHNESS
• "Difficult" personalities
• Advantageous to performance
• Pursuit of goals

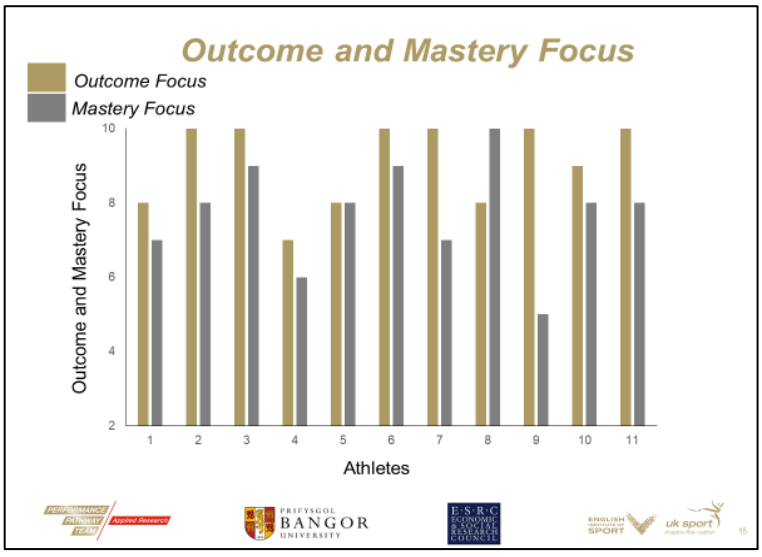

Ruthlessness
Ruthlessness
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10 11
Athletes



3. Approach to Competition

OUTCOME & MASTERY FOCUS

- *Outcome focus -> Winning/ performing better*
- *Mastery focus -> self-referenced standards*
- *Dual focus*



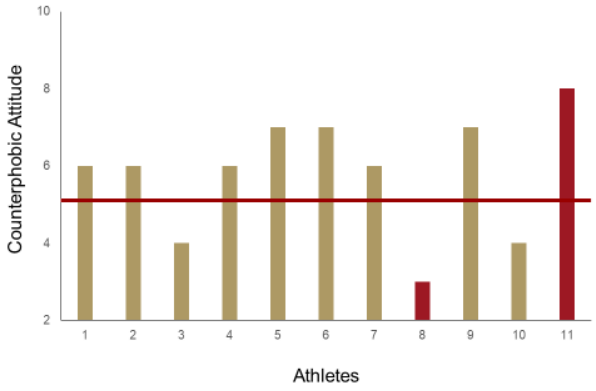
3. Approach to Competition

COUNTERPHOBIC ATTITUDE

- *Experience **specific, internal and intense** anxiety.*
- *Drawn towards anxiety-provoking situations.*
- *High level competition.*

1. *I am drawn to things I am afraid of.*
2. *I love how nervous competition makes me feel.*

Counterphobic Attitude

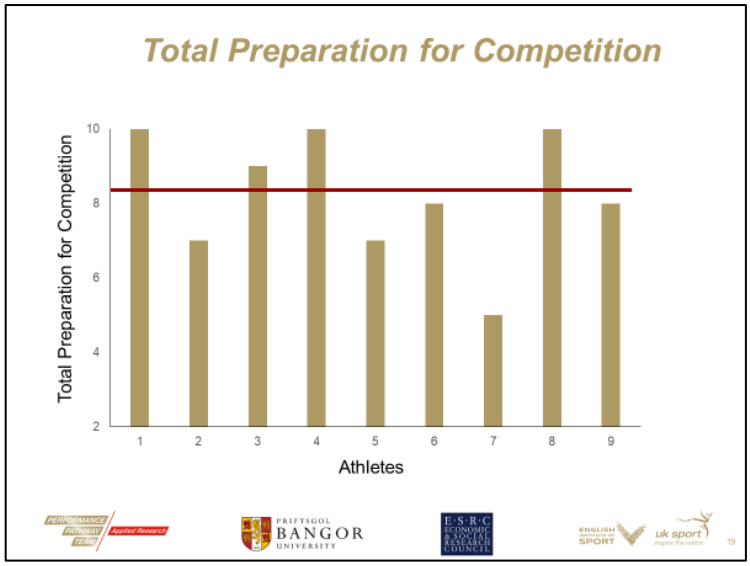


3. Approach to Competition

TOTAL PREPARATION FOR COMPETITION

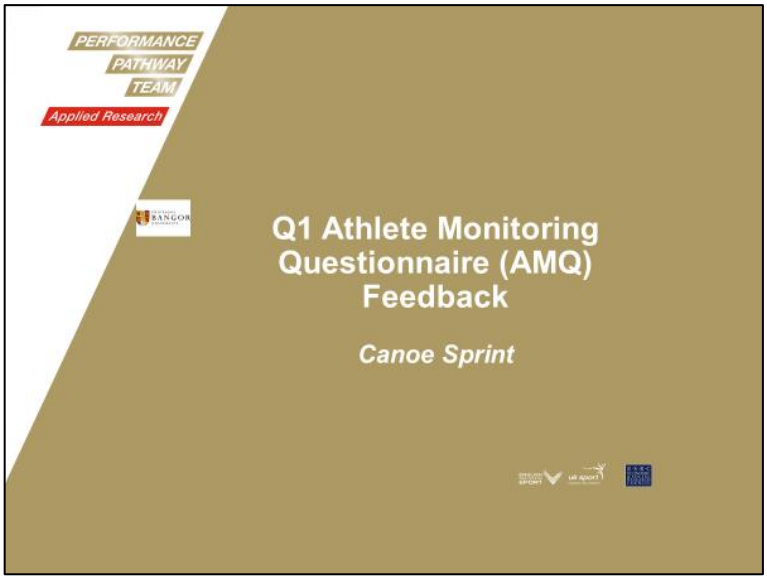
- *All required preparation.*
- *"No stone unturned"*

1. *I leave no stone unturned in preparation for competition.*
2. *I go beyond the norm to prepare for competition.*



7.1.3 Canoe Sprint Quarter 1 Feedback Session [April 2019]

I ran a feedback session with canoe sprint national coaches and support staff to disseminate descriptive findings following the start-up of data collection in the sport. The athlete health, wellbeing, and recovery subsection of slides from this session are shown below. The session involved unpacking the psychosocial profiles of the athletes, exploring past training histories, and a brief description of the first few months of athlete monitoring data. I then repeated this session with an additional member of staff who had been unable to attend.



Athlete Monitoring Questionnaire

11 weeks

8 athletes

4 coaches

Sleep

Hours (h) per night: 8 h ± 1.1 h (max = 11 h, min = 5 h)

Quality of sleep: *'Fairly Good'*

Napping: 1 day per week (max = 4 days) for 30 minutes to 1 hour

Bed time: 21:30/22:30 PM

Wake time: 7:00 AM

Sleep Duration and Quality in Elite Athletes
(Leeder et al., 2012)

Group	n	(hrs:mins)
Controls	20	8:07 ± 0:20
Athletes	46	8:36 ± 0:53
Canoeing	*11*	*8:32 ± 0:35*
Diving	*14*	*8:46 ± 0:55*
Rowing	*10*	*7:46 ± 0:40*
Speed skating	*11*	*9:13 ± 0:47*

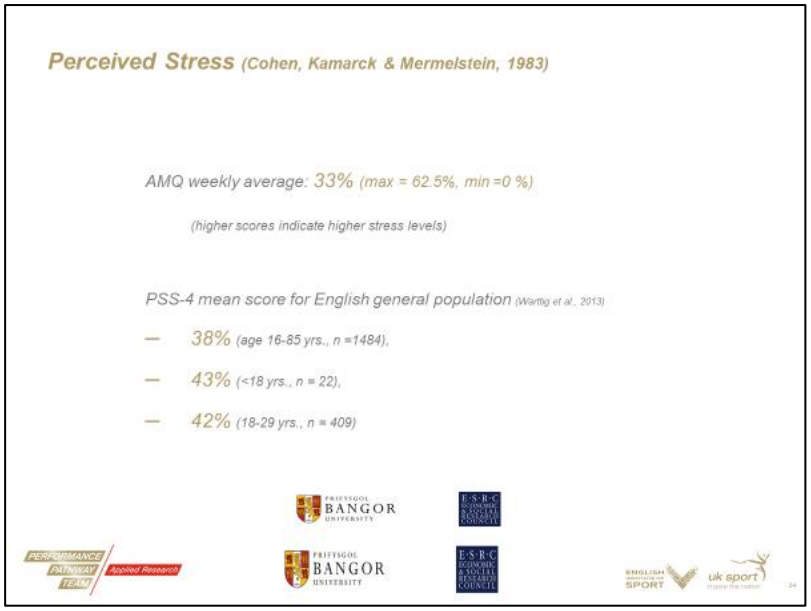
Injury and illness

Training days missed per week during injury or illness: 1 day (max = 3.5 , min = 0)

4 Injuries
4 Athletes

8 Illnesses
7 Athletes

- Knee — N=1, 1 week
- Hands & Fingers — N=1, 1 week
- Wrist & Shoulder — N=1, 4 week
- Back — N=1, 3 weeks
- Blocked / Running Nose — *Reported 8 times*
- Headache — *Reported 5 times*
- Cough & Sore Throat — *Reported 7 times*
- Fatigue — *Reported 12 times*


Perceived Stress (Cohen, Kamarck & Mermelstein, 1983)
AMQ weekly average: 33% (max = 62.5%, min =0 %)
(higher scores indicate higher stress levels)
PSS-4 mean score for English general population (Warttig et al., 2013)
38% (age 16-85 yrs., n =1484),
43% (<18 yrs., n = 22),
42% (18-29 yrs., n = 409)
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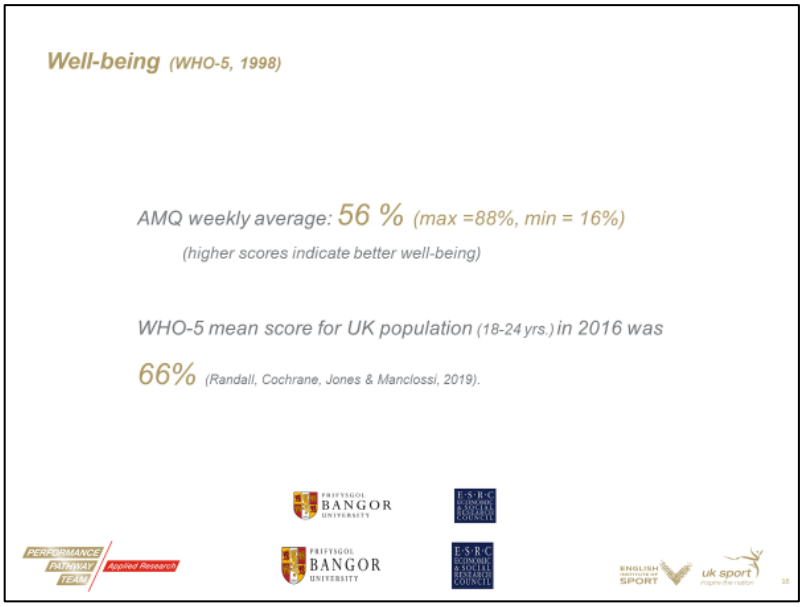
Well-being (WHO-5, 1998)
AMQ weekly average: 56 % (max =88%, min = 16%)
(higher scores indicate better well-being)
WHO-5 mean score for UK population (18-24 yrs.) in 2016 was
66% (Randall, Cochrane, Jones & Manclossi, 2019).
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Readiness, Recovery and Exertion
• Perceived readiness to train… 0 = at no time to 5 = all the time.
3/5 'more than half the time'
• Perceived recovery… 0 = very poorly recovered and 10 = very well recovered.
6/10 'moderately recovered'
• Rate of perceived exertion (RPE)… 0 = at rest and 10 = max effort.
6/10 'hard/very hard'
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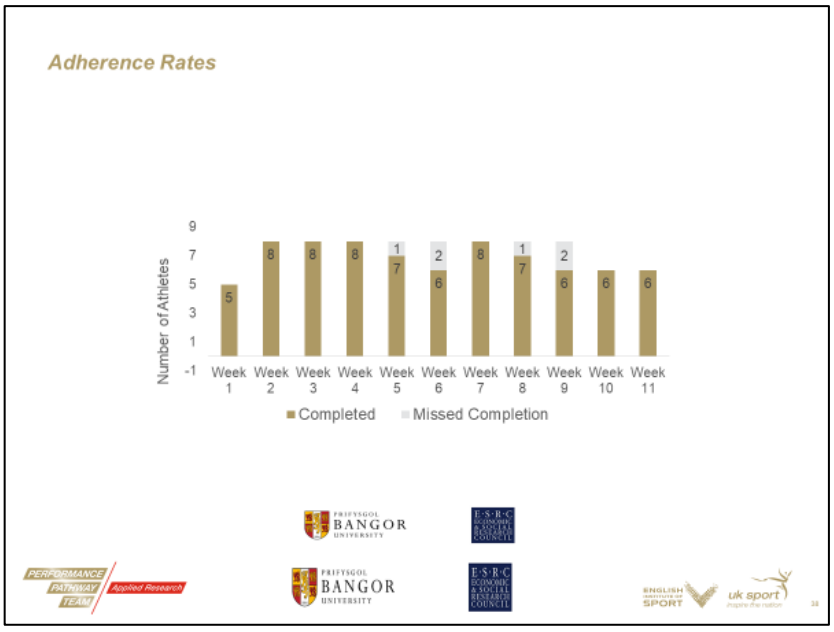
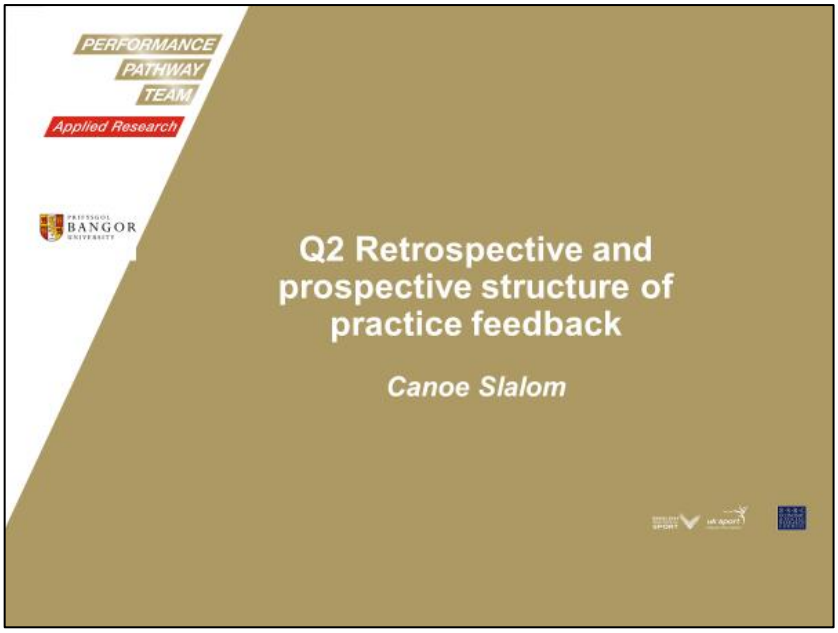


7.1.4 Canoe Slalom Quarter 2 Feedback Session [July 2019]

I ran a feedback session with canoe slalom national coaches and support staff to disseminate additional descriptive findings that followed on from the Quarter 1 feedback session. The practice and training subsection of slides from this session are shown below. The session started with updating the sport on what we had been doing and how we had responded to feedback from them. For the main content of the session, we re-examined the personality profiles of the athletes and discussed different strategies for working with them. We then went on to discuss the types of practice the athletes had been doing and the implications this might have for their training and progression.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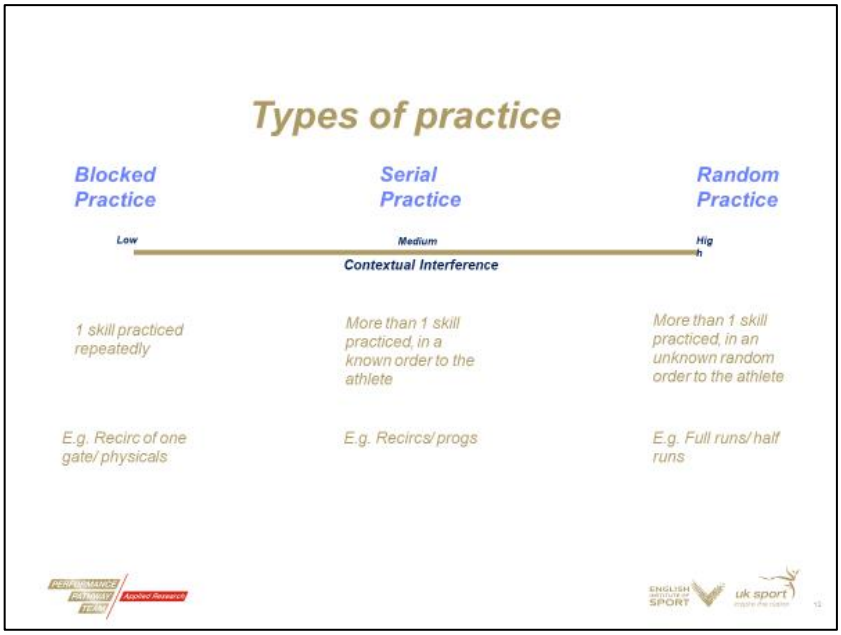
Q2 Retrospective and prospective structure of practice feedback
Canoe Slalom


Types of practice
Blocked Practice
Serial Practice
Random Practice
Low
Medium
High
Contextual Interference
1 skill practiced repeatedly
More than 1 skill practiced, in a known order to the athlete
More than 1 skill practiced, in an unknown random order to the athlete
E.g. Recirc of one gate/ physicals
E.g. Recircs/ progs
E.g. Full runs/ half runs
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Task:
You are going to be presented with some non-words.
Each letter corresponds to a finger movement:
Put your right hand palm down on the desk
A = thumb
B = index finger
C = middle finger
D = ring finger
E = little finger
Lift the appropriate fingers in the right order as quickly as possible
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Types of practice

Blocked Practice | **Serial Practice** | **Random Practice**

Low — Medium — High

Contextual Interference

- Enhances short term performance of an individual skill
- Does not encourage the development of skills long term in complex environments

- Does not enhance short term performance of skills
- Enhances long term learning and performance of these skills

Random practice can enhance learning within skilled athletes but it is likely that an appropriate level of challenge is also needed

Brady (2004); Hall, Domingues & Cavazos (1994); Lawrence & Kingston (2008); Aiken & Genter (2018)

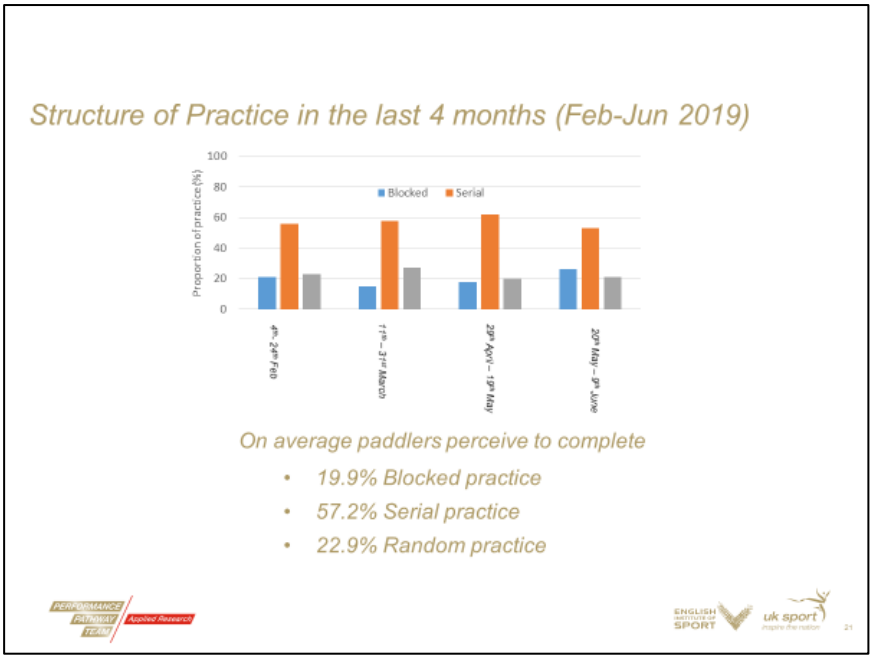
Brady (2004); Hall, Domingues & Cavazos (1994); Lawrence & Kingston (2008); Aiken & Genter (2018)

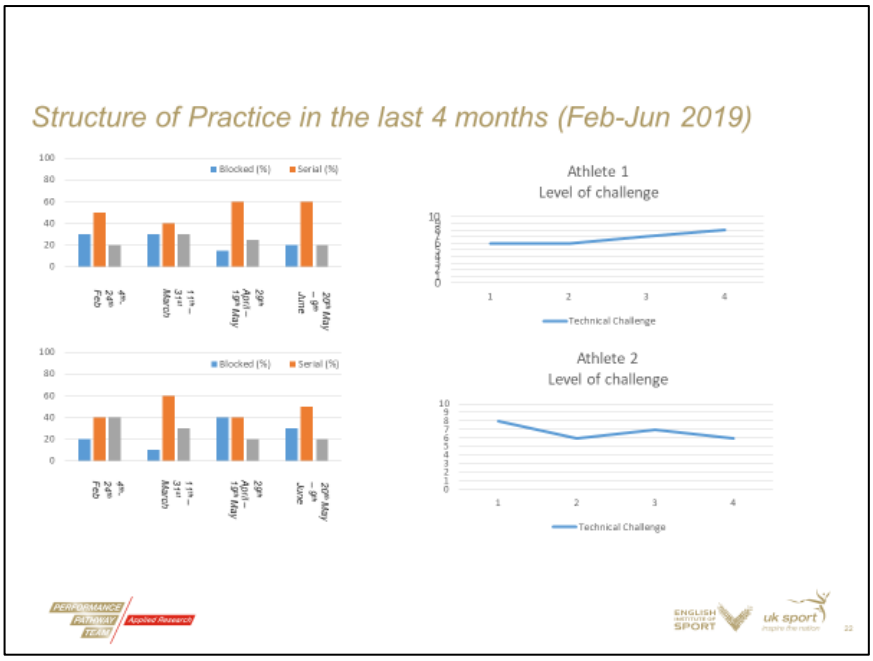
Structure of practice

- *Blocked practice enhances short term performance of individual skills but does not encourage the development of skills long term in complex environments*
- *Random practice does not enhance short term performance of skills but enhances long term learning and performance of these skills*
- *Random practice can enhance learning within athletes if delivered at the right time and with appropriate levels of challenge.*

Part 1. Structure of practice

1) *What type of practice were the paddlers doing in the year before the WCP?*
2) *What type of practice are the paddlers currently doing?*
3) *How technically challenging are they finding current practice?*





7.1.5 Canoe Slalom Quarter 3 Feedback Session [November 2019]

I ran a third feedback session with canoe slalom national coaches and support staff to disseminate additional descriptive findings that we had collected after over six months in the sport. Within this session, we disseminated data specifically relating to athlete motivation and the influence their training environment could have upon this. We then also spent time discussing the high athlete adherence for the AMQ and what we could do to increase this during competitions when adherence tended to drop. We then went onto discuss the next steps of the project specifically which athletes the sport would like to be involved in the psychosocial interviews and how we could split the athletes for the machine learning analysis. Below are the slides summarising the "next steps" from this session.

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Where are we going next?

Canoe Slalom

Psychosocial Interview

- *Critical developmental experiences*
- *Relationship with sport*
- *Pressure zone and emotional regulation*
- *Personality*
- *Relationship with family and coaches*
- *Career turning points*

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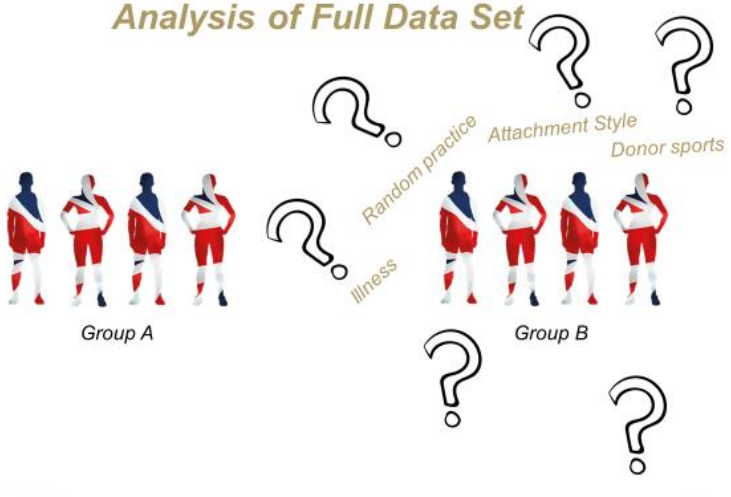
Analysis of Full Data Set



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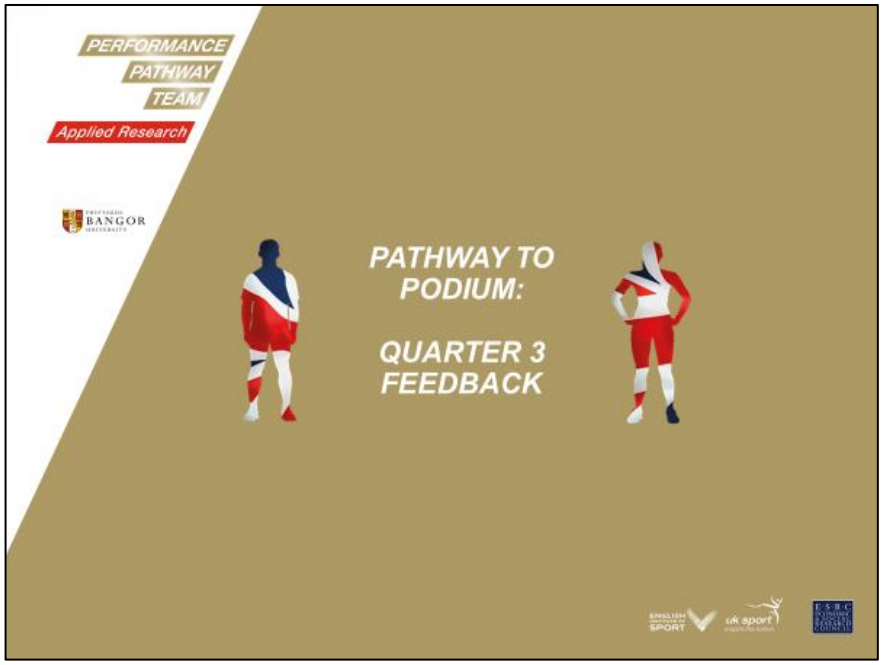
7.1.6 Canoe Sprint Individual Coach Feedback Session [December 2019]

I met with a national coach from canoe sprint to feedback on findings from the project that was also relevant to their specific areas of interest. This session provided them with evidence of the impact of the change in their coaching on athlete behaviours and attitudes. The slides from this session are shown below, as this session only related to three athletes, I have not included slides with individual athlete data.



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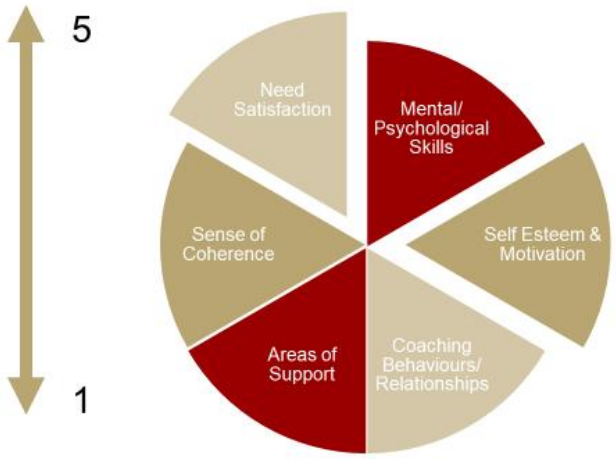
6 Month Psychosocial Questionnaire

Canoe Sprint

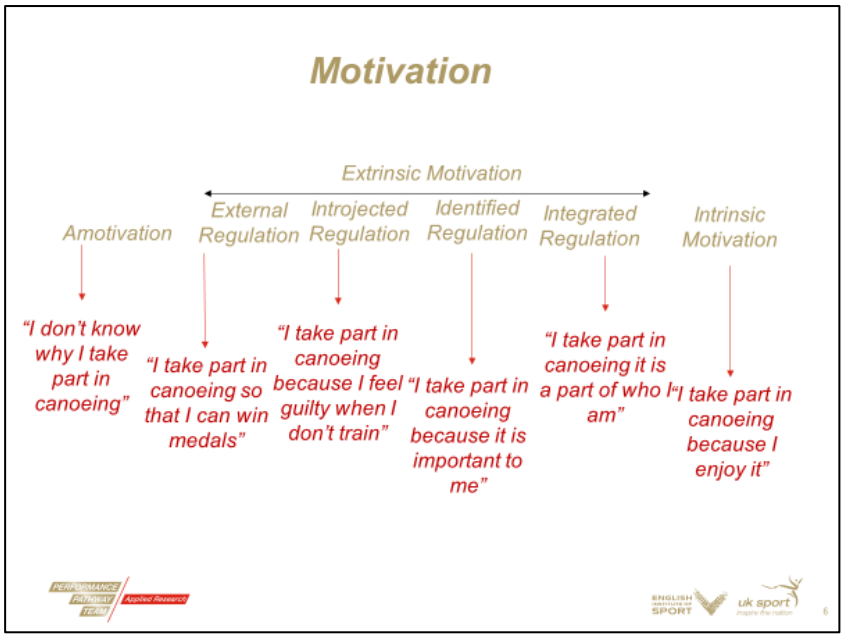
What We Measured



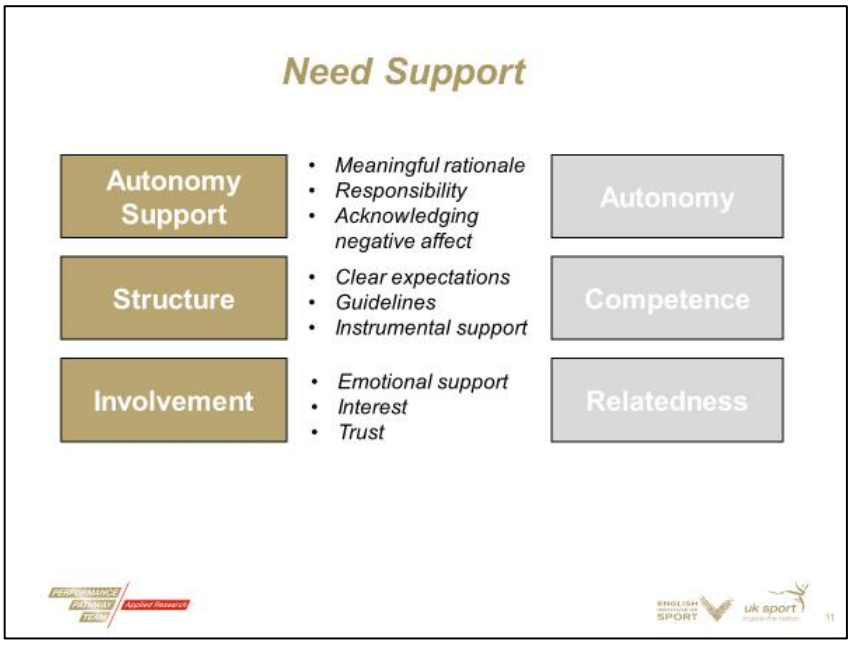
Self Determination Theory (SDT; Deci & Ryan 1985)

- Autonomy
- Competence
- Relatedness

→ **Motivation**

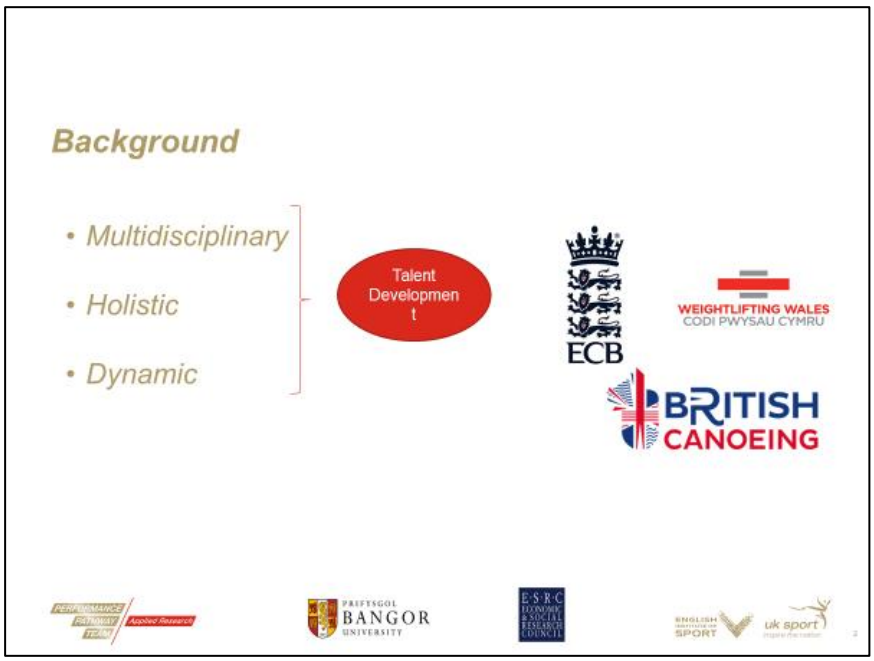

Motivation
Extrinsic Motivation
Amotivation
External Regulation
Introjected Regulation
Identified Regulation
Integrated Regulation
Intrinsic Motivation
"I don't know why I take part in canoeing"
"I take part in canoeing so that I can win medals"
"I take part in canoeing because I feel guilty when I don't train"
"I take part in canoeing because it is important to me"
"I take part in canoeing it is a part of who I am"
"I take part in canoeing because I enjoy it"


Autonomy
To feel like we have control over what we do.
Competence
To understand what is needed to achieve outcomes and feel like you've done a good job.
Relatedness
To have meaningful relationships and interactions with other people.


Need Support
Autonomy Support
Meaningful rationale
Responsibility
Acknowledging negative affect
Autonomy
Structure
Clear expectations
Guidelines
Instrumental support
Competence
Involvement
Emotional support
Interest
Trust
Relatedness

7.1.7 Canoe Slalom End of Year Feedback Session [February 2020]

I ran an end of year session with national coaches and support staff to disseminate the findings of the pattern recognition analysis following a year of data collection. This session provided lots of opportunity for discussion and identifying the meaning of these findings for the sport. Below is a subsection of slides from this session.

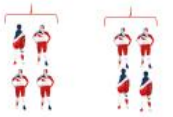


Analysis

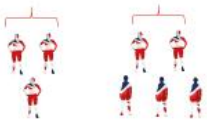
Pattern Recognition

Variables → Feature selection → Classification Models

Group Splits



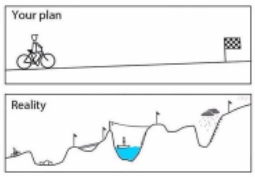
Matrix vs. Non-Matrix



TID vs. Traditional Pathway

Word of Caution

- Talent trajectory not linear
- Chicken or the egg??
- Small sample – missing data
- Discriminators not commonalities



Results: Preliminary Model
The "Game Changers"

	Matrix	Non Matrix
Hours of Deliberate Practice Jul - Sep	+	-
Hours of Water Based Training Jul - Sep	+	-
Spin techniques used during fulls/ halves Oct - Dec	+	-
Hours of anxiety specific training Oct - Dec	+	-

Variability of Practice

- High contextual interference
- Variation within practice
- Multiple types of technique

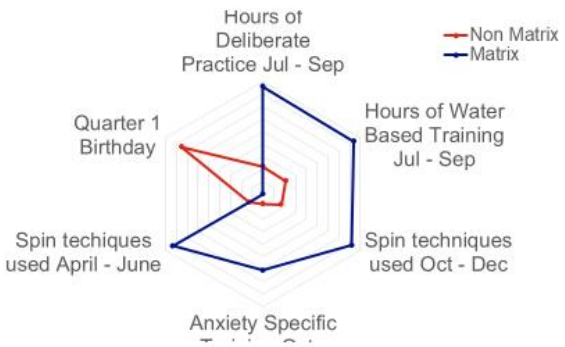
Anxiety Specific Practice

- Pressure like competition

Results: Preliminary Model
The "Influencers"

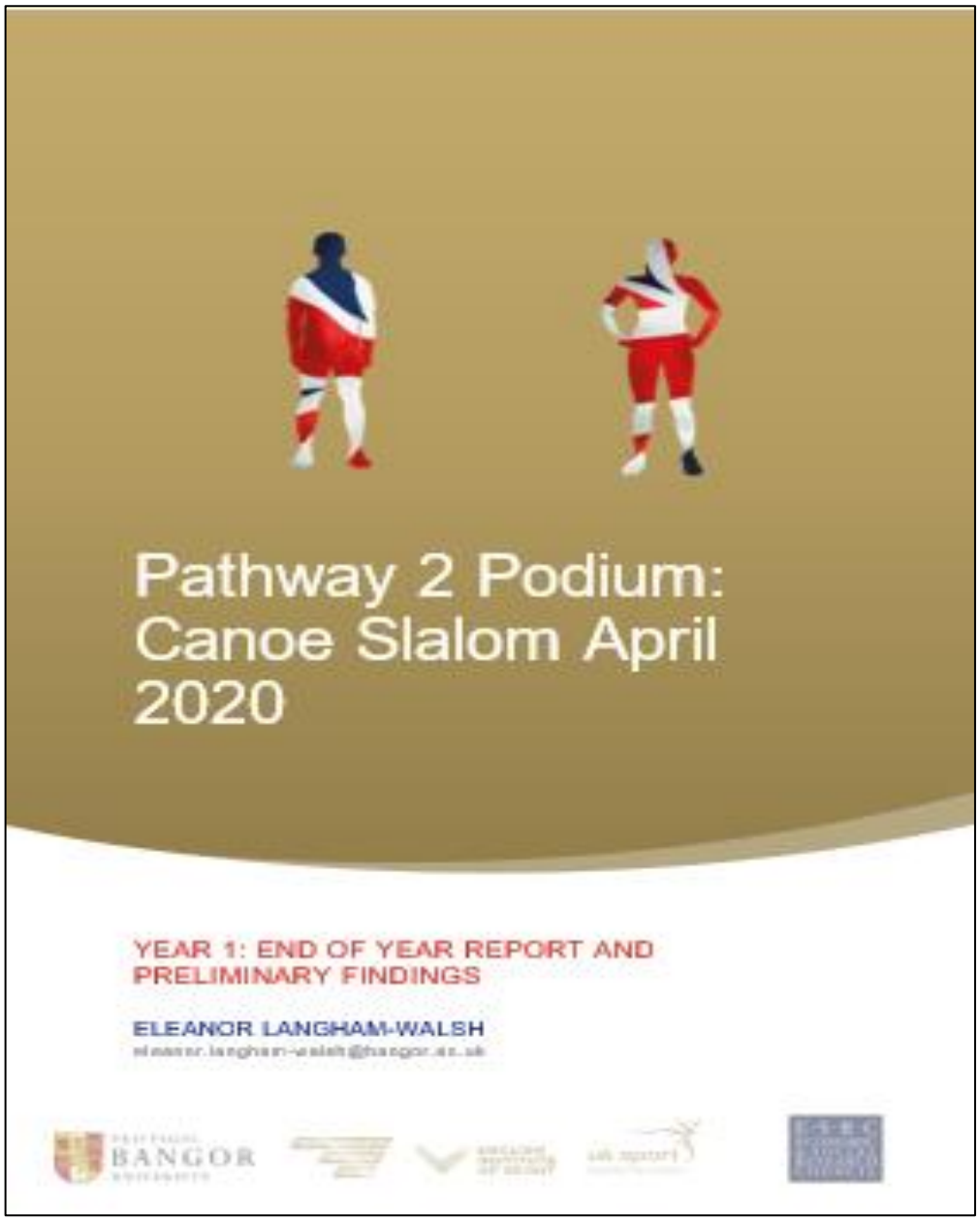
	Matrix	Non Matrix
Spin Techniques used April - June	+	-
Quarter 1 birthday	-	+

Full Preliminary Model
Classification Rate: 90.625%



7.1.8 Canoe Slalom End of Year Report and Preliminary Findings [April 2020]

Following the end of year feedback session, I compiled a report of summarising the descriptive statistics and pattern recognition analysis from the first year of involvement in the sport. Alongside this, the report also contained a context and implications section based upon the discussion of the findings in the end of year feedback session. Below is a copy of the end of year report.



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General Introduction

The Pathway to Podium Project is an interdisciplinary longitudinal research project funded by UK Sport, the English Institute of Sport, the Economic and Social Research Council, and Bangor University. It provides a unique opportunity in both research and applied practice to explore the identification and development of high-level sports performers.

Researchers are increasingly emphasising the importance of multidisciplinary approaches to talent identification and development. A recent example of this is The Great British Medallist's Project (GBM; Güllich et al., 2019), which was a multidisciplinary study exploring factors that discriminated between two matched groups of athletes: "super elites" who had won at least one World and/or Olympic gold medal plus another gold medal at a major championship, and "elites" who competed internationally and may have won either silver or bronze medals, but had never been a World or Olympic Champion. The authors were able to discriminate super-elite from elite athletes with > 90% accuracy by considering a combination of demographics, psychosocial characteristics, coach and family relationships, practice, competition, and performance development. A number of commonalities and discriminators were identified: one such commonality was a culture of striving, which was reported by both elite and super-elite athletes, whereas the experience of negative critical life events coupled with a positive critical life event was an important discriminator only reported by super-elite athletes. Whilst the GBM work has undoubtedly contributed to the literature in its identification of important determinants of expertise, there were some limitations worthy of addressing. The research was retrospective in nature, and did not distinguish between sports, which prevented the development of sport specific guidance. It is very likely that there would be differences in not only the practice and training factors, but psychosocial profiles and environmental factors as well. The rationale for the current project was to prospectively and longitudinally examine interactions between psychosocial, practice and training, illness, and injury variables with the primary unit of analysis being at the specific sport level. This approach is valuable in exposing multidisciplinary determinants of expertise specific to a particular sport.

Within the first year, a multidisciplinary bio-psycho-social model has been used to investigate the interaction of environmental, athlete, and coaching factors on athletes' ability to thrive in the high-performance sport environment. These factors include demographics (e.g., birth date, birth place, schooling), practice and training (e.g., developmental sporting history, milestones and achievements in sport, past and current training activities) psychosocial (e.g., personality and

behavioural traits), coaching (e.g., styles, practices, philosophy), competition experience, and organizational variables (e.g., culture of the sport, level and type of athlete support). The term **'thrive'** is operationalised in several different ways. These include; athlete availability (e.g., injuries, illnesses, immune functioning, and psychological well-being); athlete progression (e.g., transition up the pathway towards the Podium Programme, competition achievements, adaptability to change and increased load and expectations placed on the athlete via the Pathway); and attrition (e.g., withdrawal from high level sport). The project has been tailored for both canoeing disciplines, with an individualised, dynamic model adopted for each sport. This report focuses on canoe slalom only.

Methods

Participants

We invited 9 UK Sport funded athletes, 2 athletes coming off Podium Potential funding and 3 coaches to take part in the study. 2 declined and 1 athlete withdrew leaving us with a sample of 8 athletes (mean age = 19.1 ± 2.1 years). Initially 3 coaches of these athletes were involved. The transition of athletes across different coaching groups meant that 1 coach stopped participating and an additional coach joined the project.

6 out of the 8 athletes were based in Lee Valley with 2 in Nottingham; 1 of these athletes transitioned down to Lee Valley at the end of 2019. At the end of 2019, 1 athlete had transitioned back onto funding, 4 had retained their place and 3 were transitioning off funding.

Pathway 2 Podium Year 1 Data

For an outline of study methodology please see Figure 1. Data included in this study were collected from January 2019 – December 2019.

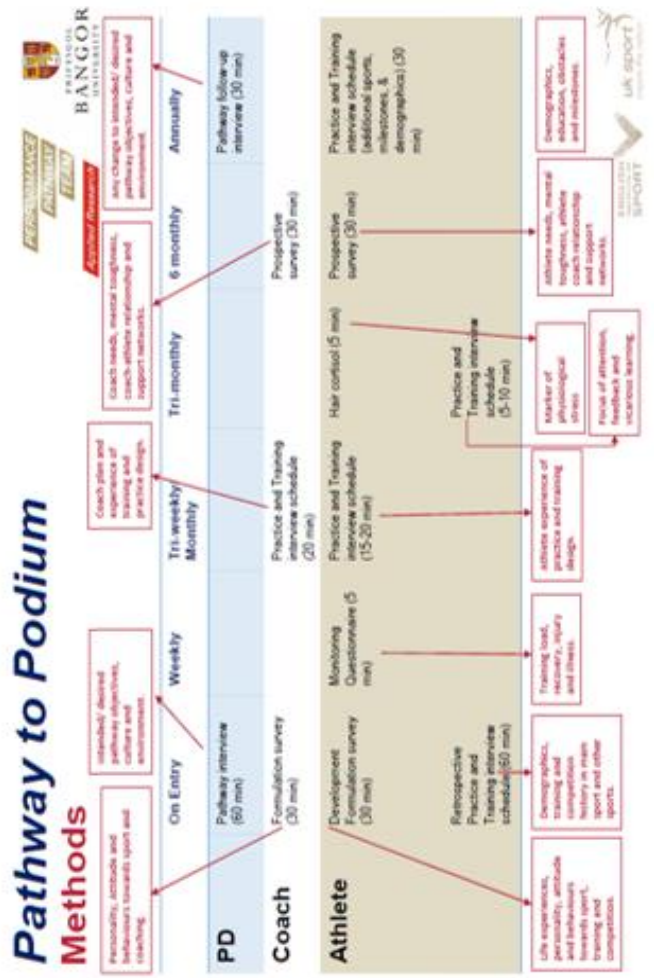


Figure 1. Study methodology.

Analysis

To analyse the data, we used a combination of descriptive statistics and state of the art pattern recognition analysis. Pattern recognition analysis was initially developed within bioinformatics to classify objects based on the features they possessed (Duda, Hart, & Stork, 2000). The aim of this type of analysis is to be used with a large number of variables to identify which of these distinguishes between two different classifications or groups. Based on discussions with British Canoe Slalom coaches and support staff, our aim was to distinguish between athletes that had qualified a matrix result in 2019 and those that had not using the variables we had collected throughout the past year. In total there were 7017 individual variables. We then grouped these across timepoints to come up with the final data set of 389 variables. For a more detailed pattern recognition procedure, please see Appendix A.

Results
Descriptive Statistics

Practice and Training

Transition through the pathway

Athletes took 4 ± 1.4 years to transition from D4 to Prem. There was a significant difference (t (5.1) = -5.8, p = 0.0) in years between athletes that had come through a traditional pathway (n = 5, 5 ± 0.6 years) as opposed to a talent ID pathway (n =3, 2.3 ± 0.5 years). The mean age for selection onto the WCP as a Podium Potential athlete was 17.1 ± 0.8 years. Table 1. identifies the athlete's transition through the pathway and squad membership before they were identified as a Podium Potential athlete.

Table 1.

Table showing squad membership.

	RTA	SRS	ENTS	EPS	Welsh Dev.	Welsh Perf.	Scottish Dev	Scottish Perf.
No. of Athletes	1	3	5		1	1	2	2

Activity during development

Deliberate Play -> Free from focus inherently enjoyable and provides immediate gratification.	Deliberate Practice -> Highly structured activity that requires effort, generates no immediate rewards, and is motivated by the goals of improving performance rather than inherent enjoyment.

Côté, Baker, and Abernethy (2007)

Deliberate play in the sampling years (age 6-12) can reduce the likelihood of burnout and drop out from sport later in adolescence. Burnout and dropout from sport is associated with early specialisation and high volume of deliberate practice (Baker, Côté & Abernethy, 2003). As shown in Figure 2, on average (across all athletes) there was a higher proportion of deliberate play in the sampling years (age 6-12) and a higher proportion of deliberate practice during the specialisation years (age 13-15).

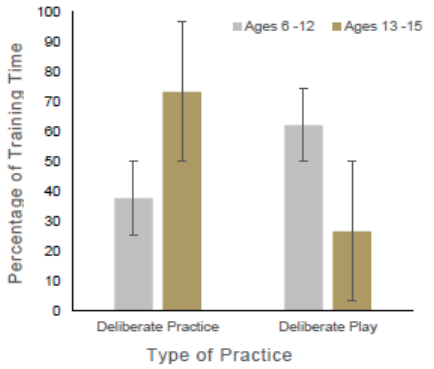


Figure 2. Proportion of deliberate practice and play throughout development.

Sports during development

Early diversification is beneficial for development in elite sport where peak performance occurs post maturation. It is beneficial because it can help develop emotional, cognitive and motor skill development (Côté, Lidor & Hackford, 2011). Athletes participated in a range of sports during their sampling years (aged 6-12 years; mean number. of sports = 4.4 ± 1.6). The current sample of canoeists' involvement in sports is consistent with the development of elite sporting expertise literature, specifically the Developmental Model of Sport Participation (DMSP; Côté, 1999; Côté, Baker, & Abernethy, 2007) Côté & Fraser-Thomas, 2007) as they participated in multiple sports in the sampling years and then went on to specialise later.

Psychosocial

The first psychosocial measure was the Athlete Development Formulation Survey (ADFS), a questionnaire that focuses on: life experiences, personality, and training behaviours. The ADFS was developed from variables found in the Great British Medallist's Project (GMB; Gullich et al., 2019) that were commonalities and discriminators between elite and super-elite athletes, alongside thirteen other psychosocial variables deemed to be important from talent development projects conducted in rugby and cricket. Figures 3, 4 and 5 show profiles of individual canoe slalom athletes for life experiences, training behaviours, and personality, respectively. Further information, definitions and results of these variables can be found in Appendices B and C.

Additional psychosocial variables were assessed at the 6-month mark. These variables are assessed repeatedly throughout the course of the project and cover aspects such as coach-athlete relationship and sources of social support. Further information, definitions and results of these variables can be found in Appendices B and D.

Figure 3. Canoe slalom case study for the life experience variables. A career turning point was a variable that discriminated between super elite and elite athletes in the GBM study (Hardy et al., 2017). For further definitions of these variables please see Appendix B.

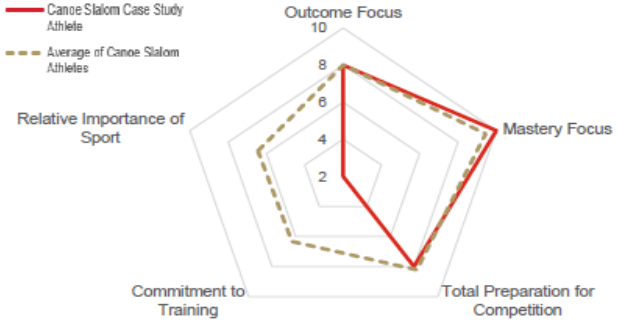


Figure 4. Canoe slalom case study for the training behaviours variables. Relative importance of sport, total preparation for competition, and a dual outcome and mastery focus were variables that discriminated between super elite and elite athletes in the GBM study (Hardy et al., 2017). For further definitions of these constructs please see Appendix B.

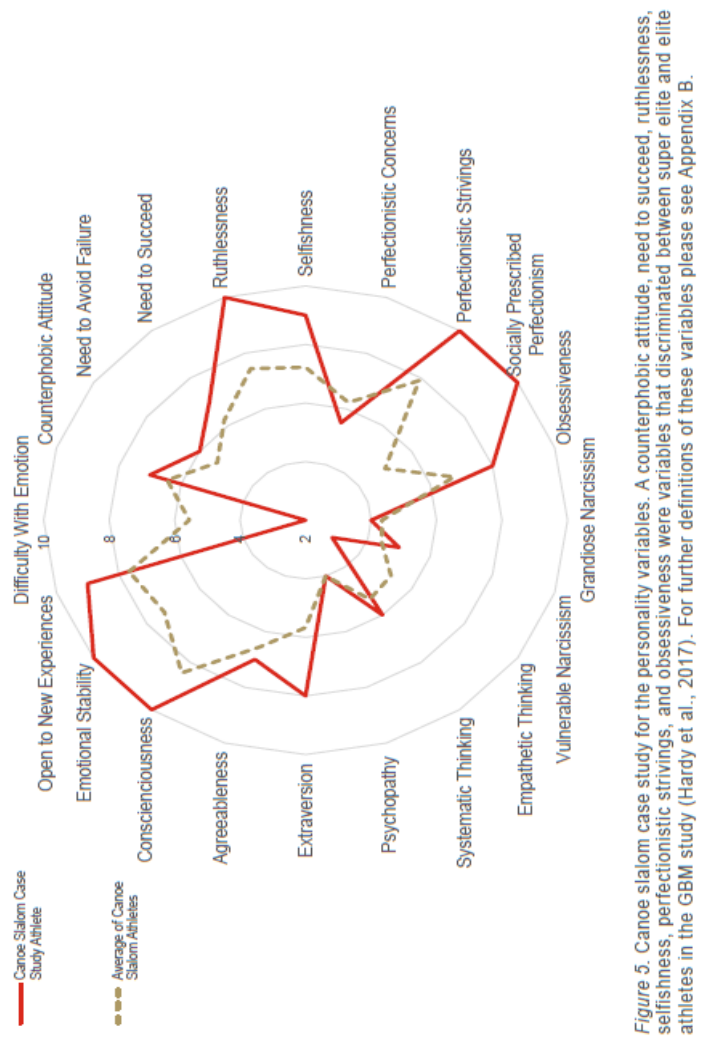


Figure 5. Canoe slalom case study for the personality variables. A counterphobic attitude, need to succeed, ruthlessness, selfishness, perfectionistic strivings, and obsessiveness were variables that discriminated between super elite and elite athletes in the GBM study (Hardy et al., 2017). For further definitions of these variables please see Appendix B.

AMQ – 82% Adherence Rate

The Athlete Monitoring Questionnaire is administered weekly to the athletes to assess:

- Training & competition volume
- Readiness to train RPE & perceived recovery
- Injury, illness & training
- Sleep
- Perceived stress and wellbeing

Impact

Figure 6 outlines the feedback loop used for the AMQ. Short-term (i.e., weekly) and long-term (i.e., quarterly) feedback is provided to athletes, coaches and support staff. From this, we designed a process to enhance communication regarding these data among the athletes' coaching and support team; the athlete completes the AMQ, the researcher then provides feedback to the athlete, coaches and support staff. Any data that meets the set of principles outlined in Appendix E. is flagged by the researcher to the coaches and support staff. Coaches and support staff then liaise with each other bringing to bear relevant contextual knowledge to better understand the situation.

Figure 6. AMQ feedback loop

Results
Pattern Recognition

In the following section, we present four subsets of the data which discriminate between athletes who made a matrix result in 2019 and those who did not. These subsets are the full data set and each of the psychosocial, practice and training and AMQ sections individually. **It is important to note that it is the *combination* of variables that discriminates between the groups and not single variables individually.** Any visualisations are crude representations for the purpose of aiding the interpretation of these findings and may not represent the complex interaction between the variables. Descriptive statistics will be provided within each section.

Considerations

- Talent trajectory is not linear. Splitting the canoeists into groups by a current matrix result is objective but will not be indicative of long-term performance potential in all athletes.
- Sample specific. Due to the small sample of athletes we do not yet know whether we could replicate these samples in another cohort of canoeists, so these preliminary findings should be taken with caution.
- Not all variables will come up in the overall model, however this does not mean that they are not important. This particular analysis identifies discriminating variables so it is important to note that other variables may also be of importance, but they may be common between both groups of athletes.

Full Data Set

The first analysis is based on the whole data set of athlete variables. A subset of 6 variables was identified as the best combination of discriminatory variables. This model classified the athletes with an accuracy rate of 90.6%. Stereotypical profiles for both groups of athletes are visualised in Figure 7. Table 4 shows the mean scores for the variables.

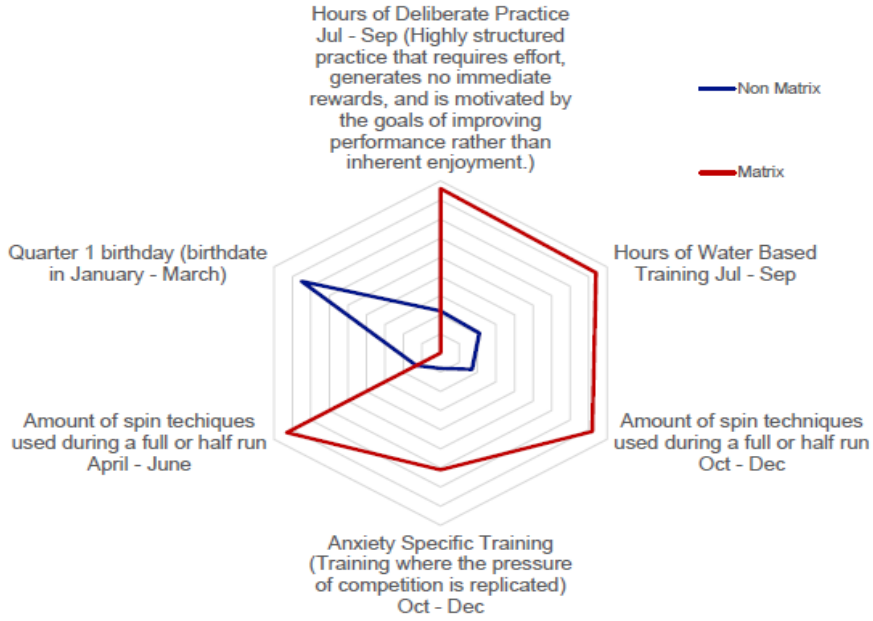


Figure 7. Full Preliminary Model discriminating between paddlers who made a matrix result in 2019 and those who did not. Note: data points reflect the normalised mean values for each group (this transformation allows all variables to be displayed on the same scale).

Table 4.

Table of means for variables identified within the full model.

VARIABLES	MATRIX GROUP	NON-MATRIX GROUP
Hours of Deliberate Practice Jul – Sep *	21.4	8.3
Hours of water-based training per week from July to September	7	4
Spin techniques in fulls/ halves Oct - Dec	4	2
Hours of anxiety specific training Oct – Dec *	5	4.7
Spin techniques in fulls/halves April – June	4	2
Quarter 1 birthdate (number of paddlers)	0	3

Note. * over three weeks

Following the full analysis, we then broke the data down into its subsections.

Psychosocial Variables

The second analysis is based on the psychosocial athlete variables. A subset of 9 features was identified as the best combination of discriminatory factors. This model classified the athletes with an accuracy rate of 81.3%. Stereotypical profiles for both groups of athletes are visualised in Figure 8. Table 5 shows the mean scores for the variables.

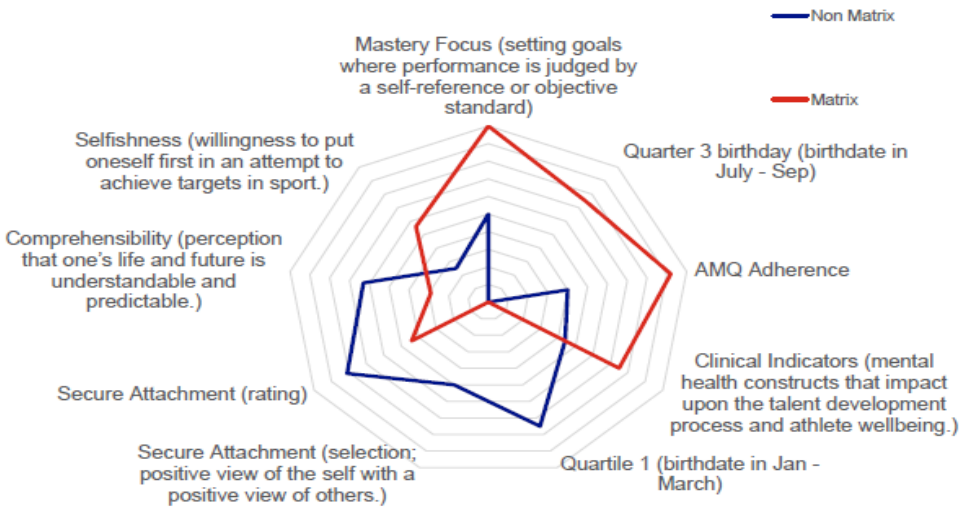


Figure 8. Preliminary Psychosocial Model discriminating between paddlers who made a matrix result in 2019 and those who did not. Note: data points reflect the normalised mean values for each group (this transformation allows all variables to be displayed on the same scale).

Table 5.

Table of means for variables identified within the psychosocial model.

VARIABLES	MATRIX GROUP	NON-MATRIX GROUP
Quarter 1 birthdate (number of paddlers)	0	3
Mastery Focus *	10	9
Quartile 3 birthdate (number of paddlers)	3	0
Percentage AMQ Adherence	96	68
Clinical Indicators	2.5	1.9
Comprehensibility	1.9	2.9
Number of paddlers selecting Secure Attachment on The Relationship Questionnaire (Bartholomew & Horowitz, 1991)	0 (3.8) ***	2 (5.3) ***
Selfishness *	8.3	7

Note. * scored from 2 – 10, ** scored from 1 – 5. *** score in brackets reflects what they athletes rated themselves on this trait.

Practice and Training Variables

The third analysis is based on the practice and training athlete variables. A subset of 5 features was identified as the best combination of discriminatory factors. This model classified the athletes with an accuracy rate of 84.4%. Stereotypical profiles for both groups of athletes are visualised in Figure 9. Table 6 shows the mean scores for the variables.

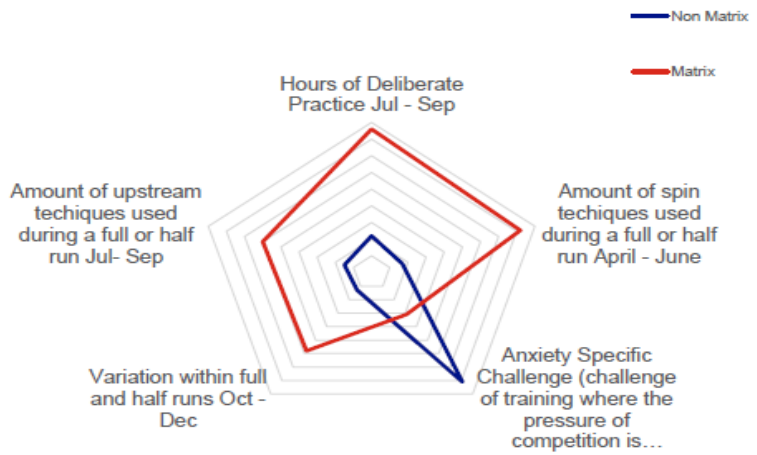


Figure 9. Preliminary Practice and Training Model discriminating between paddlers who made a matrix result in 2019 and those who did not. Note: data points reflect the normalised mean values for each group (this transformation allows all variables to be displayed on the same scale).

Table 6.

Table of means for variables identified within the practice and training model.

VARIABLES	MATRIX GROUP	NON-MATRIX GROUP
Hours of Deliberate Practice Jul – Sep *	21.4	8.3
Spin techniques in fulls/halves April – June	4	2
Anxiety specific challenge year before WCP	5.3	7.3
Hours of variation within fulls/ halves Oct – Dec *	3.4	0.7
Upstream techniques in Fulls/ halves Jul – Sep	4	2.9

Note. * over three weeks

AMQ Variables

The fourth analysis is based on the AMQ athlete variables. A subset of 5 features was identified as the best combination of discriminatory factors. This model classified the athletes with an accuracy rate of 84.4%. Stereotypical profiles for both groups of athletes are visualised in Figure 10. Table 7 shows the mean scores for the variables.

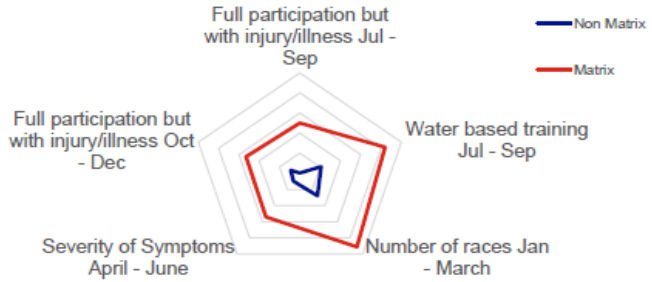


Figure 10. Preliminary AMQ Model discriminating between paddlers who made a matrix result in 2019 and those who did not. Note: data points reflect the normalised mean values for each group (this transformation allows all variables to be displayed on the same scale).

Table 7.

Table of means for variables identified within the models.

VARIABLES	MATRIX GROUP	NON-MATRIX GROUP
Hours of water-based training per week from July to September	7	4
Full participation with injury/illness Jul – Sep (%)	0.5	0
Races per week when competing Jan – March	1.6	0.6
Severity of Symptoms when ill/injured Apr – June	1.6	1.1
Full participation with injury/illness Oct – Dec	0.4	0.1

*Note. * over three weeks*

Context and Implications

These results provide us with a fantastic starting point to begin to provide true meaning for these findings. Through discussion within the sport and further exploration of the data we will be able to generate findings specific to the sport with long term implications and application. Below we are going to discuss some of these findings in more detail along with reference to contextual information and any implications for both research and applied practice.

Relative Age Effect (RAE) Reversal

Finding

The results showed that there was a greater prevalence of paddlers born later in the year that made a matrix result. Those that didn't, however, were more likely to have been born earlier in the year.

Contextual Information

The Relative Age Effect is a robust concept in sport (Cobley, Baker, Wattie, & McKenna, 2009) which explains a biased distribution of athletes that are born earlier in the year and against those born later in the year. However, at higher levels of expertise, this effect has "reversed" (Gibbs, Jarvis, & Dufur, 2012) something we are potentially seeing within our sample of paddlers. Psychosocial hypotheses have typically been adopted to account for the overrepresentation of younger athletes succeeding at the higher levels. For example a "rocky road" (Collins & MacNamara, 2012) developmental trajectory where initial challenges (for example being physically smaller due to being relatively younger) promote the development of resilience and mental toughness needed to succeed.

Implications

Is this what we are seeing here or is it just a coincidence? We are looking at a fairly small sample of paddlers in comparison to the majority of RAE research and it is important to consider whether the reversal of a RAE would withhold in a bigger sample. Including TID athletes within this sample also poses some thought due to the nature of their selection into the sport.

If we take this at face value, then it could be assumed that selection of athletes based on physical characteristics alone might be undermining the development in the system. Relatively older athletes are not developing the necessary psychological characteristics as they can rely solely on their physical

advantage when they are younger. It would also imply that relatively younger athletes only succeeding if they are able to "survive" the system. This has implications for selection at younger ages – what is it that are used as markers for selection? Is it just physical characteristics alone or are there other things that are considered?

To explore this further, we are going to undertake a RAE analysis with the younger/ development athletes and then a full sample of programme athletes to compare against the current findings.

Injury Prevalence

Finding

The results showed that paddlers that made a matrix result experience a greater prevalence of injury/ illness.

Contextual Information and Implications

This result was unexpected and perhaps an indicator of more than just injury/illness prevalence.

If we take this result at face value, it could be that those who qualified a matrix result were taking part in more races and so experience less downtime/ recovery leading to more niggles/ injuries.

However, could this be an indication that these athletes are simply more likely to overreport/ are more diligent with reporting in comparison to those that didn't make a matrix result? It could be that these athletes are more likely to seek help/ support, and therefore they are able to continue performing at higher levels.

Variability of Practice

Finding

The results showed that paddlers that made a matrix result were taking part in an increased amount of variable practice – practice that includes frequent changes of task for example using a variety of different upstream techniques throughout a course.

Contextual Information

Practice that is high in variability creates contextual interference (Battig, 1966) which initially hinders performance but enhances learning and transfer in the long term. Practice that is low in variability (e.g. performing the exact same recirc repeatedly) enhances performance in the short term but does not benefit learning and transfer (Brady, 2004).

Implications

Increased variability could enhance transfer, for example being able to reproduce movements in and react effectively to an unknown environment (like a new course at a race). This could provide an explanation for why the group that made matrix results performed better in these environments.

Anxiety Specific Training

Finding

The results showed that paddlers that made a matrix result took part in a greater amount of anxiety specific training (training where the pressure is like competition) before and after the competition season as well as more races before competition season.

Contextual Information and Implications

Training under conditions of high anxiety has been shown to increase performance under pressure (Oudejans & Pijpers, 2009).

The implication from this would be that training under anxiety conditions could be important for enhancing a paddlers performance during racing. Training with consequences/ a crowd watching/ against other people are some ways to increase this.

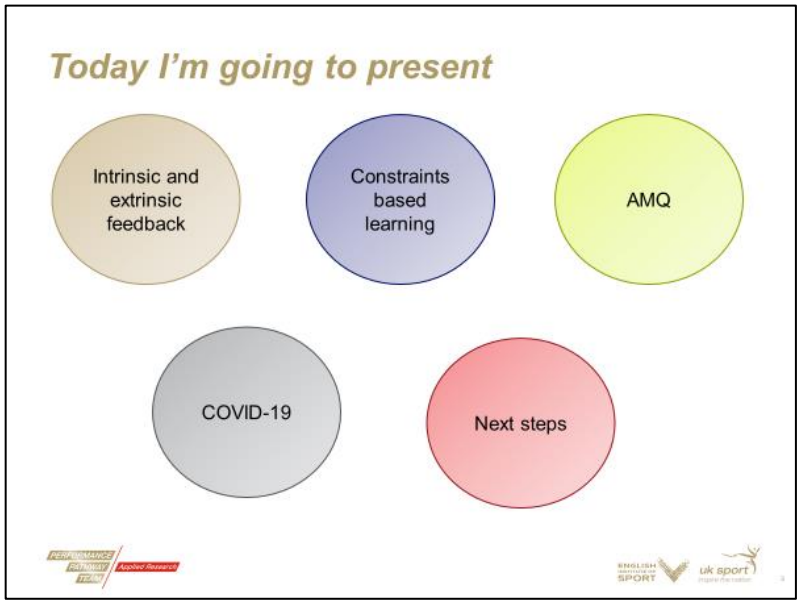
However, conversation with coaches led us to believe it is important to consider individual athletes in this approach. Sometimes it may be important for the athlete to have some training away from a pressure situation to enhance their confidence and enjoyment within the sport.

Next Steps

We plan to continue collecting this data over the coming months to add further value to the vast set of data we have collected so far. Over the summer/ autumn of 2020 we are going to analyse this data set in full, drawing all the data collected together, including comparisons between other sports involved with the P2P project. We further hope to capture some more depth variables by undertaking analysis of psychosocial interviews that have taken place in early 2020. Following this, we will then provide another report and feedback session to disseminate these findings and to explore and get a greater understanding of them in further detail.

7.1.9 Canoe Sprint Individual Coach End of Year Feedback Sessions [April 2020]

I ran three individualised feedback sessions with canoe sprint national coaches after a year of data collection. These sessions were tailored around coach interest and information that would be useful for the development of their athletes. We then went onto discuss the next steps of the project, specifically how we could split the athletes for the machine learning analysis in a way that would be useful and beneficial for the sport. Please see the slides and email feedback outlining the benefit of the project from one of these sessions. Due to the small numbers of athletes included within these sessions, I have not included slides with individual athlete data.



Intrinsic and Extrinsic Feedback

Intrinsic

Physical feel of the movement as it is being performed.

- Feedback comes from the paddler
- Not having feedback
- "What do you think?"
- "Why do you think that happened?"

Extrinsic

Provided by external sources, during or after a performance.

- Feedback from coach
- Given a time at the end of an effort
- Feedback from partner in C2
- Instant video review.

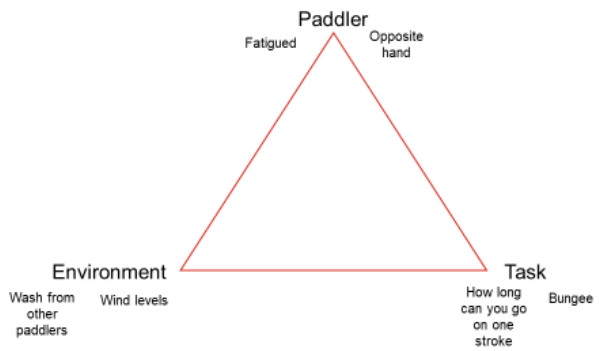
Guidance Hypothesis

Error identification & reduction ✓

Become reliant and ignore intrinsic processing ✗

Bandwidth Feedback

Constraints based learning



Self Determination Theory

Autonomy → *To feel like we have control over what we do.*

Competence → *To understand what is needed to achieve outcomes and feel like you've done a good job.*

Relatedness → *To have meaningful relationships and interactions with other people.*

AMQ

COVID data

+	-
• Long term it is a useful period (particular theme amongst talent transfer athletes).	• Loss of motivation o Lack of competition certainty o Training on own
• Time to work on things that would normally be neglected o Technique o Physical weaknesses	• Accessibility (equipment/ wifi) can sometimes limit opportunities.
• Positive coach attitude rubs off on paddlers.	• Hard only being able to make process goals.
• Enjoying a slower pace.	
• Enjoying doing things that there wouldn't normally be the time to do.	

Hi Vicky
Thank you for the link and thank you both for your time yesterday, the feedback is really appreciated and just adds lots of value to the DYP program. its very positive feedback too, which adds a measure of progression that i wouldn't normally look at, for example seeing the progression in [redacted] intrinsic feedback shows the growth in her mindset and how much she has developed as a person, is very reassuring and rewarding, it reinforces that I am moving her athlete development as a person in the right way not just physically. The holistic growth. It proves that I'm setting the right kind of training learning environment.
The questioning of the types of sessions and the breakdown of what the sessions are and why I'm doing them has also been a really good reflective exercise for me and I have enjoyed that shared self learning with Eleanor. It was also reassuring to hear that I am aligned with the girl's feedback too. More importantly I'm different to the other programs and i like that a lot😂
So about 05;00 this morning i remembered the questioning style that I use, it's called divergent questioning, it offers the chance to explore more than one answer or outcome, and encourages problem solving, working towards more self thinking independent people/athletes.
I was also thinking about what athletes have being doing to train and overcome lockdown blues, and i remembered [redacted] who is another non program C1 paddler who i am also privileged to work with, he built and designed his own ergo style paddle rig, I'm sending via to you El via whats app to share with Vicky, hope you like it he did it with his dad.
very much looking forward to the next catch up cause as you know i can chat about this sort of stuff all day

[redacted]

7.1.10 Canoe Sprint End of Project Feedback Session [February 2021]

I ran an end of year session with national coaches and support staff to disseminate the findings of the pattern recognition analysis following a year of data collection. This session provided lots of opportunity for discussion and identifying the meaning of these findings for the sport. I also repeated this session with a sport psychologist who had been unable to attend and a national coach who wanted to further explore the findings in an individual session. Following the success of this session, I was then invited to present the findings to Home Nations talent staff to look at how we could start implementing these findings further down the pathway. Due to the replication with Chapter 4, I have not included slides from this presentation.

7.1.11 Canoe Sprint End of Project Report [February 2021]

Following the end of project feedback session, I compiled a report summarising the descriptive statistics and pattern recognition analysis undertaken within the sport. Alongside this, the report also contained a context and implications section based upon the discussion of the findings in the end of project feedback session. As before, due to the replication with Chapter 4, I have not included a copy of the full report.

7.1.12 Canoe Slalom End of Project Feedback Session [February 2021]

I ran an end of year session with national coaches and support staff to disseminate the findings of the pattern recognition analysis following a year of data collection. This session provided lots of opportunity for discussion and identifying the meaning of these findings for the sport. Due to similarities with the end of year feedback session, I have not included slides from this presentation.

7.1.13 Canoe Slalom End of Project Report [May 2021]

Following the end of project feedback session, I compiled a report and one-page infographic summarising the descriptive statistics and pattern recognition analysis undertaken within the sport. Alongside this, the report also contained a context and implications section based upon the discussion of the findings in the end of project feedback session. The report mainly encompasses information from Chapter 5 and replication from the end of year report. For this reason, to avoid replication I have included the infographic but not the full report.

PATHWAY TO PODIUM REPORT
CANOE SLALOM

PERFORMANCE PATHWAY TEAM

DATA COLLECTION: JANUARY 2019 – JANUARY 2021

Psychosocial
Life, personality, behaviours, experiences towards sport

Practice & Training
Training & competition history. Experiences before and during pathway

Health and Wellbeing
To monitor, injury, illness, training load, stress during pathway

ATHLETE DESCRIPTORS

PADDLERS

6 FEMALE
2 MALE

3 X TID Athletes

HOMEPLACE

5 | 2 | 1

BIRTH QUARTILE

Jan - Mar
Apr - Jun
Jul - Sep
Oct - Dec

Relatively younger athletes can be disadvantaged due to later maturation resulting in significant challenge for them to progress in the sport.

Canoe Experience

10	AGE STARTED (YRS)
12	AGE SPECIALISED (YRS)
4	D4 – PREM (YRS)
17	Funded (YRS)

Key Findings

Below we present key findings from the **descriptive data, pattern recognition,** and **life story interviews** alongside reporting **practical recommendations** based upon the full set of results. For a more detailed examination of these results please see the remainder of this report.

EARLY DEVELOPMENT (6-12 YEARS)

On average athletes reported participation in a large proportion of **deliberate play** as well as participating in **multiple sports** during early development.

Athletes came from families where **participation in sport was inherent to family life.**

Deliberate play is enjoyable, unstructured, gratifying activity. Time spent in **deliberate play** between 6-12 years can reduce **burnout** and drop out from sport during adolescence.

Participating in **multiple sports** during early development can increase **emotional, cognitive, and motor skills.**

BENEFICIAL DEVELOPMENTAL CHALLENGES

Athletes were often underdogs and regularly exposed to other athletes of a higher competitive level.

Experiencing **adversity** (e.g., not being selected for a squad or being dropped from funding) increased athlete **motivation** and an **understanding of what was needed to achieve.**

Funded athletes took part in more races. Increased participation in competition situations increases performance under pressure (Lawrence et al., 2014).

PRACTICAL RECOMMENDATIONS

Early Environment

Increase participation in races and competitions.

Train under conditions of anxiety (e.g. timed runs and competitive sessions).

Emphasis upon mental preparation for training and competition.

Encourage a dual mastery and outcome focus.

Challenge

Incorporate challenge into the pathway (e.g., training with more advanced athletes and competing at a higher level) alongside...

Coping Mechanisms

Social support.

Psychological coping skills.

Mental preparation (e.g. goal-setting and self-talk).

Significant Moments

Opportunity to meet sporting "heroes".

Positive competition performances.

Strong coach-athlete relationships.

7.2 Reflections

Whilst perhaps the most daunting part of the project for me, providing feedback to the sports was in some sense the most valuable part and a key reason for why those involved maintained their participation. The first feedback session was really successful and enjoyed by all involved. I'm unsure if this was just because it was the best presentation I had ever given (the bar was quite low by this point!) or down to the great involvement of the canoe slalom coaches and practitioners. I think probably a bit of both. I repeated a very similar session with canoe sprint coaches, and whilst the engagement was just as good, I did not feel the session was as successful. I put this down to the interactive parts of the session relying on coaches knowing all the athletes' personalities well which was not the case for this cohort. However, this session was a positive step for me as no supervisors had been able to attend and so I had to be confident in delivering this session without having someone step in if there were difficult questions that needed answering! Following on from this session I acknowledged that the nature of training groups was different among the canoe sprint athletes compared to slalom and that tailoring sessions for coaches individually would be more beneficial than presenting group results. This meant that throughout the course of the project I had less coach engagement in feedback sessions (as not all coaches wanted them) however beneficial, influential, and worthwhile sessions with those who did. I had one particular coach within canoe sprint who couldn't wait to have their feedback sessions. I really enjoyed doing these sessions due the enthusiasm that they brought to them. As I went on to do more group feedback sessions (within canoe slalom), the novelty wore off and engagement was slightly lower than it had been at the start. I think this was down to replication of the information during the sessions as I presented similar findings as we had yet to run any additional analysis. Doing this was partly down to requirements from stakeholders who were keen for there to always be the opportunity for feedback sessions to enhance sport engagement. I took these learnings into canoe sprint and instead of presenting lots of findings regularly I gave them snippets of small information less regularly before doing a big feedback session at the end with the key findings.

Sharing feedback did have an influence on data collection due to the somewhat sensitive nature of the data we were collecting. To enhance adherence and provide a benefit to the sport, the AMQ data was shared in the form of feedback reports to both coaches, athletes, and practitioners (and parents when the athlete was under 18). The questions on the AMQ required athletes to be honest about their physical and mental wellbeing and despite strong relationships with their coaches, having this data shared with myself and in report form may have made them uncomfortable. Observations from the coaches was that when an athlete was showing signs of low mental wellbeing (e.g., lack of sleep or mood) this was not always reflected in what they reported on the AMQ. Going forward it seems important to speak with athletes about what would enable them to

answer truthfully and accurately instead of taking the same approach for everyone. It might be that an athlete is offered the opportunity to "opt in" to each practitioner individually viewing their data rather than yes or no to everyone. Furthermore, whilst participants had given their permission for data to be shared (and so ethical requirements were met), it may have been difficult for a young athlete to explicitly state that they did not want their data to be shared to someone in a perceived position of authority. In the future I would ensure that participants are given additional ways to "opt out" and ask for their data not to be shared so that they did not feel like there was any additional pressure. Additionally, the nature of how data was shared was not always explicitly stated. For example, participants were made aware that their data could be shared individually with coaches and that if they preferred this could be done in group form only, however, they were not told how this data would be presented (e.g., scores on a chart compared to discussion of personality traits). This was partly down to being unsure myself as to what the nature of feedback sessions would look like. As I spent more time in the project, I became more aware of this and how important it was to the athletes to understand explicitly how their data was being used. When I came to undertaking the psychosocial interview, I fed back the results / reports to the athletes to ensure they were happy with how their data would be shared before I presented this to any coaches. I think this is a key step going forward to provide autonomy for the athletes and build a greater level of trust between athlete and researcher.

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Appendix A

Summary of Countries in Relative Age Effect Analysis

Table A1

Summary of Countries in Relative Age Effect Analysis

Country	Number of Gymnasts						
	International Elite Gymnasts			Apparatus Specialists			
	Full Sample	Seniors	Juniors	Vault	Uneven Bars	Beam	Floor
Algeria	4	2	1	0	0	0	0
Argentina	9	6	1	0	0	0	0
Armenia	1	0	0	0	0	0	0
Australia	18	12	1	0	2	1	2
Austria	12	8	0	0	0	2	0
Azerbaijan	6	3	0	1	0	0	1
Bahamas	2	0	0	0	0	0	0
Belarus	10	4	3	1	1	0	0
Belgium	21	8	6	0	2	4	4
Bolivia	3	2	0	0	0	0	0
Brazil	12	9	1	2	0	2	4
Bulgaria	7	6	0	0	0	0	0
Canada	32	15	2	3	0	4	2
Cayman Islands	2	1	0	0	0	0	0
Chile	3	3	0	0	0	0	0
China	27	19	6	4	9	14	7
Chinese Taipei	8	8	0	0	0	0	0
Colombia	9	8	0	0	0	0	1
Costa Rica	5	4	1	0	0	0	0
Croatia	5	3	0	1	0	0	0
Cuba	3	2	0	0	0	0	0
Cyprus	3	2	0	0	0	0	0
Czech Republic	12	8	0	1	1	0	0
Denmark	10	5	1	0	0	0	0
Dominican Republic	1	1	0	1	0	0	0
Ecuador	1	1	0	0	0	0	0
Egypt	7	5	1	0	0	0	0
Finland	10	7	2	0	0	0	0
France	25	11	4	4	7	8	6
Georgia	3	2	0	0	0	0	0
Germany	22	17	2	5	6	3	3

Country	Number of Gymnasts						
	International Elite Gymnasts			Apparatus Specialists			
	Full Sample	Seniors	Juniors	Vault	Uneven Bars	Beam	Floor
Great Britain	37	16	5	6	7	6	9
Greece	8	5	1	0	0	2	0
Guatemala	3	2	1	0	0	0	0
Honduras	1	0	0	0	0	0	0
Hong Kong	3	3	0	0	0	0	0
Hungary	15	7	1	7	1	1	1
Iceland	12	8	2	0	0	0	0
India	3	3	0	1	0	0	0
Indonesia	3	3	0	0	0	0	0
Ireland	7	3	2	0	0	0	0
Israel	5	5	0	2	0	1	0
Italy	34	20	2	6	6	5	6
Jamaica	1	1	0	0	0	0	0
Japan	21	19	0	1	3	3	2
Kazakhstan	5	5	0	0	0	0	0
Latvia	8	6	1	0	0	0	0
Lithuania	3	2	1	0	0	0	0
Luxembourg	2	0	0	0	0	0	0
Malaysia	5	4	0	0	0	0	0
Malta	2	1	0	0	0	0	0
Mexico	14	9	2	2	0	0	0
Monaco	1	0	0	0	0	0	0
Mongolia	1	0	0	0	0	0	0
Morocco	2	0	0	0	0	0	0
Namibia	3	0	0	0	0	0	0
Netherlands	19	13	3	4	4	3	4
New Zealand	11	7	0	0	0	0	0
North Korea	11	6	0	3	0	1	0
Norway	9	8	1	0	0	0	0
Panama	2	0	0	0	0	0	0
Peru	3	2	0	0	0	0	0
Philippines	2	1	0	0	0	0	0
Poland	8	5	0	1	0	2	1
Portugal	7	6	0	0	0	0	0
Puerto Rico	4	2	1	0	0	0	0
Qatar	1	1	0	0	0	0	0
Romania	25	11	5	5	3	12	11
Russia	34	23	7	14	15	17	14
Serbia	4	4	0	0	0	0	0
Singapore	8	5	1	0	0	0	0
Slovakia	8	7	1	0	0	0	0

Country	Number of Gymnasts						
	International Elite Gymnasts			Apparatus Specialists			
	Full Sample	Seniors	Juniors	Vault	Uneven Bars	Beam	Floor
Slovenia	8	7	1	1	0	0	0
South Africa	9	7	1	0	0	0	0
South Korea	13	11	1	2	0	0	0
Spain	15	10	3	0	2	1	4
Sri Lanka	13	0	1	0	0	0	0
Sweden	9	4	1	0	2	0	1
Switzerland	14	11	0	2	0	4	1
Syria	1	1	0	0	0	0	0
Trinidad and Tobago	2	0	0	0	0	0	0
Turkey	7	6	1	0	0	0	0
Ukraine	9	7	1	2	8	9	5
United States	56	15	9	6	12	12	15
Uruguay	1	0	0	0	0	0	0
Uzbekistan	5	2	1	1	0	0	1
Venezuela	4	2	0	0	10	0	0
Vietnam	6	4	1	1	0	0	0

Appendix B

Athlete Psychosocial Survey Constructs and Definitions

Table B1

Athlete Psychosocial Survey Items and Origins

Construct	Item Origin	Items	Existing Scale for Validation
		Life Experiences	
Environment of Expectation and Achievement	Items generated by authors	1. My family were high achievers. 2. My family expected me to achieve high standards.	Mastery subscale of the Work and Family Orientation Scale (WOFO; Helmreich & Spence, 1978)[a].
Strong Work ethic	Items generated by authors	1. My family worked hard to achieve things that are important to them. 2. My family were very hard working.	Work Orientation subscale of the Work and Family Orientation Scale (WOFO; Helmreich & Spence, 1978) [a].
Highly Competitive Environment	Items generated by authors	1. People in my family competed against one and other a lot of the time. 2. My family members were very competitive with each other.	Competitiveness subscale of the Work and Family Orientation Scale (WOFO; Helmreich & Spence, 1978) [a].
Outcome Focus	Items generated by authors.	1. My family expected me to beat other people. 2. My family expected me to outperform my opponents.	Ego subscale of the Perception of Success Questionnaire (Roberts et al., 1998) [b].
Mastery Focus	Items generated by authors	1. My family expected me to perform to the best of my ability. 2. My family expected me to show clear personal improvements.	Task subscale of the Perception of Success Questionnaire (Roberts et al., 1998) [b].

Construct	Item Origin	Items	Existing Scale for Validation
Career Turning Point	Items generated by authors	1. I experienced a moment within my sport that inspired me. 2. Finding sport was a turning point in my life.	*n/a*
Positive Critical Sporting Event	Items generated by authors	1. I have experienced a significant event that made me more determined to succeed in my sport. 2. I have experienced a significant turning point in my sporting career that enhanced my focus.	*n/a*
Attachment Style	Items taken from The Relationship Questionnaire (Bartholomew & Horowitz, 1991)	A. It is easy for me to become emotionally close to others. I am comfortable depending on them and having them depend on me. I don't worry about being along or having others not accept me. B. I am uncomfortable getting close to others. I want emotionally close relationships, but I find it difficult to trust others completely, or to depend on them. I worry that I will be hurt if I allow myself to become to close to others. C. I want to be completely emotionally intimate with others, but I often find that others are reluctant to get as close as I would like. I am uncomfortable being without close relationships, but I sometimes worry that others don't value me as much as I value them.	

Construct	Item Origin	Items	Existing Scale for Validation
		D. I am comfortable without close emotional relationships. It is very important for me to feel independent and self-sufficient, and I prefer not to depend on others or have others depend on me. After reading each of the statements above (A-D) please circle the letter corresponding to the statement that best describes you.	
		Personality	
Difficulty with Emotional Expression	Items taken from Emotion Regulation subscale of the Between Participating scale of the Sensation Seeking, Emotion Regulation and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013).	1. I am often emotional without understanding why. 2. People tell me to describe my feelings more.	Emotion Regulation subscale of the Before Participating scale of the Sensation Seeking, Emotion Regulation and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013)[c].
Counterphobic Attitude	Emotion Regulation and Agency subscales of the Whilst Participating scale of the Sensation Seeking, Emotion Regulation	1. I am drawn to things I am afraid of. *2.* I love how nervous competition makes me feel.	Emotion Regulation and Agency subscales of the Whilst Participating scale of the Sensation Seeking, Emotion Regulation and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013)[c].

Construct	Item Origin	Items	Existing Scale for Validation
	and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013)		
Need to Avoid Failure	Items generated by authors.	1. In sport, failure is not an option for me. 2. In competition, just the idea of not winning fills me with dread.	Performance Failure Appraisal Inventory Short Form (PFAI; Conroy, Willow, & Metzler, 2002)[d].
Need to Succeed	Items generated by authors.	1. I am driven by a need to succeed in my sport. 2. Succeeding in my sport is the only thing that matters to me.	Achievement subscale of the Manifest Needs Questionnaire (MNQ; Steers & Braunstein, 1976)[e].
Ruthlessness	Items generated by authors	1. I am willing to be disliked if it means being able to achieve my targets in sport. 2. When it comes to sport, I am ruthless when I need to be.	Machiavellianism subscale of the Dirty Dozen Questionnaire (Jonason & Webster, 2010)[f].
Selfishness	Items generated by authors.	1. In sport, I put my own interests before that interests of others. 2. When it comes to sport, you have to be selfish.	Dark Triad from the Dirty Dozen Questionnaire (Jonason & Webster, 2010)[f].
Perfectionistic Concerns	Items taken from the Multidimensional Inventory of Perfectionism in Sport (Stoeber et al., 2006).	1. During training, I get completely furious if I make mistakes. 2. During training, I get frustrated if I do not fulfil my high expectations. 3. During competition, I get completely furious if I make mistakes. 4. During competition, I get frustrated if I do not fulfil my high expectations.	Negative Reactions to Imperfection Subscale of the Multidimensional Inventory of Perfectionism in Sport (Stoeber et al., 2006)[g].

Construct	Item Origin	Items	Existing Scale for Validation
Perfectionistic Strivings	Items taken from the Sport Multidimensional Perfectionism Scale 2 (Gotwals & Dunn, 2009).	1. I feel that other athletes generally accept lower standards for themselves in sport than I do. 2. I have extremely high goals for myself in sport.	Striving for Perfection subscale of the Multidimensional Inventory of Perfectionism in Sport (Stoeber et al., 2006)[g].
Socially Prescribed Perfectionism	Items taken from the Multidimensional Perfectionism Scale (Hewitt & Flett, 1991).	1. Others criticise everything I do not do perfectly. 2. Others expect my performance to be perfect.	Short version of the Multidimensional Perfectionism Scale (Cox et al., 2002)[h].
Obsessiveness	Items generated by authors.	1. I cannot live without my sport. *2.* I have an almost obsessive feeling for my sport	Obsessive Passion subscale of the Passion Scale (Vallerand et al., 2003)[i].
Extraversion	Items taken from the Ten Item Personality Inventory (Gosling et al., 2003).	1. I see myself as: extraverted, enthusiastic. 2. I see myself as: reserved, quiet.	
Agreeableness	Items taken from the Ten Item Personality Inventory (Gosling et al., 2003).	1. I see myself as critical, quarrelsome. 2. I see myself as: sympathetic, warm.	
Conscientiousness	Items taken from the Ten Item Personality Inventory (Gosling et al., 2003).	1. I see myself as: dependable, self-disciplined. 2. I see myself as: disorganised, careless.	

Construct	Item Origin	Items	Existing Scale for Validation
Emotional Stability	Items taken from the Ten Item Personality Inventory (Gosling et al., 2003).	1. I see myself as: anxious, easily upset. 2. I see myself as: calm, emotionally stable.	
Open to New Experiences	Items taken from the Ten Item Personality Inventory (Gosling et al., 2003).	1. I see myself as: open to new experiences, complex. 2. I see myself as: conventional, uncreative.	
Grandiose Narcissism	Items taken from the 16 item Narcissistic Personality Inventory (Ames et al., 2006).	1. I think I am a special person. 2. I like having authority over people.	16 item Narcissistic Personality Inventory (Ames et al., 2006)[j].
Vulnerable Narcissism	Items taken from the Hyper-Sensitive Narcissism Scale 10 (Hendin & Cheek, 1997)	1. I am secretly "put out" or annoyed when other people come to me with their troubles, asking for my time and sympathy. 2. I often interpret the remarks of others in a personal way.	The Hyper-Sensitive Narcissism Scale 10 (Hendin & Cheek, 1997)[k].
Empathic Thinking	Items taken from the Adult Autism Spectrum Quotient (Baron-Cohen et al., 2001).	1. I frequently find that I don't know how to keep a conversation going. 2. I find it easy to work out what someone is thinking or feeling just by looking at their face.	The Adult Autism Spectrum Quotient (Baron-Cohen et al., 2001)[l].
Systematic Feeling	Items taken from the Adult Autism Spectrum Quotient	1. It does not upset me if my daily routine is disturbed. 2. I notice patterns in things all the time.	The Adult Autism Spectrum Quotient (Baron-Cohen et al., 2001)[l].

Construct	Item Origin	Items	Existing Scale for Validation
	(Baron-Cohen et al., 2001).		
Psychopathy	Items taken from the Self-Report Psychopathy Scale (Levenson et al., 1995).	1. In today's world, I feel justified in doing anything I can get away with to succeed. 2. I tell other people what they want to hear so that they will do what I want them to do.	The Self- Report Psychopathy Scale (Levenson et al., 1995)[m].
		Training Behaviours	
Outcome Focus	Items generated by authors.	1. When doing sport, I feel successful when I beat other people. 2. When doing sport, I feel successful when I outperform my opponents.	Ego subscale of the Perception of Success Questionnaire (Roberts et al., 1998)[b].
Mastery Focus	Items generated by authors.	1. When doing sport, I feel successful when I perform to the best of my ability. 2. When doing sport, I feel successful when I show clear personal improvements.	Task subscale of the Perception of Success Questionnaire (Roberts et al., 1998)[b].
Total Preparation for Competition	Items generated by authors.	1. I leave no stone unturned in preparation for competition. 2. I go beyond the norm to prepare for competition.	The List of Behavioural Items for Self-Regulated Swim Training (Young & Starkes, 2006)[n].
Commitment to Training	Items generated by authors.	1. I always produce a high-quality training session. 2. No matter what is going on in my life, I still turn in a good training session.	Quality of Training Inventory (Woodman, Zourbanos, et al., 2010)[o].

Construct	Item Origin	Items	Existing Scale for Validation
Relative Importance of Sport	Items generated by authors.	1. My sport is the most important thing in my life. 2. My sport offers me more than anything else in life (e.g. friends, family, relationships, money).	Inclusion of Others in the Self Scale (Aron et al., 1992)[p].

Note. [a =] 5-point Likert Scale anchored "Strongly Agree", "Slightly Agree", "Neither Agree nor Disagree", "Slightly Agree", "Strongly Disagree". [b] = 5-point Likert Scale anchored "Strongly Agree", "Neutral", "Strongly Disagree". [c] = 1 - 7 Likert Scale with 1 anchored "completely disagree" and 7 "completely agree". [d] = 2 to +2 Likert scale with -2 anchored "Do Not Believe at All", 0 anchored "Believe 50% of the Time" and +2 anchored "Believe 100% of the Time". [e] = 1-7- Likert Scale anchored "always", "almost always", "usually", "sometimes", "seldom", "almost never", "never". [f] = 1-9 Likert Scale with 1 anchored "strongly disagree" and 9 "strongly agree". [g] = 1-6 Likert scale anchored "never", "rarely", "sometimes", "often", "mostly", "always". [h] = 1-7 Likert scale with 1 anchored "disagree" and 7 "agree". [i] = 1-7 Likert scale with 1 anchored "do not agree at all" and 7 anchored "completely agree". [j] = place an x by the statement. [k] = 1-5 Likert Scale anchored "very uncharacteristic or untrue, strongly disagree", "uncharacteristic", "neutral", "characteristic" and "very characteristic or true, strongly agree". [l] = 4-point Likert Scale anchored "definitely agree", "slightly agree", "slightly disagree", and "definitely disagree." [m] = 1-4 Likert Scale with 1 anchored "false" and 4 anchored "true". [m] = 4-point Likert Scale anchored "disagree strongly", "disagree somewhat", "agree somewhat", and "agree strongly." [n] = We placed this on a 5-point Likert scale anchored "Strongly agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree" and "Strongly disagree." [o] = 7-point Likert scale anchored "Strongly Agree", "Agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree", "Disagree", and "Strongly disagree". [p] = Seven Venn Diagrams ranging from no overlap to majority overlap.

Grandiose narcissism, vulnerable narcissism, empathic thinking, systematic thinking, and psychopathy were not validated within this study. Attachment Style, Extraversion, agreeableness, conscientiousness, emotional stability and open to new experiences items are already validated.

Athlete Psychosocial Survey Construct Definitions

Agreeableness (Gosling et al., 2003): Being kind, cooperative and, considerate.

Career Turning Point (Hardy et al., 2017): Experience of a career turning point resulting in an increase in motivation, focus or determination to succeed.

Commitment to Training (Hardy et al., 2017): Investing significant effort into attending and completing training sessions.

Conscientiousness (Gosling et al., 2003): Being careful and diligent with a desire to complete tasks to a high standard.

Counterphobic Attitude (Hardy et al., 2017): Thriving on or being drawn to intense emotions elicited in high-level competition.

Difficulty with Emotional Expression (Barlow et al., 2013): Experiencing difficulty with understanding and describing emotions.

Dismissing Attachment Style Rating (Bartholomew & Horowitz, 1991): Positive view of the self with a negative view of others.

Emotional Stability (Gosling et al., 2003): Being able to remain stable and balanced when dealing with challenging situations and handling adversity.

Empathic Thinking (Baron-Cohen et al., 2001): Understanding and responding to another individual's mental state.

Environment of Expectation and Achievement (Hardy et al., 2017): Exposed to an aspirational environment, or culture of achievement, during developmental years.

Extraversion (Gosling et al., 2003): Enjoying human interactions and obtaining gratitude from outside of oneself.

Fearful Attachment Style Rating (Bartholomew & Horowitz, 1991): Negative view of the self with a negative view of others.

Grandiose Narcissism (Ames et al., 2006): Grandiose sense of self-importance and desire for admiration.

Highly Competitive Environment (Hardy et al., 2017): Being exposed to a highly competitive environment in sport and or other family life from a young age.

Mastery Focus (Hardy et al., 2017): Setting goals where performance is judged by a self-reference or objective standard.

Mastery Focused Environment (Hardy et al., 2017): A family value of mastery.

Need to Avoid Failure (Hardy et al., 2017): A deep-seated desire not to lose.

Need to Succeed (Hardy et al., 2017): A deep-seated desire to win/ succeed.

Obsessiveness (Hardy et al., 2017): An extreme internal pressure to engage in certain activities or behaviours.

Open to New Experiences (Gosling et al., 2003): Being open minded and open to new things.

Outcome Focus (Hardy et al., 2017): Setting goals where performance is judged by winning or performing better than other people.

Outcome Focused Environment (Hardy et al., 2017): A family value of an outcome focus.

Perfectionistic Concerns (Stoeber et al., 2006): An overly critical evaluation of one's self over mistakes.

Perfectionistic Strivings (Stoeber et al., 2006): Holding oneself to high standards and striving for perfection.

Positive Critical Life Event (Hardy et al., 2017): "Finding" one's sport, "finding" a significant (sporting) other or experiencing an inspirational (sporting) moment.

Preoccupied Attachment Style Rating (Bartholomew & Horowitz, 1991): Negative view of the self with a positive view of others.

Psychopathy traits (Levenson et al., 1995): Continuous antisocial behaviour, impulsiveness, lack of empathy and remorse.

Relative Importance of Sport (Hardy et al., 2017): "Finding" one's sport, "finding" a significant (sporting) other or experiencing an inspirational (sporting) moment.

Ruthlessness (Hardy et al., 2017): Willingness to be disliked in an attempt to achieve targets in sport.

Selfishness (Hardy et al., 2017): Willingness to put oneself first in an attempt to achieve targets in sport.

Secure Attachment Style Rating (Bartholomew & Horowitz, 1991): Positive view of the self with a positive view of others.

Socially Prescribed Perfectionism (Cox et al., 2002): A belief that others expect perfection.

Strong Work Ethic (Hardy et al., 2017): Being exposed to a strong work ethic from a young age.

Systematic Thinking (Baron-Cohen et al., 2001): A drive towards analysing and constructing systems.

Total Preparation for Competition (Hardy et al., 2017): Perception that one could not have done any more to be better prepared for high pressure competition.

Vulnerable Narcissism (Hendin & Cheek, 1997): Presents as defensive, avoidant and hypersensitive to criticism.

Appendix C

Full Length Questionnaire Utilised in the Preliminary Validation of the Athlete Psychosocial Survey

Life Experiences

Family Values

To better understand the validity of our items detailing the three dimensions of culture of striving (environment of expectation and achievement, strong work ethic and highly competitive environment) we administered three subscales (mastery, work orientation and competitiveness) from the Work and Family Orientation Questionnaire (WOFO; Helmreich & Spence, 1978) a questionnaire that more specifically assesses general achievement orientation. The authors of the questionnaire identified mastery as striving towards excellence e.g. "*I prefer to work in situations that require a high level of skill";* work orientation as positive attitudes towards work e.g. "*I find satisfaction in working as well as I can";* and competitiveness as the desire to surpass others e.g. *"I enjoy working in situations involving competition with others"*. We felt that these subscales accurately reflected the constructs we were trying to measure and so were appropriate for validation purposes. Number of items in each subscale is written in parenthesis. Mastery (8) was used to validate expectation of achievement (6), work orientation (6) for strong work ethic and competitiveness (5) to validate highly competitive environment. The preceding statement in this questionnaire was altered from "I" to "My family" to ensure family values and not individual values were measured. Items were scored on a 5-point Likert Scale anchored "Strongly Agree", "Slightly Agree", "Neither Agree nor Disagree", "Slightly Agree", "Strongly Disagree".

Outcome and Mastery Focus

Mastery focus and outcome focus in the life experiences section were validated using both subscales of the 12-item Perception of Success Questionnaire (POSQ; Roberts, Treasure, & Balague, 1998). The questionnaire measures two goal orientations from The Achievement Goal Theory (Nicholls, 1984); task and ego orientation. Task orientation refers to an individual evaluating success in terms of personal improvement and mastery (e.g., *When playing sport, I feel most successful when… I reach personal goals)*. Ego orientation on the other hand refers to the evaluation of success in comparison to others (e.g., *When playing sport, I feel most successful when… I show other people I am the best).* Mastery focus was

validated in conjunction with task orientation as like mastery focus it reflected the demonstration of mastery (Nicholls, 1984).

Outcome focus was validated via the ego subscale as both emphasise the demonstration of normative ability in comparison to others (Nicholls, 1984). Like with the WOFO the preceding statement in this questionnaire was altered from "When playing sport, I feel most successful when:" to "My family consider me most successful when:". This was done to reflect family, as opposed to, individual values as well as a non-domain specific focus. Items were scored on a 5-point Likert Scale anchored "Strongly Agree", "Neutral", "Strongly Disagree".

The POSQ was also used in the athlete behaviours section to validate mastery and outcome focus behaviours. For this the preceding statement was not altered as we wanted to identify the athlete's perception.

Personality

Need to Succeed

To examine the validity of our need to succeed items we utilised the Manifest Needs Questionnaire (MNQ; Steers & Braunstein, 1976). The MNQ is a questionnaire based on Murray's (1938) Need Theory and is used to measure the four needs of: achievement, affiliation, autonomy, and dominance within a work setting. We used the achievement subscale (e.g., *I try very hard to improve on my past performances at work*) as we felt that the characteristics of achievement best reflected a need for achievement or success. Need for achievement has been defined as "a desire to accomplish something difficult; to overcome obstacles and attain a high standard; to excel oneself; to rival and surpass others" (Murray, 1938) which taps into the components within our need to succeed construct. Items were scored on a 1-7- Likert Scale anchored "always", "almost always", "usually", "sometimes", "seldom", "almost never", "never".

Counterphobic Attitude and Difficulty with Emotional Expression

To examine our counterphobic attitude and difficulty with emotional expression items we used the Sensation Seeking, Emotion Regulation and Agency Scale (SEAS; Barlow, Woodman, & Hardy, 2013). To validate counterphobic attitude we utilised the emotion regulation (*e.g., The emotions I experience are more intense than in other areas of my life)* and agency (e.g., *If a difficult situation arises I feel able to deal with it)* subscales of the

whilst participating scale. Whilst to date there is not a published measure of counterphobic attitude, (Barlow, 2012)confirmed the three-factor structure of the SEAS scale over the three time points of between, during and after participating in an activity. The items in this subscale reflected the athletes ability to experience emotion regulation whilst participating in their sport (Barlow et al., 2013). We anticipated that this would be like the experiences of someone with a high counterphobic attitude who seeks out the high pressure sporting environments that allow them to regulate their emotions (Hardy et al., 2017). Items were scored on a 1 - 7 Likert Scale with 1 anchored “completely disagree” and 7 “completely agree”.

To validate difficulty with emotional expression we used the emotion regulation subscale of the between participating scale (e.g., *I can’t work out which emotion I am experiencing).* Emotion regulation refers to how we experience and express emotions(James J Gross, 2002). Gross (2002) explained that one component of emotion regulation was that of emotional expression. The emotion regulation subscale of the SEAS measures whether someone would struggle to regulate emotions between participating in their main activity. We expected that someone scoring high on this would also score high on our construct of difficulty with emotional expression. Items were scored on a 1 - 7 Likert Scale with 1 anchored “completely disagree” and 7 “completely agree”.

Ruthlessness and Selfishness

We used the 12-item Dirty Dozen Questionnaire (Jonason & Webster, 2010) to validate the constructs of selfishness and ruthlessness. The Dirty Dozen Questionnaire is a concise measure of the Dark Triad (Paulhus & Williams, 2002): narcissism (*e.g., I tend to want others to admire me)*, psychopathy (*e.g., I tend to lack remorse)* and Machiavellianism (e.g., *I tend to manipulate others to get my way)*. Selfishness was validated against the full questionnaire as the three components of the Dark Triad combined correlate with traits that are consistent with a selfish social strategy (Jonason et al., 2010). Ruthlessness was validated against the Machiavellianism scale of the Dirty Dozen (four items) as one of the characteristics identified as making up Machiavellian behaviour is ruthlessness (Zettler & Solga, 2013). Items were scored on a 1-9 Likert Scale with 1 anchored “strongly disagree” and 9 “strongly agree”.

Perfectionism

The two dimensions of perfectionistic strivings and perfectionistic concerns were validated against two subscales from the MIPS (Stoeber et al., 2006). Perfectionistic strivings were validated against the 16 item Perfectionistic Aspiration subscale (e.g., *During training/ competition I feel the need to be perfect)* and perfectionistic concerns were validated against the 16 item Negative Reaction to Imperfection subscale (e.g., *During training/ competition I feel extremely stressed if everything doesn't go perfectly).* Research has shown that these two subscales are valid and reliable measures of the two separate perfectionism dimensions (Madigan, 2016). Items were scored on a 1-6 Likert scale anchored "never", "rarely", "sometimes", "often", "mostly", "always".

We validated the socially prescribed perfectionism items against the socially prescribed perfectionism subscale of the Multidimensional Perfectionism Scale (MPS; Hewitt & Flett, 1991) e.g. *"People expect nothing less than perfection from me".* We used the short version of this questionnaire developed by Cox et al. (2002) which has been shown to perform well in relation to its longer counterpart (Stoeber, 2018). Items were scored on a 1-7 Likert scale with 1 anchored "disagree" and 7 "agree".

Obsessiveness

To validate our construct of obsessiveness we used the obsessive passion subscale (eight items) from the Passion Scale (Vallerand et al., 2003; e.g., *I have difficulty imagining my life without this activity).* Vallerand et al. (2003) described obsessive passion as when the individual cannot help but take part in an activity that they are passionate about, and so related well to our construct of obsessiveness. Items were scored on a 1-7 Likert scale with 1 anchored "do not agree at all" and 7 anchored "completely agree".

Need to Avoid Failure

To understand the validity of our need to avoid failure construct we administered the Performance Failure Appraisal Inventory (PFAI; Conroy et al., 2002). We used the short form (five items) of this inventory that measured a general fear of failure (e.g., *When I am failing… I am afraid that I might not have enough talent).* The PFAI is based on a multidimensional model that considers fear of failure from a cognitive-motivational-relational perspective (Lazarus, 1991). We utilised this inventory as it ensured that we considered the multiple aversive consequences associated with failure (Conroy, 2001). Items

were scored on a -2 to +2 Likert scale with -2 anchored “Do Not Believe at All”, 0 anchored “Believe 50% of the Time” and +2 anchored “Believe 100% of the Time”.

Narcissism

To understand the validity of our grandiose narcissism construct we administered the 16 item Narcissistic Personality Inventory (NPI-16; Ames et al., 2006). The NPI-16 consists of 8 corresponding narcissistic and non-narcissistic responses (e.g., *I know that I am good because everybody keeps telling me so)* and *When people compliment me, I sometimes get embarrassed).* The participants scored the statements by choosing the statement that was most like themselves.

To understand the validity of our vulnerable narcissism construct we administered the Hypersensitive Narcissism Scale (HSNS; Hendin & Cheek, 1997) e.g. *“My feelings are easily hurt by ridicule or the slighting remarks of others.”*. The HSNS is a measure of hypersensitive or vulnerable narcissism which is based on Murray's (1938) conception of narcissism as someone that is both self-absorbed and vulnerable. It is scored on a 1-5 Likert Scale anchored “very uncharacteristic or untrue, strongly disagree”, “uncharacteristic”, “neutral”, “characteristic” and “very characteristic or true, strongly agree”.

Autistic Spectrum Disorder

To understand the validity of our autistic spectrum disorder (ASD) empathic thinking and systematic feeling constructs we administered the Adult Autism Spectrum Quotient (AQ; Baron-Cohen et al., 2001) e.g. *“I prefer to do things the same way over and over again.”* We felt that the AQ would be an appropriate measure of both dimensions of ASD as it is successfully predicted by the Empathy Quotient (Baron-Cohen & Wheelwright, 2004) and Systemising Quotient (Baron-Cohen et al., 2003) which measure both of the constructs respectively. It is measured on a 4-point Likert Scale anchored “definitely agree”, “slightly agree”, “slightly disagree”, and “definitely disagree.”

Psychopathy

To explore the validity of our of psychopathy construct we administered the Self-Report Psychopathy Scale (Levenson et al., 1995) e.g. *“I often admire a really clever scam.”* Items were scored on a 4-point Likert Scale anchored “disagree strongly”, “disagree somewhat”, “agree somewhat”, and “agree strongly.”

Behaviours

Total Preparation for Competition

We validated our total preparation for competition items using the List of Behavioural Items for Self-Regulated Swim Training (Young & Starkes, 2006) identifying self-regulated training behaviours in swimmers. Self-regulation refers to how an individual will guide their actions in pursuit of their goals (Kirschenbaum, 1984) and so it could be assumed that an athlete scoring high in self-regulated training behaviours will also score high on their total preparation for competition. We added a preceding statement e.g. "I am" or "I have" and altered the statements so that they were not sport specific (e.g., *I am focused and deliberate in correction drills).* We placed this on a 5-point Likert scale anchored "Strongly agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree" and "Strongly disagree."

Commitment to Training

We validated our commitment to training items against the Quality of Training Inventory (QTI; Woodman et al., 2010). The QTI is made up of three subscales: distractibility (e.g., *I am easily distracted by other people in training),* quality of preparation (e.g., *I have a competition plan that covers all eventualities),* and coping with adversity (e.g., *When my training session isn't going well, I try to overcome the problem).* These reflect training behaviours like commitment to training and so was considered suitable to use. Items were scored on a 7-point Likert scale anchored "Strongly Agree", "Agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree", "Disagree", and "Strongly disagree".

Relative Importance of Sport

To validate the relative importance of sport items we used the Inclusion of Other in the Self Scale (IOS; Aron et al., 1992). The IOS is a pictorial measure comprised of Venn Diagrams with over lapping circles labelled self and other; the level of overlap represents an individual's sense of interconnectedness and perception of a relationship. There is no measurement of relative importance of sport to date however we felt that this scale would enable us to assess the relationship between life and sport and consequently give an indication of relative importance. The labels on the circles were changed to "Life" and "Sport to make this specific to the relationship with sport. To score this measure participants were

presented with seven Venn Diagrams ranging from no overlap to majority overlap and selected the one that best described the relationship between their life and sport.

Appendix D

Cronbach's Alpha Coefficients

Table D1

Cronbach's Alpha Coefficients of Life Experiences Constructs

Variable	Study	EEA	SWE	HCE	Outcome Focus	Mastery Focus
EEA	1	.31				
	2	.35				
SWE	1		.68			
	2		.74			
HCE	1			.86		
	2			.82		
Outcome Focus	1				.68	
	2				.89	
Mastery Focus	1					.50
	2					.45

Note. EEA = Environment of Expectation and Achievement. SWE = Strong Work Ethic. HCE = Highly Competitive Environment.

Table D2

Cronbach's Alpha Coefficients of Personality Constructs

Variable	Study	Difficulty with Emotional Expression	Counterphobic Attitude	Need to Succeed	Need to Avoid Failure	Ruthlessness	Selfishness	Perfectionistic Concerns	Perfectionistic Strivings	Socially Prescribed Perfectionism	Obsessiveness
Difficult with emotional expression	1	.20									
	2	.11									
Counterphobic attitude	1		.46								
	2		.55								
Need to succeed	1			.68							
	2			.48							
Need to avoid failure	1				.37						
	2				.42						
Ruthlessness	1					.73					
	2					.72					
Selfishness	1						.56				
	2						.73				
Perfectionistic concerns	1							.59			
	2							.84			
Perfectionistic strivings	1								.55		
	2								.61		
Socially prescribed perfectionism	1									.67	
	2									.50	
Obsessiveness	1										.64
	2										.66

Table D3

Cronbach's Alpha Coefficients of Athlete Behaviour Constructs

Variable	Study	Outcome Focus	Mastery Focus	Total Preparation for Competition	Commitment to Training	Relative Importance of Sport
Outcome Focus	1	.90				
	2	.83				
Mastery Focus	1		.70			
	2		.60			
Total Preparation for Competition	1			.83		
	2			.66		
Commitment to Training	1				.84	
	2				.69	
Relative Importance of Sport	1					.82
	2					.43

Appendix E

Practice and Training Interview Schedule

Retrospective Practice Activities in Canoe Sprint

This interview is designed to provide information about your long-term involvement in canoe sprint plus background information about your developmental sporting history. It consists of four major sections. The first section focuses on demographic and family information. The second section deals with your general participation in sporting activities. Thirdly, I ask about developmental milestones and performance indicators in canoe sprint throughout your development. The first three sections will be a lot of number collecting, so please do bear with me for the first thirty minutes. The final section centres on your specific practice activities and time commitment to different aspects of your canoe sprint training. This is where I'll be asking about the bulk detail of your practice, and I'll try to keep us both on track in the early stages so that it moves smoothly and I don't take up more of your time than is necessary.

1. Demographic and Family Information

Personal Details

<Section 1 – Demographic Family>

Homeplace Throughout Development

I'll now be listing some ages to you, starting with 6 up to today.

2. Please could you tell me (from earliest to most recent) all the places where you have lived and indicate for each the approximate dates/years you were at each place?

2b. For each place you lived indicate if it was your family home and if your home location was considered rural, small town, small city, or large city.

[NB: If you were living away from home for a portion of the year at boarding school etc. please note this in the next question rather than this one.]

<Table 1.1: Places you lived>

Education Throughout Development

3. Similarly, please could you list to me (from earliest to most recent – by age again) all the schools/colleges/universities you have attended and indicate for each the approximate dates/years you attended them.

3b. We also ask you to tell us if the place you went to school was a "designated" sport school and if it was the principal place where you practiced sport.

<Table 1.2: Places you went to school>

2. Activities throughout the Lifespan

Involvement in Sports

REPEAT THIS ACCORDING TO SPORT… ACROSS THEN DOWN

In this next section, we would like to focus on sports that you were involved in throughout your development – this includes all sports that were either led or not led by an adult. Firstly, I'd like you to look back over your entire life and list any type of sporting activity that you engaged in on *a regular basis* from the earliest point you can remember. Please list to me ALL the sports you participated in starting as early as age 6, but please stop at the point in which you entered the UK Sport World Class Programme (WCP).

<Table 2: Involvement in Sport, interviewer fill in the first column, "sports">

4. I would now like you to tell me ages from when you started playing the sport to ages where you stopped. You may have stopped temporarily, in which case please also tell me when you restarted.
(Interviewer place an "X" in any of the boxes corresponding to ages that interviewee was NOT involved in the sport listed). For example, if the interviewee mentioned football, but only played from age 6 to 12, put X's in boxes corresponding to ages 13-22. Do this for each sport listed.

<Table 2, put an X for each age that interviewee was NOT involved in the listed sports>

4a. Now, considering that canoe sprint is your primary sport, I'd like you to tell me which two sports were your other 'major' or 'significant' ones.

*<Table 2, put an * to identify the two major/significant sports>*

O.K., for the rest of this section we are going to focus on Canoe Sprint. Firstly, starting from when you began doing canoe sprint at age __

4b. Can you define when the (1) race season, and (2) off season were up until the time point in which you entered the UK Sport WCP. *It is important that you tell me when these changed during the different ages as you progressed in your development, as we go through this in due course.*

< Table 2 Fill in time of period for canoe slalom>

4c) Now can you recall a typical month for your canoe sprint involvement at this age and tell me the number of hours you were engaged in canoe sprint practice across the (1) race season and (2) the off season periods that we just defined.

Please bear in mind that practice in this case is outside of competitive races and does not include s+c/fitness work. Practice could mean any of the following; individual practice without a coach, individual practice with a coach, team practice without a coach, team practice with a coach, plus any other type of canoe slalom practice that you may have experienced.

< Table 2 Fill in practice hours/week for X sport listed>

4d. Now, still at age __, I'd like you to tell me the number of hours of structured canoe sprint competition you engaged in during a typical month at (1) preseason, (2) midseason and (3) the off season.

< Table 2 Fill hours in competitive races for Canoe Slalom>

Question – Deliberate Practice vs. Deliberate Play (All Sports)

< Table 2.1 >

Before we move onto the next section, I have a more general question about your participation in all of these sports you have mentioned (as a whole).

Between the ages of 6 and 12, firstly, I'd like you to consider the amount of time in that typical week that consisted of practice activities that were effortful, focused, goal directed, and not necessarily inheritably enjoyable (deliberate practice).

Now, I'd also like you to consider the amount of time that consisted of practice activities that were fun, voluntary, developmentally free from specific focus, and provided immediate gratification (deliberate play).

5. Now please split the proportion of time (in percentage) of your typical week between these two practice types for when you were between 6 and 12 years of age.

< Table 2.1 Fill proportion of Deliberate Play and Practice between ages 6 and 12 >

5b. Please can you also split the proportion of time (in percentage) again between these two practice types (deliberate play and deliberate practice), but now for when you were between the ages of 13 and 15?

< Table 2.1 Fill proportion of Deliberate Play and Practice between ages 13 and 15 >

3. Developmental Milestones, Performance Indicators and Maturation in Canoe Sprint

<Table 3 - Performance at different ages>
DO ACROSS THEN DOWN

In this section of the questionnaire, I would like you to focus specifically on your development in canoe slalom. I would like to get a sense of your development in canoe slalom before the time point in which you entered the World Class Programme (WCP). I am going to be asking you questions about before you joined the pathway, which will aim to measure your level of performance and challenges faced as you developed as a canoer at this developmental stage.

6. Firstly, prior to joining the pathway, could you please tell me what age you were when you were <u>first</u> selected to the following squads. There may be some that do not apply to you, in which case just let me know:

- ➔ Club
- ➔ Regional Talent Academy
- ➔ England Super Regional Squad
- ➔ England National Talent Squad
- ➔ England Performance Squad

<Fill in Age First Selected in Table 3>

7. **Now would you be able to let me know the age you were when you first represented that team/ squad. If this does not apply please let me know.**

<Fill in Age First Represented in Table 3>

8. **And what level it was that you were racing at?**

<Fill in Level in Table 3>

9. **Now would you be able to let me know the *highest* level you raced at whilst on this squad?**
<Fill in Highest Level Represented in Table 3>

10. **And what age were you when you represented this level?**

<Fill in Age in Table 3>

11. **And finally, what age group were you racing in?**

<Fill in Age Group in Table 3>

I would now like to ask you about the technical challenge of playing at this level when you were first selected at age __. E.g.. With this and other skills in mind, please think about to what extent did your outcome match your intention i.e. how successful were you in completing the technical skill tasks?

12. Then please rate how technically challenging was it for you at this level?

To do this, please rate challenge from 1 – 10, with 1 being the easiest rating and 10 being the most challenging rating.
(Interviewer lists individual canoe slalom age groups the interviewees had previously reported playing in and simultaneously reports the level of challenge noted for each age group in table 3).

<Fill in Technical Challenge *in Table 3*>

I would now like to ask you about the psychological challenge of playing at this level when you were first selected at age x. E.g. worrying about not getting a certain time on a race or concern about being beaten by other canoeists who may perform better than you.

13. Then please rate how psychologically challenging this was. To do this, please rate challenge from 1 – 10, with 1 being the easiest rating and 10 being the most challenging rating.
(Interviewer lists representation level and age selected)

<Fill in Psychological Challenge *in Table 3*>

Next, I would like to ask you about your ability compared to your peers at each canoe sprint representation level.

14. Specifically, in your opinion, at what age did you become one of the best paddlers on your team at U… age group for … representation level?
(Interviewer lists the necessary age groups/levels and then reports the age stated by the interviewee for each age group/level in table 3).

<Fill in one of best player *in Table 3*>

15. Similarly, I would now like you to tell me in your opinion, the age at which you became the best paddler on your team at U… age group for … representation level?
(Interviewer lists the necessary age groups/levels and then reports the age stated by the interviewee for each age group/level in table 3).

<Fill in best player in Table 3>

16. Please tell me your age it took before you achieved your first noteworthy/significant positive performance at this age group.

This could be related to an individual milestone or your contribution to the team at a significant period, and is completely open to your interpretation…Some examples might include: making a P.B. on a specific course, winning an important competition. (*Interviewer reports significant moment detailed for the specified age group/level of canoe slalom in table 3, interview recording will also be used to collate what perceptions of early significant performance are categorized as).*

<Fill in first significant performance columns *in Table 3*>

17. I would now like you to tell me about your physical size in comparison to your team mates at this particular age group. Please tell me if you were of greater physical size (G), smaller (S) or equal (E) to your team mates/canoe sprint peers when initially selected onto this team.

<Interviewer records the responses related to physical size in Table 3>.

18.Based on your perception of what good vs poor facilities looked like during your development, please tell me whether the facilities which you practiced with at the U… age group for … representation level of canoe sprint were poor (P), below average (BA), adequate (A), good (G), very good (VG) or excellent (E).
(*Interviewer lists the canoe sprint levels associated with the age groups relevant to the interviewee and then reports interviewee's perceptions of facilities in table 3).*

20. Based on your perception of good and poor practice, I would like you to tell me about the quality of coaching you received from your principal coach (most contact time) at the U… age group for … representation level of canoe sprint. Please rate this as poor (P), below average (BA), adequate (A), good (G), very good (VG) or excellent (E). (*Interviewer lists the canoe sprint levels associated with the age groups relevant to the interviewee and then reports interviewee's perceptions of coach competency in table 3)*

<Fill in coach competency in Table 3>

21. Lastly, for this milestone, I would like to explore the development time (in months) that you missed as a paddler due to prevalence of injuries prior to joining the pathway.

Please note that these can be cumulative, therefore feel free to take some time to think about this. Prior to joining the pathway, if you never had an injury, please rate fitness at 100%. *If you did suffer an injury try to rate the percentage of full fitness for me (i.e. completely unable to practice or compete in this time would receive a rating of 0, missing half the time would receive a rating of 50% and so on…).*

(Interviewer reports prevalence of injury for each in table 3 and records nature of injury)

<Fill in Injuries in Table 3>

Milestones/Obstacles

22. Finally, for this section, I would like get a sense of your development in canoe sprint by assessing diffe
milestones that you may have achieved together with different obstacles you may have overcome. For each of
questions I ask, please tell me the age at which the specific event occurred for you. If the event did not occur t
please tell me so.

1. **How old were you when you specialized in paddling/ canoeing in general (i.e., when all of your t spent playing sports became devoted to canoe)?**

2. **How old were you when you specialised in your current sport/discipline(e.g. canoe sprint)?**

3. **How old were you when you first moved (relocated) to attend regular canoe sprint training?**

4. **Were you ever taken out of a regional talent academy? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

5. **Were you ever taken out of the England Super Regional Squad? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

6. **Were you ever taken out of the England National Talent Squad? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

7. **Were you ever taken out of the England Performance Squad? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

8. **Did you ever get dropped from a Podium Potential Squad? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

9. **Did you ever get dropped from a Podium Squad? If so how old were you? How old were you when you got reselected? Did this ever get repeated? When?**

<Fill in Obstacles and Milestones in Section 3.1>

4. Practice Activities in Canoe Sprint

What follows is a section in which we want to trace your involvement in the different types of practice possibilities during your canoe sprint development. The following section includes segments for the related practice activities you engaged in, the proportion of time spent practicing per week, the intensity of practice, and the nature of practice activities. Specifically, we will be focusing on a typical week's canoe sprint activity in the year before you entered the WCP.

Firstly, let's start with the age when you were doing canoe sprint in the year before you entered the WCP. If I refer to your responses in section 2 of this interview (refer to table 2 and look for where the most hours of practice are listed for Canoe Sprint prior to joining the pathway; pre, or race?), I can see that at age __ you stated that most hours on practice were in the …….season.

Practice

So, I'd like you to consider the rest of this section in line with a typical week's practice at that point of the season a year before you joined the pathway, which may include any of the following:

- Individual practice **without** a coach

- Individual practice **with** a coach
- Team practice **without** a coach
- Team practice **with** a coach
- Plus any other type of canoe slalom practice that you may have experienced

Number of hours

1. **With the practice outlined above…Please tell me how many hours you practiced canoe sprint in a typical week:**

i) Within UK Sport performance pathway
ii) Outside UK Sport performance pathway (e.g. local club).
iii) Which is your main club?

< Interviewer records number of hours training in and outside UK Sport in Table 4.1>

Deliberate Play vs. Deliberate Practice
<Table 4.1a>

Thinking about all of the practice you have completed in a typical week at age X in X season, I'd now like you to consider the amount of time that consisted of:

Deliberate practice: practice activities that were effortful, focused, goal directed, and not necessarily inheritably enjoyable. (Skills and drills within a boat e.g. 1,2,3 pause, 4 by 4 power strokes)

Now, I'd also like you to consider the amount of time that consisted of practice activities that were:

Deliberate play: fun, voluntary, developmentally free from specific focus, and provided immediate gratification. (Canoeing with friends, trying to stand up/ turn around in your boat, hand races)

2. **Now please split the proportion of time (in percentage) of your canoe sprint training in a typical week, between these two practice types.**

< Interviewer records % proportion split, total 100% in Table 4.1a>

Strength & Conditioning

3. **Still thinking about a typical week, how many hours would you spend on specific physical strength & conditioning training? This could also include any specific fitness sessions you did during your canoe sprint training, or any of the other sports you may have been playing.**

<Interviewer records number of hours of strength & conditioning in Table 4.1b>

Non-physical practice hours per week breakdown

4. **O.k., now still considering a typical week, please could you tell me how many hours you engaged in mental skills training practice (e.g., visualisation skills, working out pre-performance routines, relaxation or concentration techniques, familiarisation with the landmarks etc).**

4b. I would now like you to recall how many hours during the typical week you engaged in learning through watching canoe sprint (e.g., watching canoe sprint on T.V. or Instagram, watching other canoe sprint practice and/or races)

< Table 4.1c Interviewer subsequently records mental skills training hours >

Individualised practice

5. **Typically, in a typical week, as a whole, how much of your practice (%) was individualised for you (by the coaching staff)?**

< Interviewer records % of individualised training in Table 4.1d >

Technical challenge (Execution) and Tactical challenge (Decision making)

Skilled-based practice can aim to improve both technical and tactical skills. Technical practice aims to improve the execution of skills for example how well you can use power strokes etc... Whereas tactical practice aims to improve decision making skills, for example, 'what' to do in certain situations, when to change your stroke intensity etc..?

6. **With these and other examples in mind, in a typical week, what proportion of time (%) was technical practice and tactical practice?**

< Interviewer records % of technical and tactical practice in Table 4.1e >
(Note: this includes both in and outside UK Sport practice)

Technical challenge

Still thinking about skilled-based practice in a typical week for technical challenge, to what extent did your outcome match your intention i.e. how successful were you in completing the technical skill tasks?

6b. Please rate using 1-10, with 1 being that your outcome would match your intention all of the time and 10 meaning that your outcome never matched your intention.

< Interviewer records rating of technical challenge in Table 4.1e >

Tactical challenge

For tactical challenge we'll go for a rating of 1-10, with 1 being where you had to make no decisions, meaning that the level you had to think was non-existent (extremely easy) and 10 being

where you had to make lots of decisions, meaning that the level you had to think was maximal (extremely challenging).

6c. In a typical week overall how challenging did you find tactical practice?

< Interviewer records rating of tactical challenge in challenge in Table 4.1e >

STRUCTURING PRACTICE

I'm interested in your practice structure and I've got a grid here that I'd like to go through with you. If we are going to run over our allotted time, it's going to be because of this section, so I'm going to try and keep it as tight as possible. We need to start by putting percentages on this line here, and them in each of these boxes, all relating to your skill-based practice sessions and I'll guide us through this.

Part/Whole

I'm interested in finding out about the proportion of time you spent:

(a) Practicing a skill as a whole movement
(b) Practicing a skill in different parts

So let's go back to the start, to times during skill-based practice where you'd be practicing a skill as a whole movement for example a whole stroke cycle

7. **What percentage of the time (%) would skill practice have looked like this in a typical week?**
8. **What percentage of the time (%) would you have practiced parts of the whole skill for example paddling on an ergo not the water, practicing only balance in the water, focussing only on power or paddling on just one side of the boat when in a crew boat.**

9. **Can you give some examples of what the different parts were**

10. **And which ones did you do in a typical week**

Constant/Varied
(REMEMBER INTENTION NOT OUTCOME)

11. Of the time where you have reported __ % as:

(a) Practicing skills in parts - ___

12a. What percentage of the time (%) would this practice have involved you intentionally practicing where there was the same intensity of stroke rate, the courses was a similar length, your speed stayed the same, you used the same types of boat handling/ techniques/ skills and the resistance was kept the same(and so was fairly consistent). Compared to times where the stroke intensity and course length/distance was varied, and the speed changed, the types of boat handling/ techniques/ skills changed and the resistance changed (and so quite varied)?

(b) * *IF APPLICABLE* * To 'this' bit of your skills practice in between, - __

12b. What percentage of the time (%) would this practice have involved you intentionally practicing where there was the same intensity of stroke rate, the courses was a similar length, your speed stayed the same, you used the same types of boat handling/ techniques/ skills and the resistance was kept the same(and so was fairly consistent). Compared to times where the stroke intensity and course length/distance was varied, and the speed changed, the types of boat handling/ techniques/ skills changed and the resistance changed (and so quite varied)?

How Varied is Varied?

Where you have stated that you intended that aspects of your canoeing to be varied for periods (meaning that there was a different stroke intensity, a different distance and speed, different types of boat handling/ techniques/ skills, and different resistance)…

13a. To what extent did each of these 5 aspects vary when practicing in the part condition?
13b. To what extent did each of these 5 aspects vary when practicing in the whole condition?

Difficulty (Contextual interference challenge)

14. **Please think about these practice types we have just run through and tell me, in a typical week, to what extent did you find each of these practice types challenging? Please rate challenge between 1-10.**

Where:
1= Extremely easy
10= Maximally challenging

< *Interviewer completes FIGURE 1* >

SPECIFICITY AND DIFFICULTY OF PRACTICE

Context Specificity:

I would now like you to rethink about what practice was like in a typical week prior to joining the pathway in X season. I would like you to consider whether practice environments were similar to the competition environment. Examples are situations where practice environments mirror competition closely, that is, creating scenarios that were likely to occur in competition (e.g. hit a race pace or intensity, replicate the relevant stroke rate/ speed/ start transition, starting in a starting bucket etc..). Then perhaps the technical aspects of practice would involve gaining experience against equally technically skilled opponents. Or perhaps you train in a place with a similar climate to what you are

going to experience at competition. Please also try to recall situations where these examples might have happened 'accidentally', for example (in a typical) you may have been practicing with more than one club (outside of the UK Sport performance pathway) and thus been exposed to different levelled technical opponent, or perhaps you trained on the same course as competition.

15a. Based on the types of examples just spoken about, what proportion of your practice (%) was similar to competition in a typical week? (0% = never; 100% = all the time).

< Table 4.1f fill in Context Specificity >

Context Specificity Difficulty:

15b. Please can you tell me how difficult (1-10) these sorts of 'race scenario' sessions in a typical week? 1 being that your outcome would match you intention all of the time and 10 meaning that your outcome never matched your intention.

<Interviewer records difficulty on Table 4.1f>

Anxiety & Pressure Specificity (Psychological challenge):

In regards to practice matching competition, in a typical week I would like you to consider what the stress of practice was like in comparison to that of competition. Please pay particular attention to practices where pressure to perform was introduced. Examples of such practice could be the introduction of consequences to performances deemed unsuccessful (e.g., having to redo a course if you did not do it in a certain time or perhaps you will not be selected for the next competition if your performance is poor.) Maybe feeling pressure from having a stopwatch time you or other people watching.

15c. Please tell me what proportion (%) of your practice was set up so that the pressure induced was similar to that of competition (0% = never; 100% = all the time).

< Interviewer records Anxiety specificity proportion in Table 4.1f >

Anxiety Specific Difficulty:

15d. Please can you tell me how difficult this pressured practice was the year before you joined the pathway in X season? 1 being that your outcome would match you intention all of the time and 10 meaning that your outcome never matched your intention.

< Interviewer records Anxiety specificity proportion in Table 4.1f >

Induced psychological challenge

15e. In regards to situations where you practiced in a pressured environment, can you provide me with some details about how pressure was induced?

<Interviewer records this for qualitative analysis in Table 4.1f>

Focus of Attention

O.K., I now want you to spend a little more time thinking about what your typical week was like at X age in X season. I would like you to consider where your focus of attention was during practice. There are two types of situation that I would like you to consider:

1. Situations where you focused on your body (e.g., shoulder follow your hips, bury your little finger in the water, pressure on your feet and your knees)
2. Situations where you focused on the outcome of your movements (e.g., to focus on the angle and the depth of your blade, the movement of the boat etc..)

16. Please can you now tell me how the proportion of time during practice where you focused on your body movements during training, compared to when you focused on the outcome of your movements? (0% = never; 100% = all the time)? *(Interviewer reports frequency on Table 4.1g)*

< Fill FOA prevalence during practice in Table 4.1g >

FOA nature

16a. For both the body and outcome focuses you just told me about, I would now like you to recall whether the majority of that focus was on the separate aspects of a technique/skill (e.g., when you broke the technique down into parts *such as the movement and grip on the oar, how deep you needed to paddle, what angle your canoe is at*) or whether they were more holistic and simply focused on the technique as a whole (*e.g., move smoothly, fast, attack etc….*

(Interviewer records the responses on chat 4.1f; Place a 'p' if interviewee reports that the majority of their focus was on separate or individual aspects of a skill or place an 'h' if the focus was more holistic in nature. In situations where it is 50:50, place an 'e).

< Fill in FOA nature column; P/H/E in Table 4.1g >

Intrinsic/Extrinsic Feedback

Again thinking back to your typical week when you were age x in x season, I would like you to tell me about the opportunities during practice that allowed you to develop your own feedback. For example, instances where you might only be given feedback when you asked your coach/peers for it? Or where your coach/peers asked you to describe what a skill felt like or how you could improve performance before giving you feedback? Maybe you were provided feedback after a period of delay? Maybe you just generated your own feedback a lot of the time…

Compare this with times where your coach would be there providing constant feedback, without allowing delay for you to think about this yourself.

17. **Please tell me what proportion of practice contained these types of feedback activities (i.e., activities where you afforded times to think about your own feedback before being provided it by a coach or peer, or where feedback was purely self-generated), compared to the times where feedback was actively given to you continuously during your practice**

(0% = never; 100% = all the time). *(Interviewer records intrinsic/extrinsic feedback prevalence on Table 4.1g)*

< Table 4.1h Fill in Intrinsic/Extrinsic Feedback >

Constraints/Prescriptive Learning Approaches

For your typical week at X age in season X, I would like to understand how often practice encouraged you to learn skills with a prescriptive coaching approach versus a task based coaching approach. To help you recall this first let's discuss what a prescriptive coaching approach looks like and what a task based coaching approach looks like.

Prescriptive coaching typically involves lots of demonstrations and verbal instructions about how to perform a skill in a technically correct fashion together with lots of feedback and guidance about how to adjust this technique on future attempts.

Task based coaching typically involves creating situations where learners are encouraged/forced to find solutions to scenarios through exploration and discovery. In a little more detail, the scenarios are created by:

1. Manipulating the **task** (such as the conditions imposed by the coach (e.g., taking the gate as a leftie or a rightie, making you use a different boat, paddle into the bank, beach ball example, over distance work)
2. Manipulating the **environment** such as the climate (e.g. a particularly windy day), and the availability of sensory information (i.e., the vision, hearing, or 'feel' of the canoeist or may be playing in a reduced area, or with extra noise or spectator, paddling into a head wind)
3. Manipulating you as an **individual**, perhaps by limiting your movement or skills in which you execute, or may be by inducing pressure and / or fatigue.

In constraints based coaching, when these types of manipulations have been imposed by the coach, or maybe even by yourself, your movements change as a result of these and *not* as a result of the coach 'telling you what and how to do things'.

18. **Now, with your understanding of prescriptive and task based coaching, can you please tell me how much of your practice (%) during your typical week at X age in X season consisted of prescriptive coaching and how much consisted of task based coaching.** There may have been times where practice fell into neither of these categories and coaching was actually non-prescriptive and non-directional meaning you were left to your own devices, where you did NOT set your own task constraints, in which case just let me know.

    < Interviewer fills in proportion of time (%) of coaching approaches in Table 4.1i >

Key Transitional Point
<Excel Sheet>

Finally, I would like you to think about whether there was a key learning experience that took place at any point before you entered the WCP? This is open to your interpretation, but please be as specific as possible- stating why you think this was key.

Appendix F

Coach Psychosocial Survey

You are about to complete a two-part survey that will help us to understand a little more about who you are and what experiences you have had in your life. This survey has been developed by researchers at Bangor University as part of a project with UK Sport, which aims to identify the factors that influence the development of super-elite performance.

The first part of the survey is about your personality and attitudes to your sport, the second section asks about your relationships with other people. Each section contains a series of statements. Please read each statement carefully and then decide the extent to which you agree or disagree with the statement by circling the number that is most relevant (1 if you 'Strongly Disagree' or 5 if you 'Strongly Agree'). Please try to answer the statements as carefully and honestly as possible. You may or may not think that some of the things we are asking about are surprising, sensitive or somewhat private and may be wondering why we are asking them. We are asking these questions in an attempt to gain as complete an understanding of you as possible. The more we know about you the better we can understand the factors that influence athlete progression through the development pathway and the better we are able to support both athletes and coaches.

We take confidentiality very seriously, particularly as we are asking questions about your life to this point. There are no right or wrong answers in the survey and your answers will not affect your position as a coach or your athlete's position in the pathway. None of the information will be passed on without your permission, except in circumstances where you or someone else is at risk. Please speak to a member of the research team about this if you have any questions so we can make sure that only appropriate information is passed on. Just to reiterate, your answers will not affect your position as a coach or your athlete's position in the pathway, the aim is simply to be able to better understand you so that you and your athlete can be supported through the pathway as well as possible.

Personality and Attitude Towards Your Sport

The following questions relate to your personality as well as your attitudes as a coach. For these statements, please think about how well they describe you as a person and your views towards coaching. It is important that you think about how they best describe you *now* and *not* how you would like to be in the future….

	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
1. I love how nervous competition makes me feel					
2. As a coach, failure is not an option for me					
3. As a coach, I am driven by a need to succeed.					
4. I cannot live without coaching.					
5. When coaching during training, I get completely furious if I make mistakes.					
6. When coaching during competition, I get completely furious if I make mistakes.					
7. As a coach, I put my own interests before the interests of others.					
	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
8. I am often emotional without understanding why.					
9. I am drawn to things I am afraid of.					
10. Succeeding as a coach is the only thing that matters to me.					
11. I feel that other coaches generally accept lower standards for themselves in sport than I do.					
12. I have an almost obsessive feeling towards coaching.					
13. When coaching during training, I get frustrated if I do not fulfil my high expectations.					
14. When coaching during competitions, I get frustrated if I do not fulfil my high expectations.					
15. Others criticise everything I do not do perfectly.					
16. In competition, just the idea of not winning fills me with dread.					

17. As a coach, you have to be selfish.					
18. People tell me to describe my feelings more.					
19. I am willing to be disliked if it means being able to achieve my targets as a coach.					
20. Others expect me to be perfect.					
21. I have extremely high goals for myself as a coach.					
22. Something inside me means that I can't help myself from coaching.					
23. When it comes to coaching, I am ruthless when I need to be.					
24. I think I am a special person.					
25. I like having authority over people					
26. I am secretly "put out" or annoyed when other people come to me with their troubles, asking for my time and sympathy.					
27. I often interpret the remarks of others in a personal way.					
28. I frequently find that I don't know how to keep conversations going.					
	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
29. I find it easy to work out what someone is thinking or feeling just by looking at their face.					
30. It does not upset me if my daily routine is disturbed.					
31. I notice patterns in things all the time.					
32. I do not take advantage of people even when it would be good for me.					
33. How much I like someone really depends on how much that person does for me.					
34. In today's world, I feel justified in doing anything I can get away with to succeed.					

35. I tell other people what they want to hear so that they will do what I want them to do.					
36. I see myself as: extraverted, enthusiastic.					
37. I see myself as: critical, quarrelsome.					
38. I see myself as: anxious, easily upset.					
39. I see myself as: open to new experiences, complex.					
40. I see myself as: reserved, quiet.					
41. I see myself as: sympathetic, warm.					
42. I see myself as: calm, emotionally stable.					
43. I see myself as: conventional, uncreative.					
44. I see myself as dependable and self-disciplined.					
45. I see myself as disorganised, careless.					

Relationships with others

In this section, we would like you to read each of the following four statements and decide whether the statement is like you or not, by circling the number which you most agree with (1 = Not at all like me, 7 = Very much like me). Once you have done this for each of the four statements please answer the final question by deciding which of the four statements ***best describes you:***

	Not at all like me			Somewhat like me			Very much like me
A: It is easy for me to become emotionally close to others. I am comfortable depending on them and having them depend on me. I don't worry about being alone or having others not accept me.	1	2	3	4	5	6	7
B: I am uncomfortable getting close to others. I want emotionally close relationships, but I find it difficult to trust others completely, or to depend on them. I worry that I will be hurt if I allow myself to become too close to others.	1	2	3	4	5	6	7
C: I want to be completely emotionally intimate with others, but I often find that others are reluctant to get as close as I would like. I am uncomfortable being without close relationships, but I sometimes worry that others don't value me as much as I value them.	1	2	3	4	5	6	7
D: I am comfortable without close emotional relationships. It is very important to me to feel independent and self-sufficient, and I prefer not to depend on others or have others depend on me.	1	2	3	4	5	6	7

After reading each of the statements above (**A – D**) please circle the letter corresponding to the statement that best describes you.	A	B	C	D

Appendix G

Prospective Athlete Survey

You are about to complete a five-part survey that will help us to understand a little more about who you are and what experiences you have had in your life. This survey has been developed by researchers at Bangor University as part of a project with UK Sport, which aims to identify the factors that influence the development of super-elite performance.

The first part of the survey is about experiences within your sport, the second part asks about the coaches and staff within your sport, the third section asks about any support you may or may not receive, the fourth section asks about your life and the fifth attitudes towards your sport. Each section contains a series of statements. Please read each statement carefully and then decide the extent to which you agree or disagree with the statement by circling the number that is most relevant (1 if you 'Strongly Disagree' or 5 if you 'Strongly Agree'). Please try to answer the statements as carefully and honestly as possible. You may or may not think that some of the things we are asking about are surprising, sensitive or somewhat private and may be wondering why we are asking them. We are asking these questions in an attempt to gain as complete an understanding of you as possible. The more we know about you the better we can understand the factors that influence athlete progression through the development pathway and the better we are able to support you as athletes.

We take confidentiality very seriously, particularly as we are asking questions about your life to this point. There are no right or wrong answers in the survey and your answers will not affect your position in the pathway. None of the information will be passed on without your permission, except in circumstances where you or someone else is at risk. Please speak to a member of the research team about this if you have any questions so we can make sure that only appropriate information is passed on. Just to reiterate, your answers will not affect your position in the pathway, the aim is simply to be able to better understand you so that you can be coached and supported on your development through the pathway as well as possible.

Experiences in your Sport

In this section, we would like to know about your feelings, experiences and behaviours within your sport. Firstly, with your main sport in mind, please respond to the items with regard to your feelings and experiences…

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
1. I am skilled at my sport.					
2. I feel I am good at my sport.					
3. In my sport, I get opportunities to makes decisions.					
4. In my sport, I feel I am doing what I want to be doing.					
5. I choose to participate in my sport willingly.					
6. In my sport, there are people who I can trust.					
7. I have a close relationship with people in my sport.					

Please now indicate how true each statement is as an indication of how you typically think, feel and behave as an athlete…

8. I am able to use my emotions to perform the way I want to.					
9. I consistently overcome adversity.					
10. Even minor setbacks disturb my focus.					
11. I often keep thinking about the mistakes I have made and let this interfere with my performance.					
12. I include imagery in my preparation.					
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
13. When I have to do something that worries me, I imagine how I will overcome anxieties and perform successfully.					
14. I do certain things that are bad for me if they are fun.					
15. I am good at resisting temptation.					
16. When I fail, people are less interested in me.					
17. When I am failing, significant others are often disappointed in me.					
18. I dislike asking people for help and advice.					
19. When faced with a problem there is no one I can ask to help.					
20. I find it hard to push myself to overcome difficulties.					
21. I am able to adapt and change when things aren't going right for me.					
22. I socialise with my teammates much less than I used to.					
23. If something unexpected happens I find it really hard to adapt.					
24. I feel that I have a number of good qualities.					

25. I certainly feel useless at times.					
Now could you please indicate why you generally do things in your sport…					
26. Because it gives me pleasure to learn more about my sport.					
27. Because I find it enjoyable to discover new performance strategies.					
28. Because participating in a sport is an integral part of my life.					
29. Because through sport, I am living in line with my deepest principles.					
30. Because I have chosen this sport as a way to develop myself.					
31. Because I found it is a good way to develop aspects of myself that I value.					
32. Because I would feel bad about myself if I did not take the time to do it.					
33. Because I feel better about myself when I do it.					
34. Because people I care about would be upset with me if I didn't.					
35. Because I think others would disapprove of me if I did not.					
36. I used to have good reasons for doing sports, but now I am asking myself if I should continue.					
37. It is not clear to me anymore; I don't really think my place is in sport.					
Coaches and Staff					
We would now like to ask you about the coaches and other staff involved in your development as an athlete. With this in mind please rate the following statements. The coaches and staff who work with me…					
38. Recognise that different athletes have different needs.					
39. Help team members develop their strengths.					
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
40. Talk enthusiastically.					
41. Talk in a way that makes me believe I can succeed.					
42. Show performers how to look at difficulties from a new angle.					
43. Get me to rethink the way I do things.					
44. Encourages athletes to be team players.					
45. Get the team to work together for the same goal.					
46. Expect us to achieve high standards.					
47. Always expect us to do our best.					
48. Lead by example.					
49. Always set a good example.					

50. Personally praise me when I do outstanding work.					
51. Give me special recognition when I do very good work.					
52. Take into account my individual needs.					
53. Encourage me to take my own initiative.					
54. Give me good advice.					
55. Make it clear to me what I need to do to get results.					
56. Make me feel like I matter to them.					
57. Are concerned about my well-being.					
We would now like to ask you specifically about your main coach. With them in mind please respond to the following statements.					
58. I feel committed to my coach.					
59. I feel that my sport career is promising with my coach.					
60. I like my coach.					
61. I trust my coach.					
62. When I am coached by my coach, I feel responsive to his/her efforts.					
63. When I am coached by my coach, I am ready to do my best.					
64. Sometimes my coach seems indifferent to my needs.					
65. My thoughts and feelings are important to my coach.					
66. My coach dismisses my concerns too easily.					
67. My coach is concerned about me as a person.					
My coach…					
68. Pays close attention to what I do.					
69. Carefully watches me doing the skills and drills.					
70. Encourages me to make suggestions on how I can improve my performance.					
71. Asks my opinion on how I can improve my performance.					
72. Provides support to help attain my goals.					
73. Makes sure I understand what I need to do to improve.					
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
74. Gives me advice on how to improve my skills.					
75. Tells me when I do a particularly good job.					
76. Expresses appreciation when I perform well.					
Support					
In this section we would like to ask you about support that may or may not be available to you as a sportsperson. We are first going to ask you about your social media, with this in mind, Please respond to the following statements…					

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
77. For me, Social Media isn't good for getting any kind of real help or support.					
78. The support I get on Social Media is of practical help to me.					
79. I'm happy when people comment on my posts.					
80. I'm happy when people "Like" my posts.					
81. I get a lot of negative responses on my social media.					
82. It freaks me out if my friend/follower number decreases.					
83. If I need help with something, I could post it on Social Media and I'd get the help I need.					
84. If I needed information about something, I could post it on Social Media and I'd get the help I need.					
Now consider the following statements with your sporting organisation in mind...					
85. The NGB really cares about my well-being.					
86. The NGB cares about my opinions.					
Now please indicate to what extent you have these types of support available to you. If needed, to what extent would someone…					
87. Provide you with comfort and security.					
88. Care for you.					
89. Enhance your self-esteem.					
90. Boost your sense of competence.					
91. Gives you constructive criticism.					
92. Gives you advice on performing in competitive situations.					
93. Help with travel to training and matches/ competitions.					
94. Help with tasks to leave you free to concentrate.					
Your Life					
Here are a series of questions relating to various aspects of our lives. Please respond to the following statements…					
95. In the past 10 years your life has been completely consistent and clear.					
96. Your life in the future will probably be completely consistent and clear.					
97. When you think of the difficulties you are likely to face in important aspects of your life, do you have the feeling that you will always succeed in overcoming difficulties.					

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
98. You very often have feelings that you are not sure you can keep under control?					
99. You very often have the feeling that you do not really care what goes on around you?					
100. Doing the thing you do every day is a source of deep pleasure and satisfaction.					
101. It has never happened to you in the past that you were surprised by the behaviour of people whom you though you knew well.					
102. It has never happened that people whom you counted on disappointed you.					

Appendix H

Variables Collected and Entered into the Multidisciplinary Analysis

Table H1

Variables Collected and Entered into the Multidisciplinary Analysis

Health, wellbeing, and recovery factors	Practice and training factors	Psychosocial factors	Socio-demographics factors
Availability	Age of Specialisation	Early developmental environment	Number of siblings
Fully available to train	In sport	Environment of expectation and achievement	Birth quartile
Reduced availability to train	In discipline	Strong work ethic	Birth order
Unavailable to train		Highly competitive environment	Sex of sibling(s)
Sleep	Sport specific training	Outcome focus	Size of birthplace
Quality	Deliberate practice	Mastery focus	Size of homeplace during development
Hours	Deliberate play	Career turning point	Schooling
Latency	Individualised practice	Positive critical life event	Private
Days napping	Technical practice	Personality	Sport specialist
Nap length	Tactical practice	Counterphobic attitude	Relocated for training
Training	Varied practice	Need to succeed	University student
Hours	Constant practice	Need to avoid failure	
Readiness to train	Part practice	Difficulty with emotion expression	
Perceived recovery	Whole practice	Ruthlessness	
Perceived rating of exertion	Context specificity	Selfishness	
Number of competitions / races	Anxiety specificity	Perfectionistic concerns	

Health, wellbeing, and recovery factors	Practice and training factors	Psychosocial factors	Socio-demographics factors
Perceived stress	Focus of attention	Perfectionistic strivings	
Perceived recovery	Feedback	Socially prescribed perfectionism	
Illness / injury	Nature of instruction	Obsessiveness	
Chronic / acute	Challenge	Grandiose narcissism	
Symptoms	Other training	Vulnerable narcissism	
Area	Strength and conditioning	Empathic feeling	
Effect on performance	Mental skills training	Systematic thinking	
	Vicarious learning	Psychopathic traits	
	Mental fatigue	Extraversion	
		Agreeableness	
		Conscientiousness	
		Emotional stability	
		Open to new experiences	
		Training behaviours	
		Outcome focus	
		Mastery focus	
		Total preparation for competition	
		Commitment to training	
		Relative importance of sport	
		Need preference	
		Autonomy	
		Competence	
		Relatedness	
		Attachment style	
		Secure	
		Dismissive	
		Preoccupied	

Health, wellbeing, and recovery factors	Practice and training factors	Psychosocial factors	Socio-demographics factors
		Fearful Need Satisfaction Autonomy Competence Relatedness Mental toughness Psychosocial characteristics of developing excellence Adverse response to failure Imagery and active preparation Self-directed control and management Perfectionistic tendencies Seeking and using social support Active coping Clinical indicators Self esteem Motivation Intrinsic Integrated Identified Introjected External Amotivated Transformational leadership Individual consideration Inspirational motivation	

Health, wellbeing, and recovery factors	Practice and training factors	Psychosocial factors	Socio-demographics factors
		Intellectual stimulation Acceptance of group goals High performance expectations Appropriate role model Contingent reward Need support Autonomy support Structure Involvement Coach-athlete relationship Commitment Closeness Complementarity Responsiveness Coaching behaviours Observation Effective questioning Goal setting Developmental feedback Motivational feedback Support Organisational support Emotional support Esteem support Informational support Tangible support Sense of coherence Comprehensibility Manageability	

Health, wellbeing, and recovery factors	Practice and training factors	Psychosocial factors	Socio-demographics factors
		Meaningfulness Relationality Dropped from squad Resection for squad	

Appendix I

Psychosocial Interview Schedule

WELCOME:

For this part of the study, I'd like you to speak freely about your journey to reaching your peak in your sport. I have some general and specific questions, but I make no assumptions about you and your sports career/history. People in all walks of life reach elite levels of performance through very different pathways and with very different experiences. In other words, there's really no right or wrong way – certainly, we don't have any consistent evidence of one right or wrong way. I want to know about your story in your own words.

NOTE: *Re-iterate confidentiality and non-disclosures*

Are there any questions you'd like to ask me about this before we proceed?

START OF INTERVIEW

Here, I'd like to find out more about you as a person, what made you, and where your competitive excellence came from. We're interested in your story, everything that might have had an influence, from your early childhood, through juniour development, and on to your competitive peak.

THEMES

Although I'd like you to speak freely, I will make reference to your development as a performer across your early experiences, through to the present. At the same time, I should point out that I have six themes which I want to make sure we address at some point during the interview. You need not worry about those themes – it's my job to make sure each gets covered. I will, however, be placing these six themes out in front of me to help me, and I will be asking some specific questions. Please don't let this distract you. This will help me keep a record, because I'm sure you will be telling me a lot and I want to be sure I don't miss anything. Remember that if there is anything you really don't want to talk about then just say so.

The six themes are:

(1) Critical Developmental Experiences

Some feel it's both the positive *and* negative events in our lives that really shape who we become - some events may have been particularly important.

(2) Relationship with sport

Here I'm getting at what your reasons were for pursuing your sport specifically rather than other sports, what particular aspects of the game did you most enjoy. Additionally, I'm interested in your (a) motivation to train, (b) motivation to compete, (c) motivation to win versus motivation to not lose and (d) motivation to reach the highest level of performance possible.

(3) Pressure Zone and Emotional Regulation

Athletes can experience all sorts of heightened emotions in elite-level sport. We're interested in those aspects here. In competition, some clearly enjoy pressure, whereas others see it as a necessary evil, and some feel compulsively drawn towards it. We make no

assumptions, and there's certainly no evidence to suggest that any one attitude is better than another.

(4) Personality

Here I'm interested in whether some of your personality traits and characteristics have underpinned the sportsperson you became. It used to be assumed, without evidence, that certain traits were "good" and other traits were "bad". Again, I make no assumptions - there is no evidence that any one particular personality trait is better or worse for reaching elite levels in sport. I start from the standpoint that all traits can be helpful and unhelpful

(5) Relationships with family and coaches

Here, I'm interested in your relationships with your family (e.g., parent(s), sibling(s)), as well as with your coaches, mentors, and peers. Additionally, I am interested in your relationship with your teammates throughout your career and whether you fulfilled specific roles within the teams you played for (beyond your playing position, obviously).

(6) Career Turning Points

Here I'm interested in significant events which you feel shaped your career and your aspirations within your sport. Any injuries or illnesses which may have caused setbacks or motivated you further. Any obstacles you overcame and how you went about overcoming them, plus any particularly inspirational experiences you had and how they affected you.

Theme 1: Critical *Developmental* Experiences

Questions/points

Family background

So, let's start right from the beginning. Please speak freely, and I will weave in questions, where appropriate.

Note: Interviewer 2 will observe any disconnect between the emotions displayed and the emotionality of the event being spoken about

Early Family Situation

- Could you start by helping me to get oriented to your early family situation, what your childhood and family background were like? For example, where you were born, whether you moved around much, what your parents did at various times for a living?
- Could you tell me about the earliest childhood memories you can recall?
- Could you tell me a bit more about how things were between your parents during childhood? How did that impact on you?

Family Culture

- What was the culture like within your family? What sort of things were important to you as a family and what values were encouraged by your parents? For example, some families value quality time together above everything else, others encourage hard work and reward achievement, what was this like within your family?
- What did a typical day look like in your family as you were growing up?
- How were disagreements resolved at home? This might be disagreements between your parents, between you and a parent or between you and a sibling?

Relationship with parents (Attachment)

- I wonder if you could tell me to which parent did you feel closest and why? Could you tell me a little bit about why this feeling wasn't the same with your other parent?

- When you were upset as a child who would you go to?
- Were your parents always around, both physically and mentally/emotionally? In previous work we have done, some athletes have commented on having parents who were absent (e.g., working away, emotionally absent), while others have described having two parents who were always available. Did you have any experience of one or more parent being absent at any period in your life? How do you think this might have affected you?
- What is the first time you remember being separated from your parents? How did you respond? Can you remember how your parents responded?
- Are there any other incidents in which you were separated from your parents, which stand out in your mind?

Approach to Parenting

- What was your parents' approach to discipline? For example, some parents are very regimented, whereas others let more or less anything go by. Could you tell me a little about what your parents did in this regard?
- How independent were you encouraged to be as a child? What did this look like?

Relationship with siblings

- Could I just check on the details of your siblings? You have one brother who is older/two younger sisters etc. Is this right?
- Could you tell me whether you experienced sibling rivalry growing up, and if so, what this looked like? For example, how competitive were you when playing games with your siblings, were you equally competitive as each other, how much did you compete for your parent's attention, can you recall occasions when you were jealous of one another?
- How did your parents deal with any sibling rivalry?
- Some people have very "present" parents, whereas others have parents who are far less involved in their lives and sport and allow their children to just get on with them. What was it like for you and your siblings?
- How did your parents go about supporting you and your siblings? Was it the same or different for each sibling??
- How did the relationship between your parents and your sibling(s) compare with your own relationship with your parents?

Relationships with extended family/ other significant relationships

- What were your other relationships with other family members like for example extended family or family friends?
- How important were these relationships to you at the time? What was the impact of these relationships on you growing up?

Impact of family background

- Can you tell me how you think your family background affected your development as a person and sport performer?

NOTE: Some of this may come out earlier in the above so won't need to be replicated here)

- If you were to think through all these times, what would you say most contributed to your achieving your level of success? For example, certain athletes suggest that coming from a specific family background really influenced their desire to succeed in sport. That might be…

NOTE: Prompt if necessary: A perceived under-privileged background, particularly supportive parents/family a single parent family, deaths of significant people or being inspired by the sporting achievements of a parent or older sibling…

Other Childhood Experiences

- Can you tell me about any significant childhood experiences which stand out as being particularly positive?

Prompt: For example: Having a particularly positive experience at school, an inspirational teacher or coach, living in a particular area, access to sport and facilities, etc.

- We've spoken about various aspects of your childhood. Before we move on, I'd like to ask you specifically about certain types of developmental experiences that can link with the desire to participate in certain sports. Some of the experiences we ask about may seem very sensitive and private to you, or you may be unsure as to why we are asking them, as you may not feel they are particularly relevant. We are simply trying to get as comprehensive an understanding of you and your childhood experiences as we can. With this in mind we are interested in whether you ever experienced:
  - Feeling different to others in terms of your physical size (feeling bigger/dominant or smaller/inadequate).

- Feeling different to others in terms of your development (for example, learning difficulties such as dyslexia, finding it difficult to concentrate during classes at school, struggling with school)
- A fear of being physically hurt, threatened with violence or witnessing violence to people close to you
- Being bullied or receiving verbal abuse

  NOTE:

- Feelings of fear and anxiety, for example, some people find everyday life to be a difficult, confusing and overwhelming experience.
- Or anything else that you feel might be relevant.

- If you experienced any of these what, if anything, did you do about them?
  - ***PROMPT***: Could use an example of running away or standing up to bullys here, or something else where we provide a running away/confronting example – such as struggling with school so disengaging vs getting extra help)

- TO what extent, if any, did these experiences influence you??

Initial experiences with sport

We're going to talk about your relationship with your sport later on but I'm just interested in your early experiences of sport in general for now.

- What were your early experiences of sport? What sports did you play and how were you introduced to them?
- What made you take up sport? Can you tell me about the first time you played sport? What did you like or dislike?
- How did your experience of sport as a child compare with that of your siblings'?
- How did your experience of sport as a child compare with your experience of other activities and events at that time?
- How did playing sport make you feel? Can you give me an example of a time when playing sport elicited particularly strong feelings in you?

Transitions from junior, through senior, to reaching your peak.

- What were the major obstacles, if any? For example, non-selection, de-selection, injury, illness, lack of financial support, lack of parental support etc.
- *Note: will likely be important to relate back to things that people have said earlier. It is entirely possible that this question gets dealt with at an earlier stage of the interview so might not need dealing with here (both interviewers to be aware of this)*
- Were there things that might have derailed your progression, but somehow you kept going?
- What mental characteristics or traits do you have, which you feel allowed you keep going and deal with setbacks? How and when did you develop these characteristics/ traits?

Theme 2: Relationship with sport

Questions/points

Significance of your sport

- We're particularly interested in what it is that you like most about your sport
  - Note: some prompts that may be useful, although we must not lead them (teamwork, physicality, physically dominating someone, finding space and being creative, having a routine/being structured, having an important role within a team, being valued, the values of the sport, parental involvement, friendships)
- What is it about your sport in particular that you like, as opposed to other sports?

In the previous athletes we have studied, some have commented that their sport was their entire life, and they pursued it above everything else. However others have commented on being able to integrate their sport into their life so as to be able to perform at a high level yet without it taking over. In the next few questions we are interested in your views on these sorts of issues

- To what extent is/was your sport your entire life? For instance, to what extent (if at all) does/did it come first before other aspects of your life such as:
  - Relationships with loving partners, friends,
  - Nights out, alternate career, money, education, etc.
- How able were to you to integrate your sport into your life?
- Can you give an example of a time when you had to give something up in order to pursue your sport?
- Have you ever put yourself in a comprising position by choosing your sport first? If so could you tell me a little bit about this?
- How do you think others viewed you in regard to your pursuit of your sport? How would they view you now?

The Training Environment

- Could you tell me what your training environment was like at each of the four stages of your development (early exposure, age group, professional, international)? What was similar about the training environment across these stages and what was different?
  Prompt: How supportive was this environment, how much pressure did you experience, was there any rivalry/ internal competition?

- How often were you exposed to training with more advanced players (e.g. better or more seniour players) when you were a juniour? How did you find this opportunity to train with seniours?
- Some athletes describe having high levels of influence over their training environment, others talk about being told what to do, and some talk about a mix between the two. We are not making any assumptions as to what the "best" level of influence is. How much influence over the training environment did you have?
    - Note: If not picked up above: would you say that this influence was consistent across levels or did it change. If it did change could you tell me a bit about the differences across levels?
- What was it about the training environment that you feel worked best for you? Could you tell me a little bit about why you believe this to be the case?
- What was the worst aspect of the training environment? Again can you expand on why? Just so that we fully understand your perspective?
- Some athletes love the structure that being a performer provides (because there is a routine/pattern/habit to training), whereas others do not and prefer to be more flexible. How did/do you feel about this?

Motivation to train

People can be motivated to do things for all types of reasons. Some people do things because they simply enjoy them, others do them because they feel they are important and they want to get better at them, and others need pushing to do things, do things to avoid guilt, or obtain rewards (like winning, wanting to be the best). There is not one right or wrong motivation. Its also possible to be motivated by more than one factor at the same time.

- In regard to training, how would you describe your motivation? Can you provide some examples?
  Prompt: Were you the sort of person who is first to arrive at training or the sort of person who needs to be pushed to train hard? Were you pushed by a coach/s or teammates? How? What did that look like in real terms?

- How intense was your motivation to train? For example, was training something that "could not be missed" or were you more laid back about it
- Some athletes describe themselves as obsessed; others say they were more balanced in their relationship with their sport. Again, there is no right or wrong approach here. How do you relate to these two positions if at all?
- Were you always committed to doing what was necessary to reach the highest level or did something change that led you to become more or less committed? If so, what tipped the balance?
- How was your motivation to train different/similar to your competitive peers? Did you train more/harder than your competitive peers?
- In general, looking back on your career, how would people describe you in relation to training?

Motivation to compete

- As I mentioned earlier, motivation for doing things can be very varied. How would you describe your motivation to compete?
  Prompt: Was the focus on mastering your own performance and/or to win matches? Was one more important to you, or was it both?

- Was your motivation to compete always like this? When you were a child, were you like that with your brother/sister? How fiercely did you need to win?

Experience of winning and losing?

- What was the balance of winning/losing in your career – did you win more or lose more, and how did this shape the athlete you became?
- What was your motivation to compete and how did it change from juniour to seniour competitive years?
- Were there earlier experiences of success and failure that helped to drive you to the levels you attained? If so, could you tell me a little more about them?
- How did you deal with losing? To what extent would you go to, to avoid losing?
- Which had the greatest (emotional) impact on you: winning or losing? How? Can you give me an example?
  PROMPT: winning – feelings of calmness that stay with you for a while, intense excitement/ joy/ happiness. Losing – intense anger/ frustration/ disappointment, no emotion (we lost so nothing to feel/ think about).

- What were your emotions like after competing? Were they the same if you'd won or lost? Some athletes describe a sense that they have dominated or controlled their fear, other athletes describe experiencing feelings of well-being, peace, calmness or an emotional silence: The internal gremlin, voices, doubts etc. are quiet for a period of time. How do you relate to these two positions?

- How would others perceive you and your need/desire to win?

NOTE: Interviewer must be sure to use throughout this theme as a prompt: "You've said xxxxx.

How would other people (e.g., partner, coach, parent, sibling, etc.) describe you?"

Theme 3: Pressure Zone and Emotional Regulation

Questions/points

Type of emotions experienced

- I'd like to ask you a bit about the lead-up to an International match now. Can you talk me through your pre-match preparation, from a few days before, to the start, during, and after the match itself? Can you explain what you were feeling, what you were thinking at that point (e.g., self-doubt, going to toilet, sweating, etc.)?
- Were you anxious before a match? What were you most anxious about?

  Prompt: Losing, looking bad, letting the coach down, physicality of the game (making the first hit, being the subject of the first hit, seriously hurting someone) etc.?
- Did you ever experience intense anxiety before a match? If so, how did you respond to this and did you find it helpful or unhelpful? For example, some people find that anxiety can cause them to choke, or underperform whereas others thrive on it and it can actually help improve their performance? How do you relate to these two positions (you might be closer to one end than the other or maybe somewhere in the middle, you might have experienced both in different situations)?
- You said that you found this anxiety helpful/unhelpful, did this differ depending on the match or situation? If so, could you provide some examples of when you found anxiety to be helpful and when you found it to be unhelpful
- What other emotions did you experience around matches and competition? How did these emotions affect you?

The (emotional) pressure of competition

- Did you enjoy the emotional intensity of competition or did you consider it a 'necessary evil'?
- Athletes often talk about competition in many different ways. For example, some athletes talk about needing to compete, that the intense emotion of competition is like a magnet: which they are compulsively drawn towards, others describe competition more as a desire (something they want to do). For some the emotional pressure of competition is a necessary evil, something they learn to endure. What were your feelings toward competition?

  Prompt: do you feel that competition was more of a need or desire for you? If so, what makes you think that? If you describe both needs and desires was one ever stronger than the other, or were both equally as strong? Can you provide me with some examples?

- If anxious before competing, why do you think you still did it so much? I only ask what seems an odd question, because, generally in life, most people would consider emotions like anxiety to be really unpleasant and do their best to avoid them. Most people if they are afraid of something will move away from it. So if I put a snake on the table a person with a phobia of snakes would move away. However, some people feel compelled to go toward the very thing they are afraid of. So despite being afraid of the snake they'd move toward it – even pick it up – to prove they can master that fear Does that line of thinking resonate with any of your experiences in your sport or everyday life? Can I have an example?

  NOTE: use analogies of tiger trapped in corner, or running away from something, or feeling like you can't move forward or away (frozen to the spot) if needed here to help

- What was your emotional experience pre-match specifically in relation to the physical component of the game?
- What were your feelings towards your opponent, for example some players talk about the desire to get a hit in first on their opposite number others talk about the desire to find space to avoid being tackled? What was your experience of this?

Emotional intensity of competition

- We've talked about competition being an intense emotional experience. Did you find that high level competition was the most emotionally intense experience you have ever had? Is there anything outside your sport that gave you this sort of emotional intensity (e.g., birth of a child, death of a loved one)? It's quite normal to answer yes or no to this sort of question, we make no assumptions here about what is a better answer so please don't worry about providing a response that you think you should.
- How would other people perceive you in this regard?
- In relation to the emotional intensity of competition, was it important for you to get in that place?
  - How alive did you feel when you were competing at a high level? ?

How self-aware do you think you were in those moments? How did that compare with other aspects of your life? What words would you use to describe this experience? ***NOTE:*** Prompt - I ask these questions, because some get lots of emotional experience within loving relationships and would not feel the need to do anything that creates more emotion. Others feel there is something missing / lacking in relationships with other people that they can only get in a setting that provides strong emotions. Where do you sit on this?

Emotional bluntness

Experiencing emotions

- Not having strong emotional responses in sport could be helpful. For example, some people might feel that it would be an advantage not to experience intense emotions before a big game. What was your experience in relation to the intensity of your emotions before a game?
- How connected do you feel to yourself and the world before and during matches and competition?
- Some athletes talk about 'zoning out', detaching themselves, or having an ability to compartmentalise situations in order to be able to deal with them better? Can you relate to this at all and can you give some examples of this in relation to your sport?

Regulating emotions

- Some people do experience intense emotions in high pressure situations but are able to regulate their emotions, for example some rock climbers are able to regulate their feelings of fear, which minimises their physical response to that feeling: their palms don't sweat and their legs don't shake. How able were you to regulate your emotions before a game?
- Where there particular techniques you used to help regulate your emotions or was this something which was just automatic?

Identifying emotions

- Everyone experiences emotions differently. Some people experience very specific/clear and intense emotions that they are able to differentiate between. Others experience a generalised feeling of intense emotion and they can't quite work out exactly what emotion it is. How able were/are you to differentiate between various emotions?

- Are there emotions which you find more difficult to differentiate between? As an example, did you know when/if you ever felt nervous and/or excited? Could you tell the difference between the two?

Expressing emotions

  - How would other people describe you in terms of your emotional expressiveness? (Are they aware that they don't experience the intense emotions of performance the way people might expect them to?)
  - How would you describe your emotional expressiveness in everyday life in comparison to competition? ***PROMPT***: How do you react to good/ bad news, are you able to remain calm about things which others get worked up about for example poor driving, children misbehaving etc.?
- I've been asking you a lot of questions about emotions. Would you say it has been easy to describe these feelings and emotions or not? I say this, because, in a sense we're asking you to describe in words how something really *felt*. It's quite possible that these feelings are not really accessible to conscious thought and words. Is that the case for you? Would you say you find it easy or difficult to talk about emotions?

Coping strategies and Psychological strategies

- Please tell me about any other coping and or psychological strategies you employed when competing?
- Did these coping strategies ever become automatic, or did you consciously have to think about using them? Again, this is no right or wrong answer here, as athletes talk about both approaches. Some athletes also talk about some strategies being automatic and others being consciously employed
- What other psychological strategies have you used?

NOTE: One of the difficulties for some of these athletes may be a difficulty expressing themselves verbally (i.e., they have tended to express themselves with their body). This makes yes/no responses potentially more likely. The interviewer will need to be aware of this and be sure to reflect on (and record) such responses. (Observation of whether there's a mismatch between the emotion they're speaking about and the emotion they're displaying and how emotional they are when talking about emotional events will be important here).

Theme 4: Personality factors

Here we're interested in personality. I want to be clear from the outset that I do not believe any particular personality trait is inherently good or bad. Although society might suggest that some traits are more or less desirable (provide some examples) I do not subscribe to this view. I am of the opinion that every personality trait can be beneficial in certain environments, particularly in high level sport.

As some examples, research with the military suggests that war heroes share some of the same characteristics as people with Autism Spectrum Disorders. There is also lots of evidence that effective leaders have a level of narcissism and psychopathy associated with them that is above average. One study, which specifically looked at US Presidents, suggests that certain 'negative' characteristics are in fact adaptive in certain occupations, including leadership positions. This is important as one is not likely to succeed at the highest levels without feelings of superiourity, being fearless etc.

Questions/points

Potential and natural talent

- Do you think you always had potential and natural talent? Were you simply born to play your sport?
- How easy did you find it reach a good standard in your sport and to win? Did you find it easier than your competitive peers to train and win or was it something to do with your up-bringing?
- Did any of your close or extended family play your sport or other sports? How did your parents feel about you playing your sport?

NOTE: Some of these issues may also have been covered in positive and negative events, and also in relationships. Athletes will need to be carefully guided, as we are likely to touch upon issues that they have not thought about in depth before and possibly never expressed.

- How do you think your friends or fellow performers would describe you?
- How did your school reports, teachers, and coaches typically describe you?

Perfectionism/obsessiveness

- Some people are very laid-back, whereas others are more perfectionist/obsessive – either of these two extremes could be beneficial. To what extent were/are you a perfectionist? Obsessive? Were you always like this?
- Was this perfectionism about you (i.e. was it self-focused) or was it about the team (team level of perfectionism)
- How do you think this may have influenced your career?

Agency

- How much control do you generally feel like you have over the world? (Would you describe yourself as a pawn in a chess game, where external influences largely control what happens, or the chess player, where you are in control of making things happen). Do you feel this is the same in your sport? Did you ever notice any change in how much influence you felt you have/had over things after playing in important games? Can you provide examples?
- How comfortable were you with taking risks during major games? How open were you to new experiences/ideas? How creative do you think you were?
- Were you encouraged to take risks during your sporting career (training, competition)? If so, by whom? Did you take a lead in risk-taking?
- How comfortable were you in taking the lead and influencing others? Were you happy to influence others to benefit yourself (emphasise that this is NOT bad!)

Conscientiousness

- How conscientious were you? Were you always that way?
- What was your level of conscientious in comparison to your competitive peers? What is it that makes you think you were more/less/ similar?

Optimism/attribution

- Were you always optimistic, or sometimes pessimistic? How did (would) people most close to you (coaches, parents, training partners) typically describe you?
- In general, what sort of questions did you ask regarding the high-points and low-points in your life? Do you try to find reasons for things happening? People often have characteristic styles for describing why good and bad things happen. Can you describe the sorts of thought processes that you go through when you win or lose a particularly important game? Have you always looked at things this way?

Openness and agreeableness

- How much did/do you reflect on the things which happen in your life? Is this something you find easy and enjoyable, is this something you do naturally?
- How important is it to you, that the things you do fit with your own values and ideals? Can you give me an example of this in relation to your sport?
- In general how do you respond to rules and authority? How easy do you find it to comply with specific guidelines or instructions?
- How comfortable are you with making demands of other people or imposing your will on to other people and situations? How do you respond when other people impose things on you?

Coachability

- How open were you to different coaching methods and trying new things in training?
- How did you find receiving feedback from coaches? Was this something you found difficult to deal with or did you appreciate getting feedback?
- In general, was the feedback you received from coaches in line with your own views of your performance and abilities? Were there times when you felt coaches either overrated or underrated your performance and/or ability? Can you give me an example?

Narcissism

We've already talked about your emotional response to pressure, such as anxiety however I would like to ask you a bit more about the type of pressure which comes with having a high profile job and performing in front of an audience.

- How do you view this kind of pressure? What are your experiences with this and how did you typically respond to it? How would others describe you in this regard?
- Some people loathe training whereas others love it. Can you tell us how you felt?
- Did/do you like being admired by others?
- Wanting to get recognition for doing things well is normal. Some people might try and get this by performing really well in some situations or being a leader. Others like to be recognised for being a team player/helpful/mother Teresa/saint. To what extent if any do either of these apply to you?

Psychopathy/fearless dominance

- I mentioned earlier the idea that some people like to get the first hit in on an opponent and try and dominate them. For some people, the idea of being dominant/powerful is quite a large part of who they are. Again, this is not necessarily a bad thing. To what extent did you want to dominate your opponents in your sport? Was this consistent across all aspects of your life or just while performing?
- Also, how bold or fearless would you say you were, if at all? For example, how willing were you to put your body on the line during a performance? How far would you push this and what was your physical risk taking like in comparison to your team-mates? Did this happen more/less often in certain circumstances (e.g., key games, key points in tight matches etc.)?
- With regard to social situations, how much would you say you led or dominated in social situations? Do you like to be in control, or do you sit back preferring others to make decisions or take the lead? Was it always like this?

Other-focused personality traits

- How did you relate to your team-mates, did you develop strong friendships, to what extent did you confide in one another about your experiences?
- How important is/ was the performance of your team-mates to you? How aware were you of the performance of others?
- How did the experiences of your team-mates affect you? How much did you understand and empathise with their experiences?
- How did watching your team-mates deal with setbacks such as drop in performance, injury, de-selection, make you feel?
- To what extent were you supportive of your teammates? Or did you feel it was important to leave them to solve their own problems?

NOTE: For this point, the interviewer should pick up on some specific points raised by the athlete under positive and negative events.

Theme 5: Relationships with coaches and family

Questions/points

Coach relationships

- Could you tell me about the most influential coaches you've worked with and rank the top 3 or 4, without whom you might not have reached your level of expertise. Could you describe your reasons for giving them these rankings?

- Tell me about your relationships with your coach(es).

Prompt: What was he/she like, what were the most important things he/she did/do, what environment did they create?

How helpful were these environments? Were they a challenge?

What did it feel like to work with this coach? How did this coach make you feel emotionally?

What was it about your coach(es) that makes you say that?

What was this coach like in terms of discipline, did they set specific boundaries? How did you respond to this?

Did you ever regard any of your coach(es) as being some sort of surrogate parent?

NOTE: If absent father, do you think that's got anything to do with why this coach was so important?

NOTE: Potential to link early childhood perceptions with the coaching experience - an emotional hook into the sport. An example prompt here might thus be: "You said earlier that your father worked a lot and was often not at home, that you spent a lot of time with your mum. When that happens, many people search for a sort of father figure - often a coach; what was your experience of coaches?"

Relationships with other people: e.g., Team members, mentors, teachers

- We are interested in your relationships with other important people, such as team members, mentors, and teachers. Could you tell me a little bit about some of your relationships with these important others (in addition to people we have already discussed)?
    - Prompt: what was their role in shaping who you became?
- Within your wider social circle have you had any difficulty in sustaining satisfying relationships? Could you give me an example?
- Other than things we have mentioned earlier (e.g., obsessiveness over your sport) were there other things that may have influenced the relationships you had with important others (e.g., time of season, intensity of training)?
- ***NOTE:*** Interviewer must be sure to use throughout this theme as a prompt: "You've said xxxxx. How would other people (e.g., partner, coach, parent, sibling, etc.) describe you?". Romantic relationships as well as friendships, relationships with family members should all be explored.

Theme 6: Career turning points and other experiences

Mid-career turning points

- Can you recall any specific turning points during your career and how did they exert their influence on you?
- Please tell me about any other particular points which may have prompted you to consider where you might go in your sport,

Prompt: the following might all be considered turning points (although this is far from an exhaustive list)the transition from juniour to seniour sport, winning/losing major competitions, being part of a particularly successful or unsuccessful team, receiving particularly favourable/unfavourable media reports, etc.

- Was there some specific point when you developed any specific goals or aspirations? To what extent did you envisage reaching the level you did in your sport?

Injuries & Illness

- Please would you tell me a bit about injuries and illnesses throughout your life? What I'd like to do is ask if you could just recall the three most major injuries or illnesses that you experienced – those that you feel had a significant impact (e.g., a meaningful change in your planned training and competition behaviour) on your journey to reaching your highest level in your sport.
- Please now tell me why you consider these injuries/illnesses to have been so significant.
- What impact did these injuries/illnesses have on your development, training, or competition? Are they still having an impact in any way?
- In relation to your experiences of managing the injuries/illnesses you describe, what were the most valuable things you as an individual did to aid your recovery? (How did you deal/cope/manage with these injuries/illnesses?)

Other obstacles and/or setbacks

- What other obstacles did you experience in your career?

Follow up: How long did that setback/obstacle keep you from training and competing? How did you experience/view/deal with that?

- Earlier we discussed some things regarding personality. How did your personality influence you in getting through the setback?

- Prompt: Were you conscientious in getting through the setback/obstacle, or optimistic/pessimistic? What reasons did you give for the setback/obstacle?

Development Programs

- If you were involved in Development Programs, is there anything you would want to add about the benefits or otherwise of the development program?
  - E.g., What specifically about it was beneficial or otherwise? When did being a part of a development program matter most and why (if at all)? What was going on then that was of help/hindrance?
  - Use of sport science support?
  - Coach support
  - Lifestyle support
- Could you tell me here a bit about the climate/culture in the Development program and the way things were run?
- Is there anything else you would specifically want to say about climate / culture and the leadership of the sport and programs you were involved with?

Leadership

- At what point did you receive your first leadership position in the sport?
- What were the most important leadership development experiences you were exposed to?
- What are your feelings on leadership and being a leader in the various teams you have played for?
- In your experience, what influence and responsibility did you have as a player, in shaping the team culture? What was the impact of player input (or lack of)?

Ending of sport

-

Are there any other specific things, which we've not already talked about, which are important in the context of retirement?

Finally

Is there anything we may have missed that you feel would be important? For example, are there factors outside of your sport that would give us some insight into why you became the sportsperson you did/are? Something unique to you, perhaps that makes you different everyone else? As I've already touched on a few times during this interview, is there something else from before you even got into sport that you feel might be important for a full understanding of how you developed into the athlete you were? Is there something you don't quite understand or just feel but have difficulty expressing (can't really say what it is) – that unsaid or unexplainable something? Something you'd almost feel might sound silly/dumb but that somehow you feel is relevant?