Personality, Deliberate Practice, and Expertise Development in Sport

Rafael Alves Ballón Tedesqui

Thesis submitted to the University of Ottawa
in partial fulfillment of the requirements for the
degree of Doctor of Philosophy in Human Kinetics

School of Human Kinetics
Faculty of Health Sciences
University of Ottawa

Abstract

Conscientiousness-related personality traits are relevant predictors of many outcomes in achievement domains outside sport. They have also been associated with several outcomes in sport, however, their relative role on athletes' deliberate practice (DP) and other criteria of expertise development has not been investigated. The overall aim of this dissertation was to examine the role of conscientiousness-related traits on sport expertise development. It had six specific purposes: (a) to examine the structural validity of conscientiousness-related measures; (b) to understand whether athletes' DP amounts, skill level, and other criteria of expertise development could be predicted by these measures; (c) to identify the best personality predictor and combination of predictors that explained the maximal variance in different criteria of expertise development; (d) to examine whether grit facets predicted athletes' practice engagement across a demanding sport season; (e) to explore coaches' perspectives on the behavioural indicators of conscientious, gritty, and self-controlled athletes in training; and (f) to explore coaches' views about how these personality traits may impact athletes' quantity and quality of practice and development toward higher skill levels. The dissertation used a sequential explanatory mixed-methods design, wherein Phase 1 (Articles 1, 2, and 3) quantitatively pursued purposes (a) to (c), Phase 2 (Article 4) addressed (d), and Phase 3 (Article 5) qualitatively addressed (e) and (f).

Article 1 tested the factor structure of the Brief Self-Control Scale in sport and showed distinct associations between *self-control* variables and (a) sport-specific practice amounts, (b) engagement in various practice contexts, and (c) threats to commitment to one's sport, in a diverse sport sample. Article 2 conducted factor analyses of the Grit Scale in sport and examined a full latent variable model showing associations between *grit* variables and several criteria of

expertise development. In particular, perseverance of effort associated with athletes' weekly amounts of DP, engagement in different practice contexts, and skill level, while consistency of interests associated with athletes' commitment to their sport. Article 3 comprised two studies. In Study 1, path analyses were used to assess the role of *conscientiousness* on criteria of expertise development. At the broad level, conscientiousness predicted athletes' engagement in practice contexts and commitment to their sport; at the facet-level, achievement-striving was the best predictor of athletes' weekly DP and engagement in practice contexts. The systematic test of the role of self-control (Article 1), grit (Article 2), and conscientiousness (Article 3, Study1) for key criteria of expertise development culminated with Study 2 of Article 3, which reported comparative analyses of the predictive ability of self-control, grit, and conscientiousness facets—which had shown to be significant predictors when assessed separately—for the criterion measures of sport expertise. Study 2 showed that (a) perseverance of effort was the best predictor of athletes' weekly DP, engagement in mandatory practice, and the only predictor of higher skill level, (b) achievement-striving best predicted athletes' engagement in optional practice, and (c) consistency of interests best predicted athletes' commitment to their sport. Article 4 tested whether athletes' self-reported levels of grit (broad and facets) were longitudinally associated with their coach-reported practice engagement throughout one sport season. Perseverance of effort was the grit variable most related to indicators of practice engagement, the only variable related to overall practice engagement across three time points, and the only variable marginally associated with athletes' stability of practice engagement over time. Article 5 explored coaches' views about the behavioural indicators of athletes' conscientiousness, grit, and self-control in the daily training environment and how these traits impacted athletes' training and development. Coaches described (a) conscientious athletes as systematic and detail-oriented, highly

considerate of others, and highly engaged in self-regulation; (b) gritty athletes as those who persevere despite adversity and work hard in practice; and (c) self-controlled athletes as those who control impulses, resist temptations, and delay gratification. Coaches believe grit, conscientiousness, and self-control play important roles on athletes' development toward higher skill levels, but results generally highlighted the preponderance of perseverance of effort. Potential mechanisms (e.g., *conscientiousness—self-regulation—practice quality* and *conscientiousness—self-regulation—skill level*) were highlighted to help explain the personality-expertise link found in Phases 1 and 2.

This dissertation contributed to the literature on sport expertise by parsimoniously identifying conscientiousness-related personality traits that were associated with measures of athletes' practice quantity, quality, and stability, commitment to sport, and higher skill level. Although several facets (i.e., perseverance of effort, consistency of interests, achievement-striving, self-discipline, and dutifulness) showed associations with practice and performance-related outcomes, this dissertation generally highlighted the role of grit facets. In particular, while *perseverance of effort* was the best predictor of athletes' amounts of DP, the only grit variable associated with quality practice engagement over time, and the only predictor of higher skill level, *consistency of interests* was the best predictor of commitment variables. Furthermore, results based on coaches' descriptions (a) provided behavioural indicators of conscientiousness-related traits that serve as reference points for practitioners aiming to help athletes develop desirable traits, (b) suggested that gritty athletes 'work hard' and conscientious athletes 'work smart', and (c) proposed mechanisms to explain the personality-expertise link found in the quantitative studies. Taken together, the results of this dissertation suggest that the tendency to persevere despite adversity and mindfully use self-regulated processes seems to be a powerful

predisposition for athletes' development toward expert levels of performance.

Acknowledgements

This journey would simply not be possible without the direct and indirect collaboration, support, encouragement, partnership, and contribution from so many people over the past 5 years.

First, a huge thanks to my inspiring supervisor, Dr. Brad Young. Brad, what a great coach, mentor, leader, teacher, supervisor, and collaborator you are! You have helped me grow as a researcher, journal writer, conference speaker, workshop facilitator, and as a professional. You have been a great role model of work ethic, hard work, engagement, commitment, and all those things that help people excel in academia, in sport, and in life. Your challenging yet supportive and critical yet constructive approach along with the passion you bring to work and the unparalleled dedication to all your students have made a lasting impression on me.

Working with you has challenged many beliefs I held about myself. I thought I was detail-oriented, but your thoroughness made me become really eagle-eyed. I thought I was already a hard worker, but you pushed me to the boundaries of effort and depletion, making me even grittier. I thought I could handle a lot of pressure and stress, but you made me become extremely resilient. I thought I was a good problem-solver, but your constant demand for quality work made me become an excellent self-regulated learner and sharp professional. There are not enough words to describe how grateful I am for all you have done for me. Thank you, Brad.

Thanks to my former and current lab mates, especially Scotty who was a great mentor, colleague, friend, and role model of discipline, leadership, and productivity. Thanks to Linds for the thought-provoking exchanges and the amazing partnership and collaboration. Thanks also to Justin, Dora, Meagan, Alex, and Ange for the helpful discussions, feedback, and friendship throughout. Thanks to my current lab mates Lisa and Chelsea, who witnessed times of huge

stress and always provided great support and encouragement throughout. Thanks also to my recent lab mates, Matt, Stu, and Tyler for the cheering that helped me reach the finish line. Outside my lab, thanks to Kelsey for always being so kind and helping me see things on a positive light and to Tiago for the encouragement and friendship throughout. Thanks to Kylie and Corliss for the friendship and good times shared either attending or organizing conferences. Thanks to Mélanie for listening to me complain so many times about life as a PhD student (as well as for heating my lunch when there was no other microwave on the 4th floor).

I would like to thank Dr. Nat Durand-Bush and Dr. Diane Ste-Marie for accepting to be my committee members and for providing engaging comments and feedback on my comprehensive exam, my proposal, and during our yearly exchanges when I gave updates on my progress.

A big thanks to Dr. Audrey Giles who has been an amazing referee, supporting several funding applications and job applications. Thanks also to Dr. Joe Baker who has been a great collaborator and also a referee in funding and job applications. And thanks to Dr. Michelle Fortier, Dr. Jenn Brunet, Dr. Alex Dumas, Dr. Martin Camiré, Dr. André Lachance, and Dr. Diane Culver for the exchanges and advice throughout this journey.

Thanks to several University of Ottawa staff members who helped me get through this journey, including Anne for helping me get through the really busy days when I was a part-time professor and Rabea for the patience and help with the whole dissertation submission process.

I would like to thank all the local, provincial, and national sport organizations that collaborated with my recruitment efforts. And thanks to my research participants: athletes and coaches who provided the data for this dissertation by donating their time to complete surveys, participate in interviews, share a little bit of their own or others' personalities, and sport histories.

I am grateful to several funding bodies that supported my doctoral studies. Thanks to SSHRC for the Joseph-Armand Bombardier Canada Graduate Scholarship, to the Government of Ontario for two Ontario Graduate Scholarships, and to the University of Ottawa for Admission and Excellence Scholarships and for a number of research and conference travel grants.

Outside academia, there are a number of people who supported my PhD journey.

Thanks to my mom for the unconditional love and for always supporting my decisions. Thanks to my dad for always telling me to pursue my dreams. Thanks to my stepmom, stepdad, and all my (numerous) siblings who always cheered for me, especially Katy who helped by taking care of my child and of things at home when I was extremely busy with work (i.e., most of the time). And thanks to other family members and friends who cheered for me throughout this journey.

Finally, I am grateful to God for giving me the inspiration, energy, and courage to keep going and especially for giving me Ruan who motivates me to be the best version of myself every day. And I am infinitely grateful to my love, Shanna, who has simply been the best wife, lover, partner, friend, and supporter in this journey. You encouraged me to begin this adventure when I was still unsure. You lifted me up when I was discouraged. You supported all my decisions despite many of them taking hard tolls on our lives. You always gave me confidence when I doubted myself. You took care of everything else when all I did was work. And, best of all, you still love me despite all I made you go through. I love you so much and will be forever grateful. A huge thank you!

Table of Contents

Chapter I: Introduction

It is indisputable that sport success depends on a high degree of persistence. To develop expertise, athletes need to remain engaged over many years in high amounts of deliberate practice (DP), defined as highly effortful activities specifically designed to improve the current level of performance (Ericsson, Krampe, & Tesch-Römer, 1993). The role of unwavering persistence can be better appreciated when one considers the numerous constraints athletes need to face daily in their training over the course of development. These constraints include: (a) feeling fatigue and little enjoyment in physically strenuous workouts (i.e., effort and motivational constraints; Ericsson et al., 1993); (b) dealing with injuries and setbacks (Haugaasen & Jordet, 2012); and (c) delaying the need for immediate gratification since evidence of improvement and positive results may appear only in the long run (Côté, Baker, & Abernethy, 2003; Young & Medic, 2008). The ability to persevere in the face of difficulties is not sufficient for expertise development, but is certainly necessary. Ericsson et al. (1993) argued that "commitment to deliberate practice distinguishes the expert performer from the vast majority of children and adults who seem to have remarkable difficulty meeting the much lower demands on practice in schools, adult education, and in physical exercise programs" (p. 400).

In discussion relating to the DP framework, Ericsson et al. (1993) noted the potential role of *personality* (see also Ericsson, 1996, 2003, 2007, 2014), claiming that several personality factors "may differentially predispose individuals toward deliberate practice as well as allow these individuals to sustain very high levels of it for extended periods" (p. 393). They also called for future research to investigate whether individual differences related to the motivation to practice might influence attained performance levels. Nevertheless, in a comprehensive review more than two decades later, Baker and Young (2014) concluded that little research on DP in

sport has examined such factors. Therefore, there was a need to better understand whether and which personality traits enable individuals to practice more, practice better, and subsequently develop toward expert levels of performance. The overall purpose of this dissertation was to examine: (a) whether personality traits that are conceptually and empirically related to striving behaviours (e.g., conscientiousness) can predict athletes' quantity and quality of DP, persistence in relevant practice activities over time, and athletes' skill level; and (b) coaches' perspectives about athletes' behaviours during daily training that indicate high levels of these traits and how these traits may impact athletes' development toward expert performance levels.

Literature Review

The Role of Deliberate Practice in Expertise Development

The DP framework (Ericsson et al., 1993; for reviews, see Baker & Young, 2014; Baker, Young, McCardle, & Tedesqui, in press) proposes that long-term engagement (i.e., at least 10 years; Simon & Chase, 1973) in a specific form of practice activities (i.e., DP) is needed for expertise development. DP comprises highly effortful activities specifically designed to improve the current level of performance that are not always intrinsically rewarding and do not lead to immediate personal, social, or financial rewards (Baker & Young, 2014). Thus, DP requires individuals to be able to work hard and delay the need for immediate gratification (Côté et al., 2003), since evidence of performance improvement is usually not available after a short-term engagement in DP. DP is not any form of practice and is distinguished from mere experience in a domain and from playful and competitive activities (Ericsson et al., 1993). Ericsson et al. (1993) also proposed additional effort and motivation constraints on DP: (a) because of its effortful nature, individuals can sustain DP for a limited amount of time per day before requiring rest and recovery (i.e., effort constraint); and (b) DP is not necessarily inherently motivating and

satisfaction from engagement in DP activities would stem from the improvement in performance observed over time after a prolonged engagement in DP activities (i.e., motivation constraint).

Research applying the DP framework to sport has provided some support for its predictions, namely that expert individuals accumulate more hours in select DP activities than their less-expert peers at successive points in their career (e.g., Helsen, Starkes, & Hodges, 1998; Hodges & Starkes, 1996; Young & Salmela, 2010; for reviews, see Baker & Young, 2014; Baker et al., in press). Researchers also generally agree that expertise results from prolonged efforts to improve performance while negotiating motivational and effort constraints. Not all athletes are able to deal with these constraints and this may be one of the reasons why each year around a third of young athletes dropout from sport (Weiss & Amorose, 2008).

Not all of the tenets of the DP framework are supported unequivocally (Baker & Young, 2014; Baker et al., in press), however. A meta-analysis (Macnamara, Moreau, & Hambrick, 2016) found that DP explained only 18% of the variance in sport performance. The large amount of unexplained variance supports the view that DP is necessary but not sufficient to explain expertise development (Campitelli & Gobet, 2011; Hambrick et al., 2014; Starkes, Deakin, Allard, Hodges, & Hayes, 1996; Sternberg, 1996), especially considering the existence of multiple primary (e.g., genetic, training, and *personality*) and secondary (e.g., socio-cultural and contextual) influences on expertise development (Baker & Horton, 2004).

Our understanding of sport expert development may be aided by an examination of individual differences in the ability to persist at hard work despite challenging circumstances. Baker and Horton (2004) argued that "without the proper motivational disposition, it is unlikely that an athlete would be capable of attaining any significant level of proficiency…. It is likely

that innate[1] predispositions facilitate the completion of required amounts of training" (p. 217-218). Elsewhere, researchers have acknowledged the role of trait-like dispositions such as motivation, determination, competitiveness, and willingness to work hard (e.g., Monsaas, 1985; Ward, Hodges, Starkes, & Williams, 2007) in sport expertise development. In non-sport domains, it has been suggested that individual differences in the capacity to overcome constraints and stay committed to a challenging, far-off, but rewarding goal (e.g., academic success) may help explain why some individuals develop more than others (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011). Although not discussed in sport, Kaufman (2014) proposed the integration of the expert performance and individual differences approaches to the study of elite performance. In this vein, this dissertation sought to explore individual differences variables for *personality* (McCrae & John, 1992), seminally determining their relations to DP in sport.

Personality and Sport

Personality can be defined as relatively stable patterns of thoughts, feelings, and behaviours that distinguish individuals (Roberts, Wood, & Caspi, 2008) or "the most important ways in which individuals differ in their enduring emotional, interpersonal, experiential, attitudinal, and motivational styles" (McCrae & John, 1992, p. 175). The Big Five personality dimensions, also called the Five-Factor Model (FFM; McCrae & John, 1992), were developed to integrate and systematize diverse conceptions and measures of personality (McCrae & Costa, 2008). Each factor represents a set of broad cognitive, affective, and behavioural tendencies that can be further divided into more specific facets. The five broad factors are: (a) conscientiousness,

[1] [Footnote added by current author] It is important to note that referring to personality as an innate predisposition does not mean that personality is 100% determined by one's genes. A meta-analysis of behavioural genetic studies showed that approximately 40% of individual differences in personality were due to genetic and 60% were due to environmental influences (Vukasovic & Bratko, 2015).

(b) neuroticism, (c) extraversion, (d) agreeableness, and (e) openness. The FFM has become the most accepted model of personality in psychology (John, Nauman, & Soto, 2008).

Personality has an important predictive role on academic (Poropat, 2014), health (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007), relationship (Ozer & Benet-Martínez, 2006), military (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014), and occupational (Barrick, Mount, & Judge, 2001) outcomes. Limited research suggests that sport performance can also be predicted by personality (e.g., Aidman, 2007). In a longitudinal study that followed junior hockey players over 15 years, a composite personality measure including competitiveness, need for achievement, self-confidence, and coachability was able to predict athletes' future NHL performance (Gee, Marshall, & King, 2010). Aidman (2007) advocated for the combination of physical ability measures with personality assessment to predict the likelihood of success in athletes' transition from junior to senior competitive levels. However, sport talent[2] identification and development programs have not always considered personality assessment, instead, emphasizing physical ability measures over personality ones (Ziv & Lidor, 2014).

In a comprehensive review, Allen, Greenlees, and Jones (2013) concluded that personality is an important determinant of long-term success in sport. Personality variables have successfully discriminated between international/national-level and less-skilled athletes (Allen, Greenlees, & Jones, 2011). Allen et al. (2013) also discussed how personality factors may indirectly impact sport achievement through associations with behaviours needed for success in sport, including quality of training, although they did not connect personality to DP or quantity of training. Paralleling this notion, the current dissertation examined the contention that athletes

[2] The word *talent* has various definitions and determinants. In this dissertation, *talent* is used in reference to a high level of displayed ability relative to one's peers. Accordingly, *talent development* refers to the development of high skill levels. For a comprehensive conceptualization of talent in sport, see Baker, Wattie, and Schorer (2018).

scoring higher in pertinent personality variables may be able to self-control better in the face of temptations to quit, which would enable them to commit longer to improvement efforts and accumulate a greater *quantity* of DP. This indirect notion was characterized by findings reported by Woodman, Zourbanos, Hardy, Beattie, and McQuillan (2010), in which one personality variable, *conscientiousness*, had a positive impact on gymnasts' quality of preparation.

The Role of Conscientiousness

Conscientiousness—the tendency to control one's behaviour in the service of one's goals (McCrae & Löckenhoff, 2010)—may be the most relevant FFM personality factor for understanding striving and practice behaviours in achievement domains such as academia (Poropat, 2009) and occupational excellence (Barrick et al., 2001; also see Poropat, 2014, for a meta-analysis). Sport research also suggests conscientiousness plays the most important role, and is most consistent, in determining various sport outcomes. For example, national and international-level athletes scored particularly higher in conscientiousness, but also higher in agreeableness, and lower in neuroticism, compared to club and regional-level athletes (Allen et al., 2011). Allen and Laborde (2014) suggested that conscientiousness and neuroticism may be the most important factors for sport success. Piedmont, Hill, and Blanco (1999) queried whether the FFM could predict soccer players' performance. Results indicated that, despite both conscientiousness and neuroticism presenting associations with coaches' ratings of performance, conscientiousness was the only predictor of actual game statistics, explaining approximately 8% of the variance. Malinauskas, Dumciene, Mamkus, and Venckunas (2014) tested the FFM and found differences between athletes and non-athletes, but only in levels of conscientiousness, with athletes demonstrating higher levels. Overall, sport research appears to identify conscientiousness as the most influential factor for sport outcomes. This identification seems to

be conceptually sound, especially considering that conscientiousness is the one FFM factor that parallels athletes' need to self-control to deal with constraints related to DP in the pursuit of long-term expertise goals. Thus, the current dissertation focused extensively on variables relating to conscientiousness. Notably, research had yet to identify which conscientiousness facets may be the most influential for sport expertise development as well as how each facet may have a unique contribution toward an understanding of athletes' training and development.

Broad General Factors vs. Narrow Specific Facets

In survey research on personality, the use of short measures to assess the five factors in the FFM can lead to substantial decreases in predictive validity because they lack the breadth and depth of detailed personality inventories (Roberts et al., 2007). In contrast, the predictive validity of personality tends to increase when lower-order facets are assessed (Roberts et al., 2007), and this is the case with respect to conscientiousness. Thus, compared to the use of a broad scale of conscientiousness, using subscales to assess specific conscientiousness facets may help to more robustly predict particular achievement outcomes (e.g., Duckworth, Peterson, Matthews, & Kelly, 2007). Paunonen and Ashton (2001) contrasted the predictive ability of Big Five factors against their facets and found that facets were able to substantially increase the prediction achieved by factors. For example, adding measures of specific facets to the prediction of grade point average (GPA) by Big Five factors increased the amount of variance explained by around 15%. Students' scores on some conscientiousness facets (e.g., perfectionism and industriousness) correlated better with their scores on a standardized test of aptitude and with number of absences from class than measures of the broad conscientiousness factor (MacCann, Duckworth, & Roberts, 2009). Beyond improvements in predictive validity, it is important to evaluate and gain a better understanding of the unique contributions of different conscientiousness facets within

specific contexts (Roberts, Lejuez, Krueger, Richards, & Hill, 2014).

According to the FFM, there are six specific facets comprising conscientiousness, including: (a) *competence*, the degree to which individuals are effective, efficient, and prepared; (b) *order*, a preference for neatness, organization, and structure in life; (c) *dutifulness*, the tendency to be governed by rules and adhere to one's principles; (d) *achievement striving*, the tendency to set more challenging goals and work harder to accomplish them; (e) *self-discipline*, the ability to begin and complete tasks despite boredom and other distractions; and (f) *deliberation*, the tendency to interpose thought before the impulse to act (McCrae & Löckenhoff, 2010). Although all six facets might plausibly contribute to achievement, in domains other than sport, Duckworth et al. (2007) argued that different facets might have different implications for different types of achievement. In occupational striving situations, for example, *achievement striving* and *deliberation* differentially predicted job performance; while *achievement striving* was best correlated with effort (r = .21), *deliberation* was best correlated with irresponsible behaviour (r = -.24; Hough, 1992).

It is plausible that different facets of conscientiousness may also have different effects on DP in sport. An inspection of the six conscientiousness facets suggests that each may parallel the characteristics of DP. For example, athletes low in *self-discipline* may be less likely to complete required amounts of DP during the off-season. Those high in *deliberation* might be better able to inhibit the impulse to skip effortful practice sessions, thus amassing greater amounts of DP. Athletes high in *competence* would tend to feel more prepared, thus readily accepting challenges in DP. In addition, because athletes high in *order* tend to prefer structure and organization, they might be better equipped to follow a strict routine of training sessions despite its inherent challenges. Finally, it may be that athletes high in *dutifulness* are better at complying with

coaches' requests, while those high in *achievement striving* might be more ambitious, avoid settling for easy goals, and work harder in DP to achieve a valued goal such as expert status.

Although each conscientiousness facet may uniquely explain variance in athletes' practice, surprisingly, virtually no previous research has explored the link between conscientiousness traits and athletes' engagement in DP activities to understand high achievement in sport. Moreover, there are other conscientiousness-related measures[3] for assessing athletes' approaches and striving in relation to DP that may converge with some of the aforementioned facets but that may also offer different levels of predictive validity, due to conceptual (see Appendix A) and measurement differences. These conscientiousness-related traits are reviewed in subsequent sections and include grit and self-control.

Grit: Perseverance and Passion for Long-Term Goals

With noted conceptual parallels to conscientiousness (Roberts et al., 2014), *grit* involves "working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007, p. 1087-1088). Grit is defined as perseverance and passion for long-term goals. Duckworth et al. (2007) suggested that grit is a trait shared by the most prominent persons in most achievement domains. Research has shown that compared to less gritty individuals, those who scored high on grit: (a) had higher GPAs (Duckworth et al., 2007, Study 3); (b) were 35% less likely to change careers frequently, staying with the same avocation constantly over time (Duckworth et al., 2007, Study 2); (c) were 55% more likely to persevere and complete a rigorous military summer training program

[3] From this point forward, the expression "conscientiousness-*related*" measures or traits is used to broadly refer to personality traits that fall under the conceptual definition of conscientiousness (i.e., tendency to self-control in order to achieve goals), thus reserving the expression "conscientiousness subscales, facets, or traits" to the six conscientiousness facets originally described in the FFM.

(Duckworth et al., 2007, Study 4); and (d) engaged in more DP, subsequently reaching higher ranks in a National Spelling Bee competition (Duckworth et al., 2011). Taken together, these results suggest that grittier individuals work harder and longer than less gritty counterparts, and switch less between achievement pursuits. Working hard and remaining committed to one's goals over long periods of time are also critical factors in a sport expertise pursuit.

The finding that grit predicts consequential outcomes in the academic, military, interpersonal, and occupational domains (e.g., Eskreis-Winkler et al., 2014; see Credé, Tynam, & Harms, 2017, for a meta-analysis) is important. Despite increased attention given to grit in other achievement domains, research on sport expertise has rarely specifically investigated the predictive validity of grit for athletic outcomes. This is a seeming omission, especially considering that sport expertise is an obvious long-term achievement domain requiring athletes' enduring persistence in DP activities despite several obstacles along the way. An exception is the work of Larkin, O'Connor, and Williams (2015) who found gritty youth male soccer players performed better on sport-specific perceptual-cognitive measures and reported higher amounts of sport-specific practice than less-gritty counterparts. Importantly, no studies have tested the predictive validity of grit at the facet level for sport expertise development.

Grit is comprised of two facets named *perseverance of effort* and *consistency of interests* (Duckworth et al., 2007). Athletes who score high on *perseverance of effort* would tend to sustain effortful DP activities and accumulate the necessary number of DP hours to develop expertise. In keeping with the specializing and investment stages of the Developmental Model of Sport Participation (DMSP; Côté, 1999; Côté, Baker, & Abernethy, 2007), athletes who score high on *consistency of interests* would tend to remain engaged with the same sport over time despite difficulties. Having consistency in one's interests might be particularly important for

sport expertise development, especially considering that “interest in other activities” and “conflict of interest” have been cited among the major reasons for youth sport attrition (Butcher, Lindner, & Johns, 2002; Rottensteiner, Laakso, Pihlaja, Konttinen, 2013).

Expertise researchers generally use two criteria to assess the relevance of a variable of interest—conscientiousness-related traits, in the current dissertation—for explaining sport expertise development. First, more skilled or expert athletes must differ from less-skilled or less-expert athletes on the variable investigated (e.g., Abernethy, Thomas, & Thomas, 1993; Ericsson & Smith, 1991). Second, the variable of interest must be associated with indicators of quality practice (e.g., DP), a prominent predictor of expertise development (Baker & Horton, 2004; Ericsson et al., 1993). Despite the conceptual relevance of grit for expertise outcomes, it is surprising that virtually no research has evaluated whether grit facets have predictive validity among athletes for criterion measures of expertise development frameworks (e.g., Abernethy et al., 1993; Ericsson et al., 1993). Within the field of sport more broadly, few studies have investigated the role of grit. For example, Martin, Byrd, Watts, and Dent (2015) found gritty wheelchair basketball players to be the most engaged with their sport. Additionally, Meyer, Markgraf, and Gnacinski (2016) compared a single short grit scale with a longer version consisting of the two subscales. They found the short grit scale had better psychometric properties and found no differences in grit scores between athletes from different competitive levels. In another study, Joseph (2009) explored whether grit could distinguish performance levels in a uniform sample of collegiate volleyball players and found non-significant results. He concluded that grit was not a useful predictor of athletic performance. However, his uniform and small sample size (i.e., 57 players from the same university) coupled with a simplified dependent measure (i.e., average performance in a season) did not allow definitive conclusions.

In conclusion, few studies have investigated the role of grit on sport outcomes and only one within an expertise development framework (e.g., assessing DP and skill levels). Importantly, no prior studies in sport expertise have considered grit as a two-facet personality trait, instead limiting their assessment to the broad trait level. In light of these gaps and issues, one of the goals of this dissertation was to address these limitations by first establishing the structural validity of the Grit Scale in sport and second, finding whether each grit facet differentially predicted DP amounts, skill level, and practice engagement over time in a diverse sample of athletes from different ages and sports.

Grit vs. Conscientiousness. There are both theoretical and empirical grounds to consider grit as a subcomponent of the broad conscientiousness factor (Roberts et al., 2014). From an empirical standpoint, previous research has shown a high correlation between grit and conscientiousness (r = .77; Duckworth et al., 2007, Study 2). On theoretical grounds, both gritty and conscientious individuals tend to strive more toward goals and achievements (Roberts et al., 2014). Despite this high convergence, an inspection of the literature suggests there may also be divergence in the sense that each grit and conscientiousness facet may explain unique variance in DP. For example, it may be that individuals high on the consistency of interests facet of grit have a more stable interest in their achievement domain which would allow them to *stay longer* in the same domain of expertise and accumulate higher DP amounts over the years. Conversely, an athlete scoring highly on the self-discipline subscale of conscientiousness would endure higher loads of daily practice, ultimately accumulating *more DP amounts* per year. Research has yet to explore the differential impact of grit and conscientiousness facets on athletes' expert development.

In non-sport domains, grit demonstrated incremental predictive validity for measures of

success over and beyond conscientiousness (Duckworth et al., 2007, Studies 2 and 5). However, Duckworth et al. (2007) limited their evaluation of grit and conscientiousness to the broad factor level. The failure to compare facets of grit against facets of conscientiousness may have hindered the validity of their conclusions on the low predictive ability of conscientiousness in comparison to grit and prevented them from capturing eventual differences in the impact of each subscale (facet). Duckworth and Quinn (2009) compared a psychometrically-improved short measure of grit (i.e., the Grit-S) with conscientiousness but again failed to examine the predictive power of specific facets. They recognized that comparing grit with "fine-grained measures of the facets of conscientiousness would have provided a more rigorous test of the incremental predictive validity of the Grit-S" (p. 173). Thus far, no attempts have been made to understand how each grit and conscientiousness facet may uniquely explain variance in DP and other criteria of expertise development. The current research aimed to remedy this state of affairs by conducting a comparative analysis between grit and conscientiousness facets to examine whether they have incremental predictive validity for DP amount, engagement in different practice contexts, sport commitment, and skill level.

Self-Control vs. Other Conscientiousness-Related Traits

Self-control is one's ability to control thoughts, regulate emotions, and resist temptations (Muraven & Baumeister, 2000). It involves "actions with valued, longer term goals in the face of conflicting impulses to seek immediate gratification" (Duckworth & Steinberg, 2015, p. 1). High trait self-control has been associated with task persistence (Dvorak & Simons, 2009) as well as with several positive outcomes in school, relationships, and health (Tangney, Baumeister, & Boone, 2004; see De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012, for a meta-analysis).

The Brief Self-Control Scale (Tangney et al., 2004) is the most widely used measure of dispositional self-control. There is evidence in research outside sport that this survey assesses two facets (e.g., Maloney, Grawitch, & Barber, 2012; Morean et al., 2014), impulse control and self-discipline. Within the field of sport expertise, only Toering and Jordet (2015) examined self-control. They found impulse control significantly explained whether male Norwegian professional soccer players had been selected for the national team. Furthermore, more-skilled soccer players scored higher for levels of restraint. Restraint was also positively associated with amounts of soccer practice. Although Toering and Jordet assessed average daily practice hours, their work focused on associations between self-control and 11 lifestyle activities (e.g., sleeping and watching TV). They did not look at the associations of self-control variables with various contexts of practice. This is a limitation as not all practice contexts are similar. It is possible that more self-discipline is required of an athlete to initiate optional practice compared with mandatory practice which is prescribed by a coach. Overall, research suggests trait self-control may be critical in the initiation and maintenance of instrumental practice habits. However, no studies have related dispositional self-control to conditions of practice and various training contexts (Englert, 2016), nor have any examined self-control within an expert development framework (e.g., Abernethy et al., 1993; Ericsson et al., 1993).

Self-control shows both conceptual (Roberts et al., 2014) and empirical (Tangney et al., 2004) parallels with conscientiousness. However, there are exclusive characteristics within each trait that may have different implications for athletes in pursuit of expertise. For example, both the impulse control facet of self-control and the deliberation facet of conscientiousness refer to one's ability to control impulses toward higher interests (see Appendix A) and both self-control and conscientiousness include a self-discipline facet. However, because the self-discipline facet

of self-control additionally assesses one's ability to break habits, athletes who score high on self-discipline/self-control might be better able to change from old to newly refined practice habits. In contrast, high scores on other conscientiousness facets such as achievement striving may allow athletes to exert greater effort and pursue higher goals related to DP, both predispositions that are not captured by self-control facets.

Self-control and grit have been found to be correlated in previous research (Duckworth & Gross, 2014). However, in a comparative study, grit was a better predictor of cadets' perseverance in intense military training over the course of the summer (Duckworth et al., 2007, Study 4). Duckworth et al. (2007) conceptually distinguished the impact of grit and self-control on achievement success. While grit refers to *long-term* perseverance and passion, self-control represents the successful *momentary* inhibition of impulses. Thus, it would be possible for someone to have an enduring persistence toward long-term goals but be unsuccessful in overriding momentary temptations (i.e., high grit, low self-control). Similarly, it would be plausible to find an individual who is successful in inhibiting everyday temptations but does not manage to reach long-term goals (i.e., high self-control, low grit). To date, no previous studies have evaluated the differential impact of each of these conscientiousness-related traits on athletes' development toward expertise.

In sum, although conscientiousness-related traits are relevant predictors of several outcomes in achievement domains outside sport (and are associated with a limited number of outcomes within sport), their relative role on athletes' DP and other criteria of expertise development remained to be investigated. The benefit of considering the differential impact of each conscientiousness-related trait on athletes' DP and skill level is the possibility of maximizing the explanation of variance in DP and, ultimately, in the likelihood of an athlete

developing expertise. It is possible that each trait uniquely impacts athletes' development by allowing them, for example to: (a) inhibit the impulse to quit an effortful DP session (e.g., deliberation and impulse control), (b) sustain effortful DP over time (e.g., achievement striving and perseverance of effort), (c) maintain long-term interest in the same achievement domain (e.g., consistency of interests), or (d) follow a tedious and repetitive routine of practice (e.g., order).

This doctoral dissertation aimed to assess the unique effects of each conscientiousness-related trait on athletes' quantity and quality of practice, engagement in different practice contexts, commitment to their sport, and achieved skill levels. In addition, by simultaneously assessing the relative impact of each measure, another aim was to uncover not only the best personality predictor of athletes' DP amounts and skill level, but also the most parsimonious combination of traits that offered the maximal amount of explanation of different criteria of expertise development. No previous sport studies have undertaken such an enterprise. A final aim was to explore, from coaches' views, how these conscientiousness-related traits translate into behaviours in the day-to-day training environment and how these traits impact athletes' training and development toward the highest levels of performance.

Coaches' Perspectives on Conscientiousness-Related Traits

Personality traits such as grit refer to "tendencies to act, think, and feel that are relatively stable across time and situation" (Von Culin, Tsukayama, & Duckworth, 2014, p. 306). From late adolescence through late adulthood, "the evidence for structural continuity of personality traits appears to be strong, with most studies showing little if any serious changes in the factor structure of the Big Five across time or age groups" (Roberts et al., 2008, p. 377). Because personality traits may be less malleable, Gee et al. (2010) argued that personality assessment

might help coaches not only optimally select athletes who have a predisposition to work hard and reach higher skill levels, but also "maximize their ability to understand and relate to each individual athlete" (p. 8-9). The more coaches know about athletes' personality and how they learn and practice best, the better prepared they may be to help athletes develop by delivering tailored instructions.

Coaches have considered athletes' traits (e.g., discipline) as key predictors of progress (Holt & Dunn, 2004; Oliver, Hardy, & Markland, 2010). Thus, it is plausible that coaches may prefer to work with athletes who have a certain personality type regardless of their displayed level of ability. In Ericsson's (2003) chapter, national-team coach Nick Cipriano commented on the type of athlete he would prefer to work with. He remarked:

> I would much prefer to work with an athlete with mediocre talent but a high work ethic, versus a talented athlete with moderate commitment…. It is highly unlikely that talent coupled with a moderate work ethic will propel an athlete to achieving expertise in sport…. Unfortunately, in my 20-plus years of coaching, I have yet to see an attitude transformation take place…. It is work ethic that propels athletes to work through performance plateaus and resume training following a serious injury or a subpar performance at an important competition. Simply stated, talent in isolation of a work ethic is a wasted talent. (p. 401-402)

Cipriano preferred to coach athletes with high work ethic, a construct associated with conscientiousness (Piedmont et al., 1999) that has successfully predicted task persistence and intensity (Meriac, Thomas, & Milunski, 2014). The theoretical assumption that would account for Cipriano's observation is that certain personality traits (e.g., grit) may allow the moderately skilled athletes to persevere and thus amass benefits from long-term engagement in DP,

ultimately reaching higher levels.

Coaches' views on the role of personality for athletes' development likely impact how athletes are selected and coached. However, no prior studies have explored coaches' perspectives about how athletes' conscientiousness-related traits translate to behaviours in the daily training environment or how these traits might impact their quality of practice and athletic development. Talent identification and development programs may benefit from knowledge about how coaches perceive and identify personality traits that predispose athletes to sustained DP. Therefore, another goal of this project was to explore coaches' perspectives on how conscientiousness-related traits may facilitate athletes' engagement in DP and skill development and examine what training behaviours indicate that an athlete has high levels of these traits.

Method

This dissertation involved three different phases and the collection of both quantitative and qualitative data, thus adopting mixed-methods procedures (Creswell, 2014) and providing a stronger understanding of the research problem (Creswell, 2003). Combining quantitative and qualitative methods is not always straightforward as each method is based on a distinct paradigm involving different assumptions about the nature of knowledge and appropriate means of generating knowledge (e.g., objectivism vs. subjectivism; Morgan, 1998). An approach was adopted to ground the mixed-methods study on the ideas of pragmatism, whereby knowledge is viewed as "both constructed *and* based on the reality of the world we experience" (Johnson & Onwuegbuzie, 2004, p. 18). From a pragmatic view, "research approaches should be mixed in ways that offer the best opportunities for answering important research questions" (Johnson & Onwuegbuzie, 2004, p. 16). As a result, this dissertation sought to combine quantitative survey-based data for personality influences on expertise with qualitative data obtained through

interviews with coaches on the practical influence of personality on athletes' practice and skill development. The dissertation adopted a sequential explanatory mixed-methods strategy (Creswell, 2011) in which quantitative studies were followed by a qualitative study to provide richness and assist in the interpretation of the quantitative findings. The sequential explanatory mixed-methods design was chosen to provide a richer understanding (via qualitative findings) of the associations (or lack thereof) between conscientiousness-related traits and criteria of sport expertise development, previously identified in the quantitative studies.

Purpose

The overall aim of this dissertation was to examine the role of conscientiousness-related personality traits on sport expertise development. It had six specific purposes: (a) to examine the structural validity of conscientiousness-related measures in sport; (b) to understand whether athletes' DP amounts, skill level, and other criteria of expertise development could be predicted by these measures; (c) to identify the best personality predictor and combination of predictors that explained the maximal amount of variance in different criteria of expertise development; (d) to examine whether grit facets predicted athletes' practice engagement across a demanding sport season; (e) to explore coaches' perspectives on the behavioural indicators of conscientious, gritty, and self-controlled athletes in training; and (f) to explore coaches' views about how these personality traits may impact athletes' quantity and quality of practice and development toward higher skill levels. Phase 1 quantitatively pursued purposes (a) to (c), Phase 2 addressed (d), and Phase 3 qualitatively addressed (e) and (f). All procedures were approved by the Research Ethics Board of the University of Ottawa (Appendices B through J).

Phase 1: Quantitative, Cross-Sectional Design

Participants. In Phase 1, over 600 Canadian junior (aged 12-17) and senior (aged 18 and

above) athletes were recruited. However, only 244, 250, and 270 had complete data for analyses on self-control, grit, and conscientiousness scales, respectively.

Instruments. Data were collected through online surveys that included demographic questions (Appendix K), questions about athletes' skill level and DP history (Baker, Wattie, & Schorer, 2015; Hopwood, 2013; Ward, Hodges, Starkes, & Williams, 2007; Appendices L and M), six Conscientiousness subscales (International Personality Item Pool; Appendix N), the Grit Scale (Duckworth et al., 2007; Appendix O), and the Brief Self-Control Scale (Tangney et al., 2004; Appendix P).

Skill level. To assess athletes' skill level, participants were asked questions about their main sport, highest level of competition (i.e., from local to international), highest performance scores/measures (for objectively-measured sports such as swimming and athletics), and self-reported skill level (e.g., novice, intermediate, expert; Baker et al., 2015).

Deliberate practice history. Participants were prompted to think about a typical mid-season week and asked about their average weekly engagement in (a) informal play in their primary sport, (b) organized competition, and (c) sport-specific DP (Hopwood, 2013). They were also asked about their total years of involvement in their primary sport.

Conscientiousness subscales. Conscientiousness was assessed using six scales from the International Personality Item Pool (IPIP), a public-domain website that originated from the collaboration of personality researchers world-wide (Goldberg et al., 2006). IPIP's Conscientiousness subscales have shown high convergent validity with Costa and McCrae's (1989, as cited in IPIP) original Conscientiousness subscales (i.e., correlations from .87 to .99).

Grit Scale. The Grit Scale (Duckworth et al., 2007) contains 12 items and was developed to be face valid for both adolescents and adults pursuing goals in a variety of domains (e.g., work

and school). Previous factor analyses have shown that the Grit Scale measures two facets: (a) consistency of interests over time, and (b) perseverance of effort in the face of adversity.

Brief Self-Control Scale. The Brief Self-Control Scale (Tangney et al., 2004) has 13 items that measure dispositional self-control, defined as one's ability to restrain undesirable impulses, control thoughts, regulate emotions, and achieve optimal performance by persisting at goal-directed behaviour.

Procedure. Following ethical approval, the survey was pilot tested with a small sample of athletes to ensure the questions were clear, had appropriate language, and were face valid for adolescent and adult Canadian athletes. Next, major sport organization bodies in Canada, such as Own the Podium and the Canadian Sport Institute Ontario, were contacted, asked to provide endorsement for this project, and asked to forward our online survey link (FluidSurveys) to their members (coaches, adult athletes, and parents of minor athletes). The survey took about 20 min and participants provided input only once (i.e., minimal burden).

Research Questions and Data Analyses. Phase 1 answered three research questions. They are articulated below along with corresponding analyses. **RQ1:** *Are the conscientiousness-related personality scales psychometrically sound for use with a sample of athletes?* Separate confirmatory factor analyses (CFAs) assessed the psychometric properties of the Brief Self-Control Scale and the Grit Scale, but not the IPIP Conscientiousness subscales; with respect to the IPIP Conscientiousness subscales, they were relatively well-established and personality researchers do not recommend further factor analyses of well-established personality constructs (Hopwood & Donnellan, 2010). These analyses were important for the Grit Scale whose fit indices in previous research (i.e., comparative fit index [CFI] = .83 and root-mean-square error of approximation [RMSEA] = .11; Duckworth et al., 2007, Study 1) were below recommended

values (i.e., CFI close to .95 and RMSEA close to .06; Hu & Bentler, 1999). CFAs were carried out using AMOS Software (Byrne, 2010). The structural validity of the Grit Scale and the Brief Self-Control Scale had rarely been examined in the sport domain. Therefore, this was a logical starting point. Further, by ensuring the validity of these scales in sport, this project would provide researchers with valid tools to further assess the influence of conscientiousness-related constructs on DP and other sport outcomes.

RQ2: *Can grit, conscientiousness, and self-control facets predict key criterion outcomes related to athletes' amount of DP, sport commitment, engagement in different practice contexts, and skill level?* **RQ3a:** *Which personality facet is the best predictor of variance in each of these outcomes?* **RQ3b:** *What parsimonious combination of facets can explain the maximal amount of variance in DP, sport commitment, engagement in practice contexts, and skill level?* In pursuing these questions, different sets of analyses were performed for the dependent variables: (a) multiple regressions and path analyses to predict athletes' amounts of DP, sport commitment, and engagement in practice contexts; and (b) analyses of variance and logistic/multinomial regressions to predict athletes' skill level (e.g., from local to international levels of competition).

There was a planned systematic progression to these analyses. First, the predictive ability of each trait was assessed separately for the constituent facets within each broad factor (i.e., self-control, grit, and conscientiousness, separately). Next, only those facets that had been found to be significant predictors (when assessed separately) were brought together for culminating, comparative analyses for explaining key criterion outcomes, in order to (a) identify the best predictor of each outcome, (b) determine their unique and also their additive contributions to the prediction of the different outcomes, and (c) find the parsimonious combination of traits that explained the maximal amount of variance in the outcome measures. The analyses controlled for

variance due to age.

Since there were no gold standard personality measures in sport, and certainly none related to DP, this study was exploratory in nature. However, an inspection of the conceptual parallels between the three conscientiousness-related measures (see Appendix A) and their items (see Appendices N, O, and P) allowed the consideration of some predictions. First, given its parallel with the requirements of expertise (i.e., long-term engagement in DP), it was expected that grit would explain the most variance in DP amounts and skill level, especially considering gritty individuals' ability to sustain effort over time (i.e., perseverance of effort). Also, the ability to maintain long-term interest in the same domain–an obvious requirement of the expertise framework–is only assessed by the Grit Scale (i.e., consistency of interests). In addition, prediction was expected to be enhanced by self-control given its assessment of individual's ability to inhibit impulses, which is arguably critical for athletes in pursuit of excellence as it would help them override the urge to quit strenuous DP when faced with attractive alternatives (e.g., socializing with friends; Tedesqui & Young, 2015). Lastly, other conscientiousness facets were expected to offer unique prediction. For example, athletes scoring highly on the achievement striving sub-scale would tend to set *higher goals* for themselves (e.g., reaching higher skill levels) and *work harder* toward those goals (e.g., making extra effort in DP). Additionally, athletes scoring highly on the self-discipline sub-scale of conscientiousness would be better able to focus on relevant DP activities, which would allow them to accumulate more DP hours per day. These were all viable, yet speculative, hypotheses to be explored based on the DP framework. Confirmation of these predictions would suggest that different conscientiousness-related traits uniquely contribute to explanation of variance in DP, sport commitment, practice engagement, and skill development in sport.

Phase 2: Quantitative, Prospective Design

Participants. In Phase 2, 13 athletes from two Canadian canoe/kayak clubs were recruited for a prospective study with data collection at three time points throughout the season. Club choice was important and was governed by several criteria. First, chosen clubs had to offer programs that were structured, competitive, and demanding. Secondly, there needed to be an environment wherein athletes were expected to come to all practices, yet because attendance was not policed, athletes could voluntarily choose to stop coming—presumably because they were not able to deal with the effort and motivational constraints imposed by the training schedule. Finally, there had to be a demanding training schedule involving almost daily sessions throughout the season.

Procedure. Two clubs that fit the criteria were identified and partnerships were sought. Next, a convenient day and time was scheduled for athletes to complete the demographic questionnaire (Appendix K) and the Grit Scale (Appendix O), and for coaches to independently rate their athletes' engagement in training at that point in the season (Appendix Q). Coaches rated each of their athletes (only those participating in the study) on a Likert scale ranging from 1 (not at all true) to 5 (very true) on six items indicating practice engagement (i.e., hard work, positive attitude, diligence, perseverance, time investment, and openness to challenges) and one item indicating attendance. Coaches also rated their athletes' practice engagement around two months later (time 2), and again four months after time 1 (time 3). To control for potential confounds impacting coaches' ratings of athletes' practice engagement (e.g., moving away or injuries), participants would be excluded from the analysis in cases where their coach reported the occurrence of any one of these situations; however, no such situations were observed. Data collection was meant to capture whether fluctuations (or stability) in athletes' practice

engagement throughout the season could be explained by their early season self-reported grit scores.

Research Questions and Data Analyses. Phase 2 aimed to answer **RQ4a:** *Do athletes' self-reported grit scores predict their coach-reported practice engagement over the course of a season?* **RQ4b:** *Which grit variable (perseverance of effort, consistency of interests, or composite grit) shows greater predictive validity for indicators of quality practice?* For each athlete, we computed an index of stability of practice engagement over time and then we inspected whether athletes' grit scores at time 1 were associated with the quality of their practice at each time point as well as with the stability/fluctuation of their practice engagement across the season. Based on the predictive validity of grit for persistence outcomes in non-sport domains (e.g., Eskreis-Winkler et al., 2014), perseverance of effort was expected to be the strongest predictor of athletes' practice engagement. Phase 2 was valuable because of its prospective design, thus allowing to determine whether grit variables were valid predictors of athletes' persistence in DP activities over time.

Phase 3: Qualitative, Interview Study

Participants. Eleven expert coaches of developing athletes were recruited for interviews. Coaches were identified based on Côté and Gilbert's (2009) considerations of coaching knowledge, athletes' outcomes, and coaching contexts. They were performance coaches (Côté, Young, North, & Duffy, 2007) from both individual and team sports, who worked in exclusive elite programs, had at least10 years of experience, and had coached at national and international competitive levels, with acknowledged roles as talent selectors.

Instrument. A semi-structured interview guide (Appendix R) containing open-ended questions was used to explore coaches' perspectives about how conscientiousness-related traits

translated into behaviours in the daily training environment, as well as the role of these traits on athletes' training and development. In line with the interactive sequential nature of the mixed-methods design (Creswell, 2011), the interview guide was deliberately refined to reflect the results from Phases 1 and 2, focusing on traits identified as influential for athletes' training and development. Although the interview guide contained a set of pre-established questions, the interview happened in a flexible way with regards to the order of questions, the elaboration of probes, and the follow up of unanticipated issues raised by participants. The interview guide was developed with two main goals: (a) understanding coaches' perspectives regarding behavioural indicators of athletes' personality characteristics related to conscientiousness, and (b) understanding coaches' views on the relevance of these traits for different criteria of expertise development.

Procedure. The interview guide was piloted with two coaches to test its efficacy, clarity, and identify missing questions. Next, to recruit accessible (Stake, 2005) high-level coaches, a combination of sampling strategies was used. Convenience sampling was used to access the most receptive high-level coaches. Also, the first participants were able to recommend potentials candidates for subsequent interviews (i.e., snowball sampling; Marshall, 1996). Coaches were contacted via major sport organizations in Canada, which were sent a letter of information describing the study and requesting their collaboration by recommending coaches for an interview. Interviews were scheduled in person or on Skype (with video) at coaches' convenience. Interviews were audio-recorded, transcribed verbatim, and analyzed.

Research Questions and Data Analyses. Phase 3 sought to answer two RQs. **RQ5:** *How do coaches describe behavioural indicators of conscientiousness, grit, and self-control within the daily training environment?* **RQ6:** *From coaches' views, how do conscientiousness, grit, and*

self-control relate to athletes' quantity and quality of practice, commitment to their sport, and skill development? No hypotheses were formulated, given the exploratory qualitative nature of the research questions. NVivo software assisted in the organization and management of the data. Data were analyzed according to thematic analysis guidelines (Braun & Clarke, 2006), which help researchers identify, analyse, and report patterns or themes in the data. The importance of a theme depended on its ability to capture a relevant aspect in relation to the research questions, regardless of its prevalence (Braun & Clarke, 2006). Data were coded inductively (i.e., data-driven approach) and deductively (Fereday & Muir-Cochrane, 2006). The deductive approach to qualitative coding was driven by the researcher's theoretical interest in the area (e.g., identification of behavioural indicators of conscientiousness-related traits) and by the project's research questions (Braun & Clarke, 2006). As such, deductive themes were expected to consist of: (a) behavioural indicators of conscientiousness, (b) behavioural indicators of grit, (c) behavioural indicators of self-control, (d) relevance of the investigated traits for enhancing practice quantity and quality, (e) relevance for sport commitment and long-term engagement, (f) relevance for advancing to higher skill levels, (g) the trait a coach considered the most relevant for athletic development, and (h) situations in practice where specific traits may have a negative influence. The inductive approach was used to code the data and organize them into subthemes related to the overarching deductive themes. Results from Phase 3 were expected to add richness to the interpretation of results from Phase 1 and 2, especially if they shed light into how personality traits (i.e., those identified as being differentially influential on athletes' DP amounts and skill level in the previous phases) impacted athletes' practice and development in the daily training environment.

Trustworthiness. To ensure the quality and rigour of Phase 3, several strategies were

used. First, to provide consistency and familiarity with the data, all interviews were conducted by the main researcher. Next, participants were given the opportunity to check the accuracy of the content of their interview transcripts (Whittemore, Chase, & Mandle, 2001); none indicated any issues. Next, all transcripts were read and re-read to gain familiarity with the data (Braun & Clarke, 2006). Finally, discussions with the project supervisor, an expert in the expertise literature, about the themes and the coding procedure allowed verification of the analytical procedures.

Organization of the Dissertation

In the following chapters (Chapters II to VI), the articles reporting the findings of the three phases of this research are presented consistent with the style of the journals where they were published/submitted. Results of Phase 1 are reported in Articles 1, 2, and 3 (Chapters II to IV). Phase 2 is reported in Article 4 (Chapter V). Phase 3 is reported in Article 5 (Chapter VI).

Phase 1 represents the quantitative, cross-sectional stage of testing. Article 1 tested the factor structure of the Brief Self-Control Scale in sport and showed the association between self-control variables and (a) sport-specific practice amounts, (b) engagement in various practice contexts, and (c) threats to commitment to one's sport, in a diverse sport sample. Article 2 reports the results of (a) factor analyses of the Grit Scale in sport and (b) a full latent variable model predicting several criteria of expertise development. Article 3 reports two studies: (1) Study 1 used path analyses to assess the role of conscientiousness subscales on criteria of expertise, and (2) Study 2 compared the associations that facets of self-control, grit, and conscientiousness (which had shown to be significant predictors when assessed separately) had with criterion measures for practice, sport commitment, and skill level. Notably, Study 2 in Article 3 represents the culminating, comparative analyses of the entire Phase 1, in which data were drawn and analyzed from the same sample of over 600 Canadian athletes from diverse sports.

Phase 2 is reported in Article 4, which tested whether grit variables could predict athletes' practice engagement throughout one season.

With respect to the qualitative Phase 3, Article 5 explored coaches' views about the behavioural indicators of athletes' conscientiousness, grit, and self-control in the daily training environment and how these traits impacted athletes' training and development.

In the General Discussion (Chapter VII), the purposes of this research program are revisited and findings from the three phases are integrated. The chapter further discusses the strengths, implications, and limitations of the research, and suggests future research directions, as well as conclusions. The references for the Introduction and Method sections (Chapter I) as well as for the General Discussion (Chapter VII) are presented at the end of the dissertation.

Chapter II: Article 1

Tedesqui, R. A. B., & Young, B. W. (2017). Associations between self-control, practice, and skill level in sport expertise development. *Research Quarterly for Exercise and Sport, 88*, 108-113. http://dx.doi.org/10.1080/02701367.2016.1267836.

(Running head: SELF-CONTROL & EXPERTISE)

Abstract

Purpose: To test the association between self-control (SC) variables and (a) sport-specific practice amounts, (b) engagement in various practice contexts, (c) threats to commitment to one's sport, and (d) skill development, using the Brief Self-Control Scale (BSCS) in a diverse sport sample. **Method:** 244 athletes (47% female; M_{age} = 21.96, *SD* = 6.98 years; 68.8% individual and 31.2% team sports; 13.77 (*SD* = 8.12) hrs/week of sport-specific practice) completed a survey comprising the BSCS and practice-related measures. Three skill groups (Basic/Intermediate, Advanced, Expert) were informed by athletes' self-reported highest level of competition. Separate analyses were conducted for juniors (12-17 years) and seniors (18-43 years). **Results:** A two-factor model (self-discipline and impulse control) fit the BSCS data. Fewer thoughts of quitting from one's sport were associated with higher self-discipline in juniors and seniors, and were also related to higher impulse control in seniors. Higher practice amounts were associated with higher self-discipline, however, only seniors showed such associations in voluntary practice contexts. For juniors and seniors, impulse control was associated with more voluntary practicing. There were, however, no skill-group differences for levels of self-discipline or impulse control. **Conclusions:** Self-discipline and impulse control may be dispositional characteristics associated with how athletes engage in practice and avert conditions that threaten their sport commitment. SC dispositions may relate to practice amounts differently in juniors and seniors, depending on the requirements for self-regulation in a practice context.

Keywords: personality, deliberate practice, self-discipline, impulse control

Associations between Self-control, Practice and Skill Level in Sport Expertise Development

Aspiring experts in any domain have to show a prolonged engagement in high amounts of deliberate practice (DP; Ericsson, Krampe, & Tesch-Römer, 1993), comprising highly-effortful activities specifically designed to improve performance. Expert athletes accrue more DP than less-expert athletes over successive points in career development (Baker & Young, 2014) thus requiring great discipline and commitment to effortful practice. As athletes go from early to late adolescence, they increase commitment to DP in a single sport and decrease engagement in other sport-related activities played for fun (Côté, Baker, & Abernethy, 2003). By the mid-teen years, committing to high amounts of practice in one sport entails the ability and discipline to resist attractive alternative activities (Young & Medic, 2008). To keep engaged in escalating amounts of DP over time, athletes must constantly overcome effort and motivational constraints, giving up momentary pleasures daily (Tedesqui & Young, 2015) and delaying the need for gratification (Côté et al., 2003). For example, athletes may have to resist the temptation to accept social invitations in order to attend an exhausting, less attractive, and less immediately rewarding practice session. This is underscored by the fact that professional soccer players invest far less time in social encounters (Toering & Jordet, 2015), suggesting that high-level athletes steer themselves away from gratifying contexts that compete for valuable practice time.

The premise of this study is that developing expertise through challenging sport-specific practice requires a great deal of self-control (SC). SC is required during arduous training conditions, or when faced with tempting decisions that might threaten one's commitment to practice in their sport (Tedesqui & Young, 2015). SC is the ability to control thoughts, regulate emotions, and resist temptations (Tangney, Baumeister, & Boone, 2004). In keeping with conceptualizations of SC as both a state and a trait (Tangney et al., 2004), this study looks at the

latter aspect, that is, the dispositional tendency to control one's impulses and remain disciplined while pursuing valued long-term goals (Duckworth & Steinberg, 2015). The notion of SC fits within the broader research on self-regulated learning and its value in expertise development (e.g., Zimmerman, 1989). Baker and Young (2014) contended that individual difference variables pertaining to how an athlete self-regulates may predispose them toward DP. Moreover, individuals with higher levels of SC tend to follow their workout routines and more capably translate personal intentions into exercise participation (Allom, Panetta, Mullan, & Hagger, 2016). Outside sport, high trait SC has been linked to higher achievement (e.g., Tangney et al., 2004), including better school and work performance, likely because SC fosters regular practice and good working habits (De Ridder, Lensvelt-Mulders, Finkenauer, Stok & Baumeister, 2012). Altogether, these works suggest that individual differences in SC may have a bearing on sport practice and commitment; however, no studies have specifically addressed these associations.

Only Toering and Jordet (2015) have examined SC within the realm of sport expertise. They found that one aspect of SC (i.e., impulse control) significantly explained whether male Norwegian professional soccer players had been chosen for the national team. Although there were no mean group differences between more- and less-skilled players for impulse control, more-skilled players did score higher for a second aspect of SC (i.e., levels of restraint). Amounts of soccer practice were positively associated only with levels of restraint. Although investigators used one measure that assessed average practice hours per day, they foremost focused on the associations that SC had with 11 lifestyle activities (e.g., sleep, watching TV, gaming) and not on its associations with practice in various contexts. This is a limitation as not all practice contexts are equal; for example, unscheduled practice may require athletes to recruit more self-regulated effort, or more discipline may be required to initiate optional practice

compared to when it is prescribed by a coach. Altogether, the literature suggests that trait SC may be key in the initiation and sustenance of instrumental practice habits. However, there are no studies on dispositional SC as it relates to conditions of practice and various training contexts (Englert, 2016), nor any that have examined SC according to an expert performance approach.

The expert performance approach is predicated on verification of key assumptions. First, researchers must isolate tasks or variables (e.g., SC) for which more-expert individuals perform consistently better than less-skilled individuals (Ericsson & Smith, 1991). Secondly, to infer expert development, such variables (e.g., SC) should also be positively associated with amounts of intensive, sport-specific training (Ericsson et al., 1993). Accordingly, we tested four hypotheses: (a) higher SC is related to greater amounts of sport-specific practice (H1); (b) higher SC is associated with more instrumental patterns of engagement in mandatory and voluntary practice contexts (H2); (c) higher SC is associated with a reduced vulnerability to threats to commitment (H3); and (d) more-skilled athletes score higher than less-skilled athletes on dispositional SC (H4). We also examined associations between SC and engagement in playful activities but no specific hypotheses were posited due to the exploratory nature of these analyses.

Method

Participants and Procedure

Participants were 244 athletes (47% female, M_{age} = 21.96, range = 12-43 years) mainly from Canada (85.9%) and USA (5%) in individual (68.8%; e.g., swimming) and team sports (31.2%; e.g., soccer). On average, they reported 13.77 (*SD* = 8.12) weekly hrs of sport-specific training and had 8.1 (*SD* = 5.53) years of involvement in their main sport. Informed/parental consent was obtained for all participants. All procedures received institutional ethics approval.

Instruments

All athletes completed an online survey that included demographic questions, questions about athletes' skill level and practice-related measures, and a scale assessing dispositional SC.

Skill level. Athletes reported their highest level of competition ever achieved at junior (i.e., < 18 years) and senior (aged 18 and over) age groups, by indicating an appropriate category ranging from (a) local, (b) city, (c) regional, (d) provincial, (e) national, to (f) international level.

Practice-related measures. To measure *quantity of weekly sport-specific practice*, we referred participants to a typical mid-season week and asked them to report how many hours per week they spent on individual or team sport-specific activities deliberately designed to improve performance in their main sport such as technical and tactical training (Hopwood, 2013). This estimate of weekly practice was considered a proxy measure for DP (Hopwood, 2013). We also asked participants about their weekly amount of *play activiti*es in their main sport so that sport-specific practice could be delimited from other sport-related activities.

Athletes also responded to five questions on a Likert scale ranging from 1 (never) to 7 (always). Three questions asked how often they: (a) attended mandatory practice sessions, (b) attended optional practice sessions, and (c) practiced outside scheduled training hours. Because both (b) and (c) share similar assumptions on the need for self-direction and the recruitment of personal resources to engage in these forms of practice, we collapsed them to derive a score for *voluntary practice*. These were considered measures of *engagement in practice contexts*. The last two questions asked how often athletes considered either playing a different sport or quitting their main sport. Higher responses for these final items might indicate athletes' likelihood of giving up an expertise pursuit, thus, we refer to these measures as *threats to commitment*.

Brief Self-Control Scale (BSCS). The BSCS (Tangney et al., 2004) uses 13 items (e.g., "I am good at resisting temptation", "I wish I had more self-discipline") to assess dispositional

SC. Athletes rated the degree to which items reflected their typical behavior on a Likert scale ranging from 1 (not at all) to 5 (very much). Tangney et al. (2004) showed the BSCS had good internal reliability (α = .83-.85), good test-retest reliability (*r* = .87), and concurrent criterion validity (e.g., high correlation with academic grade point average, *r* = .39). The BSCS is widely used in domains outside sport (e.g., education and work; Duckworth & Steinberg, 2015; Maloney, Grawitch, & Barber, 2012). Although the BSCS has been treated as a single SC construct, there has been support for two SC factors (e.g., Maloney et al., 2012), including the lone study to inspect the BSCS in sport (Toering & Jordet, 2015).

Data Analysis

Through confirmatory factor analyses using AMOS, we tested both a one- and a two-factor structure of the BSCS. Fit indices were far better for the two- (CFI = .92; SRMR = .05; RMSEA = .06 [90% CI = .04-.08]) compared to the one-factor model (CFI = .85; SRMR = .07; RMSEA = .09 [90% CI = .07-.10]). Thus, in our main analyses, we used two BSCS subscales (correlated at *r* = .71): (a) *self-discipline* (seven items; α = .80; factor loadings = .53-.69), one's ability to be self-disciplined and work toward goals; and (b) *impulse control* (six items; α = .71; factor loadings = .41-.68), an individual's ability to control impulses and resist temptations.

Primary analyses. Partial correlations (controlling for age) assessed the associations that self-discipline and impulse control had with each of the practice-related measures. To test group differences, we collapsed competitive levels 1 (local) to 4 (provincial) into a *Basic/Intermediate* group (*B/I*; *n* = 40 junior athletes; *n* = 33 senior athletes), level 5 (national) formed the *Advanced* group (*Adv*; *n* = 15 juniors; *n* = 31 seniors), and level 6 (international) formed the *Expert* group (*Exp*; *n* = 17 juniors; *n* = 80 seniors). We tested whether these groups differed in SC through two separate one-way ANCOVAs, controlling for age: one for self-discipline and another for impulse

control. Data were analyzed separately for junior (ages 12-17) and senior (ages 18-43) athletes.

Results

Descriptive statistics are presented in Table 1 along with associations between self-discipline (SD) and impulse control (IC) with sport-specific practice, engagement in practice contexts and threats to commitment. In terms of group differences among *seniors*, skill groups did not significantly differ in levels of SD: B/I (M = 3.23, SD = .70), Adv (M = 3.38, SD = .64), Exp (M = 3.64, SD = .69), $F(2, 140) = 1.65$, $p > .05$, partial $\eta^2 = .02$. Senior skill groups did not differ in IC levels: B/I (M = 3.38, SD = .61), Adv (M = 3.42, SD = .65), Exp (M = 3.59, SD = .75), $F(2, 140) = .11$, $p > .05$, partial $\eta^2 = .00$. Similar results were obtained among *juniors*. Skill groups did not differ in SD levels: B/I (M = 3.43, SD = .75), Adv (M = 3.45, SD = .89), Exp (M = 3.70, SD = .75); $F(2, 68) = .72$, $p > .05$, partial $\eta^2 = .02$; nor in IC: B/I (M = 3.78, SD = .64), Adv (M = 3.62, SD = .65), Exp (M = 3.48, SD = .71), $F(2, 68) = .52$, $p > .05$, partial $\eta^2 = .02$.

Discussion

Associations with Quantity of Weekly Sport-Specific Practice and Play

We found a positive association between SD and DP, with a small (Zhu, 2012), approaching a medium effect size (Cohen, 1992), for juniors. Thus, we accept H1 for juniors. SD could be valuable for young athletes aiming for the top, especially if it prompts training, and considering how younger athletes who become adult experts amass more DP than less-skilled peers from early stages (Baker & Young, 2014). Although H1 was not supported for seniors, IC and weekly play were negatively associated, suggesting an indirect benefit to seniors' training. Playful activities are not directly aimed at skill improvement and might be considered inefficient investments of time for skill acquisition, especially at later developmental stages (Côté et al., 2003). Aspiring elite athletes transitioning from adolescence to adulthood should gradually

reduce their engagement in play (Côté et al., 2003). If higher IC levels help senior athletes resist temptations to play, then IC may help seniors steer themselves to more structured DP activities.

Associations with Measures of Engagement in Practice Contexts

Nuanced associations in the expected directions between SC variables and attendance at mandatory and voluntary practice suggest that we can accept H2, especially among seniors. While SD seems relevant for seniors' engagement in both mandatory and voluntary practice, it does not seem important in either context for juniors. Differences in self-regulatory requirements imposed on juniors and seniors may help explain. Consistent with the changing nature of social influences as athletes develop through stages of sport involvement (Côté et al., 2003), junior sport appears to involve more socially- than self-regulated contexts (Bandura, 1986). For juniors, commitment may depend more heavily on external regulation (e.g., parents taking athletes to practice or coaches deciding when, what and how much practice athletes do).

Considering that practice attendance and activity among juniors may be mostly socially prescribed, this may explain why we found no associations between their SD and measures of frequent engagement in the practice contexts. As athletes grow older, as performance improves, and as they are afforded more autonomy in their decision-making, there may be a change in the agency for learning with athletes gradually internalizing self-regulation processes that allow them to increasingly control the learning situation and skill refinement (Bandura, 1986). As a result, SD may be more instrumental to seniors who no longer depend on the presence of external agents (e.g., coach or family) to regulate their attendance at, or activity during practice.

Another nuanced finding was the positive association between IC and engagement in voluntary practice among both juniors and seniors, whereas no association was found between IC and mandatory practice in either cohort. Compared to mandatory, voluntary practice presumably

requires more self-regulation; it is less socially prescribed, with less strict mandates/supervision from a coach. When there are little or no social expectations for athletes to practice (i.e., during voluntary practice), athletes' efforts to do this type of training will rely more on self-regulation, and our results suggest that junior and senior athletes' ability to resist temptations to engage in attractive alternative activities may be valuable in this regard. Although SD remains valuable in voluntary contexts among seniors, the results suggest a possible complementary role for IC in these self-regulated contexts, corroborating the notion that inhibitive self-regulation may help athletes complete large amounts of personally selected training (Tedesqui & Young, 2015).

Associations with Threats to Commitment

Overall, our results suggest that we can accept H3. SD showed an inverse association with threats to commitment for both juniors and seniors of at least a small effect size (Zhu, 2012) approaching a medium effect size (Cohen, 1992). Athletes scoring higher on SD tended to think less about quitting or switching out of their main sport, suggesting that SD may help athletes keep themselves on their developmental path in one sport. SD may aid athletes' commitment to their chosen sport by helping them *avoid* instead of *resist* temptations related to switching or quitting their main sport. If athletes are able to avoid temptations, they might not need to actually resist them. De Ridder et al. (2012) found that individuals high in trait SC tended to form habits that prevented them from needing to resist temptations. They suggested that the application of SC may be most effective by "establishing and maintaining stable *patterns* of behavior rather than by performing single acts of self-denial" (p. 91). Athletes high in trait SD may be better able to control their routines and their daily activities such that they circumvent situations that tempt them to think about quitting or withdrawing from their main sport. This situation-management ability may be what helps athletes, seniors and juniors alike, to remain committed to their sport.

Seniors high on IC thought less about quitting their main sport, suggesting that the ability to resist temptations may help seniors keep themselves on their developmental path. The lack of a similar association among juniors may be explained by differences in the context of junior and senior sport. Threats to commitment may be more salient as competitive athletes age–they reduce involvement in playful activities (Côté et al., 2003), training demands increase, and they meet greater motivational constraints as the rate of skill acquisition declines and learning plateaus are met (Ericsson et al., 1993). Thus, as athletes transition out of adolescence, the ability to resist the temptation to pursue attractive non-sport activities over one's sport practice may assume a more pivotal role in helping seniors remain committed to their development (Young & Medic, 2008).

Between-Group Differences in Levels of Self-Control

We found no skill-group differences in SC levels among juniors or seniors, thus we cannot accept H4. To fully substantiate SC within a sport expertise framework (Ericsson & Smith, 1991), it would have been important to show mean level differences on SC between multiple skill groups. The current findings do not satisfy this criterion. Considering the significant associations SC had with many of the practice-related measures, however, the lack of skill-group differences may indicate that SC variables do not necessarily distinguish skilled from less-skilled athletes, but instead may help all athletes alike develop skill by allowing them to engage in multiple practice contexts and to successfully overcome threats to their commitment.

Limitations and Future Research

Although we used Hopwood's (2013) protocol for measuring sport-specific practice, which is arguably an acceptable proxy for DP, we are limited in drawing conclusions regarding SC and DP. The debate about how to measure DP in sport continues and more associations may be uncovered with better DP measures. Further, studies might consider whether sport type or

regulatory requirements (self vs. social) moderate the link between SC and practice. Perhaps our varied sample (both sexes, several sports) diluted skill-group differences; when Toering and Jordet (2015) applied SC to discriminate performance groups in a large sample from one sport, group differences were found. Finally, future studies might gain from looking at the impact of SC on practice *quality* in addition to practice quantity and engagement in practice contexts.

Conclusion

SD may help juniors stay committed to their sport and accrue more DP. Among seniors, both SD and IC show positive associations with engagement in voluntary practice and may help them avoid threats to commitment. Given the cross-sectional nature of our data, any comparisons across age groups have to be made cautiously and we refrain from interpretations that imply directionality between SC and our practice measures. Yet, the observed associations with SC variables warrant further work examining how these traits influence DP and sport achievement.

What Does this Article Add?

First, our results corroborate previous findings outside sport on the influential role of SD on good work/practice habits (De Ridder et al., 2012). Second, they extend Toering and Jordet's (2015) work on SC and lifestyle activities in soccer to more squarely focus associations between SC and various practice contexts (e.g., DP and contexts requiring degrees of self-regulation) in a mixed-sample of athletes (e.g., genders, ages, sports). Third, this article sensitizes sport expertise researchers to (a) important associations between SC and engagement in practice contexts, as well as threats to commitment to specialized practice, and (b) the necessity for future research to substantiate skill group differences on these SC variables, to more firmly position SC within a sport expertise framework. Finally, this article illustrates how studies might integrate personality research to further understand the role of individual differences on sport expertise development.

Acknowledgments

This work was supported by the Social Sciences and Humanities Research Council of Canada (SSHRC) through a Joseph-Armand Bombardier Canada Graduate Scholarship (767-2013-2136).

References

Allom, V., Panetta, G., Mullan, B., & Hagger, M. S. (2016). Self-report and behavioural approaches to the measurement of self-control: Are we assessing the same construct? *Personality & Individual Differences, 90*, 137-142. doi: 10.1016/j.paid.2015.10.051

Baker, J., & Young, B. W. (2014). 20 years later: Deliberate practice and the development of expertise in sport. *International Review of Sport & Exercise Psychology, 7*, 135-157.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89–110). Champaign, IL: Human Kinetics.

De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality & Social Psychology Review, 16*, 76-99.

Duckworth, A. L., & Steinberg, L. (2015). Unpacking self-control. *Child Development Perspectives, 9*, 32-37. doi:10.1111/cdep.12107

Englert, C. (2016). The strength model of self-control in sport and exercise psychology. *Frontiers in Psychology, 7*, 1-9. doi:10.3389/fpsyg.2016.00314

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363-406.

Ericsson, K. A., & Smith, J. (1991). *Toward a general theory of expertise: Prospects and limits.*

New York, NY: Cambridge University Press.

Hopwood, M. J. (2013). The developmental history of athletes questionnaire: Towards a comprehensive understanding of the development of sport expertise. (Doctoral dissertation). Retrieved from http://vuir.vu.edu.au/22353/

Maloney, P. W., Grawitch, M. J., Barber, L. K. (2012). The multi-factor structure of the Brief Self-Control Scale: Discriminant validity of restraint and impulsivity. *Journal of Research in Personality, 46*, 111-115. doi:10.1016/j.jrp.2011.10.001

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271-324.

Tedesqui, R. A. B., & Young, B. W. (2015). Perspectives on active and inhibitive self-regulation relating to the deliberate practice activities of sport experts. *Talent Development & Excellence, 7*, 29-39.

Toering, T., & Jordet, G. (2015). Self-control in professional soccer players. *Journal of Applied Sport Psychology, 27*, 335-350. doi:10.1080/10413200.2015.1010047

Young, B. W., & Medic, N. (2008). The motivation to become an expert athlete: How coaches can promote long-term commitment. In D. Farrow, J. Baker, & C. MacMahon (Eds.), *Developing elite sports performers: Lessons from theory and practice* (pp. 43-59). New York, NY: Routledge.

Zhu, W. (2012). Sadly, the earth is still round ($p < 0.05$). *Journal of Sport & Health Science, 1*, 9-11. doi: 10.1016/j.jshs.2012.02.002

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*, 329-339.

Table 1

Means, Standard Deviations, and Partial Correlations between Self-discipline (SD), Impulse control (IC), and Practice-Related Variables, while Controlling for Age

	Seniors			Juniors		
Variable	*M* (*SD*)	SD	IC	*M* (*SD*)	SD	IC
Sport-specific practice[a]	14.38 (8.80)	.09	-.12	13.17 (6.78)	.27*	-.06
Play activities[a]	2.61 (4.34)	-.01	-.25*	3.76 (5.21)	-.12	-.11
Mandatory practice[b]	6.57 (.72)	.27*	.10	6.79 (.41)	.06	-.04
Voluntary practice[c]	5.08 (1.34)	.26*	.17*	5.30 (1.36)	.05	.31*
Think switching[b]	2.82 (1.55)	-.24*	-.15	2.53 (1.42)	-.26*	-.03
Think quitting[b]	2.11 (1.20)	-.27*	-.32*	1.68 (1.04)	-.26*	-.11

Note. [a] Hours per week. [b] Measured on a 7-point Likert scale ranging from 1 (never) to 7 (always). [c] Composite score of optional practice and unscheduled practice measures.

*$p < .05$. Small, medium, and large effect sizes are respectively $r = .10$, $r = .30$, $r = .50$ (Cohen, 1992).

Chapter III: Article 2

Tedesqui, R. A. B., & Young, B. W. (2017). Investigating grit variables and their relations with practice and skill groups in developing sport experts. *High Ability Studies, 28,* 167-180. doi:10.1080/13598139.2017.1340262.

(Running head: GRIT & SPORT EXPERTISE)

Abstract

Grit, the tendency to work hard toward long-term goals, maintaining effort and interest over years despite failure and adversity, has predicted several achievement outcomes. However, minimal work has examined grit within a sport expertise development framework, and specifically its association with deliberate practice (DP) in sport. Participants, 250 athletes (109 female; M_{age} = 23.40, *SD* = 10.14), completed the 12-item Grit Scale, practice measures, and reported their skill level (local to international). Factor analyses confirmed a 10-item two-factor model for use in our sport sample: consistency of interests (CI; 6 items; α = .81) and perseverance of effort (PE; 4 items; α = .75). A full latent variable model controlling for age showed PE significantly predicted weekly amounts of DP and engagement in mandatory and optional practice contexts; CI was inversely associated with threats to athletes' sport commitment. Among senior athletes, both Expert and Advanced skill groups had higher PE levels than a Basic/Intermediate group, *p*s < .05. The tendency to work hard toward long-term goals seemingly enables athletes to persist with practice activities that are pivotal to expert sport development.

Keywords: grit, perseverance of effort, consistency of interests, sport expertise, deliberate practice.

Investigating Grit Variables and their Relations with Practice and Skill Groups in Developing Sport Experts

To develop expertise, athletes must persist in long-term deliberate practice (DP; Baker & Young, 2014; Ericsson, Krampe, & Tesch-Römer, 1993). Because DP is effortful, not necessarily enjoyable, and its observable results are generally delayed (Côté, Baker, & Abernethy, 2003), sustained engagement in DP implies the ability to persevere through challenges and remain engaged in a domain despite potential threats to one's commitment. Consequently, expert athletes have been referred to as the "greatest perseverers over many years of training" (Young & Medic, 2008, p. 43).

Grit is a dispositional characteristic referring to individual differences in the tendency to work hard toward long-term goals, and to maintain effort and interest over years despite failure, adversity, and plateaus in progress (Duckworth, Peterson, Matthews, & Kelly, 2007). It is conceptualized as a two-factor construct including *perseverance of effort* (PE; one's ability to sustain effort in the face of adversity) and *consistency of interests* (CI; the tendency to remain interested in the same goal-pursuits over time). Compared to less gritty individuals, various cohorts that scored high on grit: (a) had higher grade point averages; (b) were 35% less likely to change careers frequently, staying with the same avocation over time; and (c) had greater odds of persevering and completing a rigorous military training program (Duckworth et al., 2007). Furthermore, higher grit has been associated with more domain-specific DP, which in turn was related to higher ranks in a National Spelling Bee competition (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011). Taken together, these results suggest that grittier individuals work harder and longer than less gritty counterparts and switch less between achievement pursuits, which are arguably critical behaviours for aspiring competitive athletes.

A recent meta-analysis (Credé, Tynan, & Harms, 2016) showed that grit predicts consequential outcomes in the academic, occupational, and military domains. Despite increased attention given to grit in other achievement domains, research on sport expertise has not specifically investigated the predictive validity of grit for athletic performance, nor for weekly amounts of DP or engagement in various practice contexts in sport. An exception is Larkin, O'Connor, and Williams (2015) who found gritty youth male soccer players performed better on sport-specific perceptual-cognitive measures and reported higher amounts of sport-specific practice than less-gritty counterparts. In exercise psychology, grit was linked to increased intensity of exercise (Reed, Pritschet, & Cutton, 2013); considering parallels with intensive DP, grit may relate to intensive sport practice as well.

The DP (Ericsson et al., 1993) and the expert performance (Abernethy, Thomas, & Thomas, 1993; Ericsson & Smith, 1991) frameworks, as well as a consequent body of research on sport expertise development (for a review, see Baker & Young, 2014) inform how several researchers test the contribution of *a priori* identified variables (e.g., personality characteristics) to expert development. Taken together, these works suggest two *tenets*: (a) that a variable must distinguish between groups of varying skill level, and (b) that a variable should be significantly associated with intensive practice and with conditions that facilitate practice commitment in a specific achievement domain. With respect to this latter point, no studies have investigated the potentially protective effect of grit on threats to athletes' commitment.

Credé et al.'s (2016) meta-analysis provided evidence that combining scores from PE and CI into a singular grit index results in a significant loss in predictive ability; they recommended that researchers consider the criterion validity of the factors separately. Therefore, we investigated the validity of the two-factor grit from two perspectives. As no prior studies have

confirmed the structure of the Grit Scale in sport, we first verified the factorial validity of the two-factor structure. Secondly, in accordance with the aforementioned tenets, we examined the predictive validity of the two grit factors by specifically testing: (a) whether PE and CI scores would correlate with amounts of sport-specific practice, with engagement in various practice contexts (mandatory, optional, and unscheduled practice), and with threats to commitment to an expertise pursuit (quitting, or switching out of one's sport); and (b) whether skill groups would differ in mean levels of PE and CI. To infer the contribution of grit variables to expert development, we would expect to find athletes' PE and CI scores to be positively associated with sport-specific practice (i.e., DP) and frequency of engagement in practice contexts, to be negatively associated with threats to athletes' commitment, and to differentiate skilled from less-skilled athletes. Overall, we expected PE and CI to have differences in the strength of their associations with practice-related measures and expected higher levels of PE and CI to be reported by more elite performance groups compared to less-skilled groups.

Method

Participants and Procedure

After receiving institutional ethics approval for this research, we recruited participants mainly through national and provincial organizations as well as sport clubs in Canada. Representatives (including executive and technical directors, head coaches, and board members) were contacted, informed of the purpose of the study, and invited to forward our online survey link by email to their members (i.e., athletes aged 18 and above or parents of athletes under 18 years of age). Informed or parental consent (for participants under 18 years of age) was obtained from all participants. Participants were 250 athletes (118 female; M_{age} = 23.40, *SD* = 10.14) mainly from North America (e.g., 84.8% from Canada and 4.8% from the USA). Individual sport

athletes (e.g., swimming, athletics) constituted 70% of the sample, 29% were team sport athletes (e.g., hockey, soccer) and 1% did not report their main sport. The athletes reported an average of 13.88 (*SD* = 8.58) weekly hours of sport-specific practice and an average of 8.36 (*SD* = 6.50) years of involvement with their main sport.

Instruments

The survey contained demographic questions (i.e., age and sex), practice-related questions, questions about athletes' skill level, and the Grit Scale (Duckworth et al., 2007).

Practice and commitment-related measures. Self-report items (Hopwood, 2013) assessed how many hours per week, during a typical mid-season week, athletes spent in activities deliberately designed to improve performance (e.g., technical and tactical training) in their main sport; this can be considered a proxy measure for *weekly amounts of DP* (Helsen, Starkes, & Hodges, 1998). Additionally, athletes responded to three questions on a Likert scale ranging from 1 (never) to 7 (always) assessing their *engagement in different practice contexts*. Specifically, they judged how often they attended mandatory practice and optional practice, and how often they practiced outside scheduled training hours.

Finally, athletes rated two items regarding *threats to their commitment*, which were designed to represent an athlete's acknowledged temptation to forfeit their commitment to their main sport. Specifically, they judged how often they considered playing a different sport or quitting their sport on a Likert scale from 1 (never) to 7 (always).

Skill level. Athletes reported their highest competitive level in their main sport according to categories ranging from 1-local, 2-city, 3-regional, 4-provincial, 5-national, to 6-international. Athletes reporting 1 to 4 formed the *Basic/Intermediate* group, level 5 formed the *Advanced* group, and level 6 formed the *Expert* group.

Grit Scale. Participants completed the Grit Scale (Duckworth et al., 2007) consisting of 12 Likert-scale items assessing two dispositional factors (six items each): (a) *consistency of interests*, and (b) *perseverance of effort*. On a Likert scale ranging from 1 (*not at all*) to 5 (*very much*), participants rated the degree to which items corresponded to how they were typically.

Preliminary Analyses

To ensure that we had factorial validity for our main analyses, we first tested the factor structure of the Grit Scale in our sport sample, and followed cross-validation procedures (Byrne, 2010) by randomly splitting the 250 participants into two subsamples of 125 representing calibration and validation samples, respectively. Our ratio of sample to number of estimated parameters was 5:1, meeting Bentler and Chou's (1987) minimal criterion to perform these analyses. Using the calibration sample, we tested the fit of the two-factor model of grit in AMOS version 18 (Arbuckle, 2009). The two-factor measurement model showed insufficient fit, χ^2 (53, N = 125) = 84.6, $p < .01$, CFI = .89, SRMR = .08, RMSEA = .07 (90% CI = .040-.096), and we could not confirm the model. Thus, the calibration sample was used to run an exploratory factor analysis (principal axis factoring, direct oblimin rotation, fixed two factors) in SPSS to identify refinements. An iterative process was used to arrive at the final matrix according to various primary loading (> .40) and cross-loading (not within .20) criteria, and scree test, as well as conceptual considerations. "Setbacks don't discourage me" had a very low loading (-.27) and "I finish whatever I begin" had troublesome cross-loading (.39 on factor 1, .38 on factor 2); both were deleted. The final solution representing CI (27.34% explained variance) and PE (8.72% explained variance) is shown in Table 1.

Next, we attempted to confirm this refined 2-factor model of the Grit Scale with the validation sample using AMOS. Although all standardized regression weights were higher than

.5, the model fell short of criteria for acceptable fit, χ^2 (34, N = 125) = 73.2, p < .001, CFI = .89, SRMR = .08, RMSEA = .10 (90% CI = .066-.127), and could not be confirmed. Modification indices suggested the addition of an error covariance between two conceptually-related items ("My interests change from year to year", and "I become interested in new pursuits every few months"). We re-specified the model by including the suggested error covariance and re-estimated it, resulting in an acceptable fit, χ^2 (33, N = 125) = 51.4, p < .05, CFI = .95, SRMR = .07, RMSEA = .07 (90% CI = .027-.101). See Table 1 for standardized regression weights.

Primary Analyses

We excluded participants considered outliers due to age (i.e., one participant who indicated 0 years old as well as any Masters athletes, aged 50 and above), and could not include participants with missing data for any practice-related measures. Consequently, 218 participants were advanced to primary analyses.

Practice and commitment-related analyses. We used structural equation modeling (SEM; Byrne, 2010) in AMOS to test the plausibility of relations between the latent variables (PE and CI) and practice-related measures (DP amounts, engagement in practice contexts, and threats to commitment), while controlling for age. Although the *a priori* model structure was partly based on theory (i.e., Duckworth et al., 2007) and prior work in other fields indicated grit predicted achievement, practice, and retention outcomes (e.g., Credé et al., 2016; Duckworth et al., 2011), our analysis was also exploratory because we were interested in understanding the differential links between the two grit variables and our practice and commitment-related outcomes. The observed data were fitted to the hypothesized model (see Figure 1) and assessed for goodness-of-fit based on multiple criteria such as statistical, theoretical and practical considerations (Byrne, 2010). The statistical criteria included the comparative fit index (CFI >

.90), the standardized root mean square residual (SRMR < .08), and the root mean square error of approximation (RMSEA < .08) (Byrne, 2010). Further, we inspected the modification indices to identify redundant indicators and to specify error covariances as needed, and checked the estimates of regression weights to eliminate non-significant relationships between the grit latent variables and the measured outcomes in the search of a parsimonious model (Byrne, 2010).

Skill group analyses. Two separate multivariate analyses of covariance, one for junior athletes (under 18 years of age; 34 boys, 33 girls; M_{age} = 15.46, *SD* = 1.26; weekly sport-specific practice hours = 13.46, *SD* = 6.56) and another for senior athletes (aged 18 and older; 84 men, 67 women; M_{age} = 25.06, *SD* = 6.28; weekly sport-specific practice hours = 14.60, *SD* = 8.74), assessed whether grit distinguished between skill groups. Each analysis contrasted three groups (Basic/Intermediate, Advanced, Expert) for mean levels on PE and CI, while controlling for age. Chi-square analyses revealed no imbalances in sex between the three skill groups among juniors, nor among seniors, *ps* > .05. Junior and senior athletes were assessed separately because of challenges in matching equivalence; for instance, the skill level of an international-level junior athlete cannot necessarily be equated to that of an international-level senior athlete.

Results

Relations between Grit Variables, Practice and Commitment-Related Measures

Descriptive statistics and correlations among all studied variables are presented in Table 2. The hypothesized model showed insufficient fit, χ^2 (104, *N* = 218) = 278.4, *p* < .001, CFI = .79, SRMR = .08, RMSEA = .09 (90% CI = .076-.100). Modification indices suggested the addition of two error covariances between “think switching” and “think quitting”, and between “optional practice” and “mandatory practice”. An inspection of the estimates of regression weights informed the deletion of any non-significant paths between grit variables and the

outcomes (including the elimination of "unscheduled practice"), βs < |.146|, ps > .05. The resultant parsimonious model showed acceptable fit, χ^2 (94, N = 218) = 161.8, p < .001, CFI = .91, SRMR = .06, RMSEA = .06 (90% CI = .042-.072). Significant paths between latent factors and outcomes are displayed in Figure 2.

Between-Group Differences in Skill Level

Among juniors, the multivariate result was non-significant, Pillai's trace = .039, F(4,126) = .62, p > .05, partial η^2 = .019. Among seniors, the multivariate result was significant, Pillai's trace = .135, F(4, 268) = 4.84, p < .01, partial η^2 = .067. Follow up univariate analyses indicated that skill groups differed in PE, F(2,134) = 10.26, p < .001, partial η^2 = .133. Post-hoc comparisons showed that both Expert (M = 4.52, SE = .07) and Advanced (M = 4.34, SE = .11) groups had higher PE levels than the Basic/Intermediate group (M = 3.92, SE = .11), p < .001 and p < .05, respectively. With respect to seniors' CI levels, follow-up univariate analysis indicated that the skill groups were not significantly different, F(2,134) = .67, p > .05, partial η^2 = .01.

Discussion

We found support for the use of a refined 2-factor grit model, comprising PE and CI, in our mixed-gender, mixed-sport, North American sample. Our factor analyses confirmed the constituent scales proposed by Duckworth et al. (2007), minus two items on the PE subscale. Furthermore, these two scales were associated with different criterion variables representing DP, practice and commitment-related measures, indicating predictive validity for each of the scales, respectively. These findings are in line with a recent meta-analysis (Credé et al., 2016) which recommended researchers to consider the grit factors separately to increase predictive ability.

Our findings corroborate research outside (e.g., Duckworth et al., 2007, 2011) and within

sport (e.g., Larkin et al., 2015) on the relevant role of grit variables for achievement outcomes. More specifically, there seems to be value in using two grit scales to understand expert sport development. In the discussion, we will focus on what the findings for PE and CI mean for prominent tenets relating to sport expertise (e.g., Abernethy et al., 1993; Ericsson et al., 1993) for understanding the long-term development of highly-skilled athletes (e.g., Baker & Young, 2014). According to these tenets, any variable of interest must successfully distinguish between skilled and less-skilled athletes and must show associations with DP. In the current study, PE met both criteria. CI did not pass both criteria, but showed interesting associations with commitment-related measures which we will discuss as having a potential bearing on expert development.

Perseverance of Effort

The results indicated that regardless of age, athletes' level of PE was significantly associated with their weekly amounts of DP and their attendance in both mandatory and optional practice. This finding suggests, albeit with cross-sectional data, that dispositional tendencies for working hard and remaining diligent in the face of setbacks, might be important for pressing through conditions of DP. This idea supports Ericsson et al.'s (1993) broad comment that individuals differ in their "capacity to engage in hard work (deliberate practice)" (p. 399). Because engagement in deliberate technical and tactical training entails a high degree of cognitive and physical effort (Ericsson et al., 1993) and requires individuals to delay the need for immediate gratification (Côté et al., 2003), presumably athletes who have higher PE are better equipped to persist through the challenging conditions of DP. These results also align with Duckworth et al.'s (2011) findings from National Spelling Bee competitors, in which an overall grit score was also positively associated with spellers' amount of DP as well as with engagement in different forms of practice (e.g., memorizing words alone, and being quizzed by others). Our

findings add to Duckworth et al.'s work by identifying the specific grit variable (i.e., PE) associated with amounts of DP. Also, whereas Duckworth et al. found associations between grit and different *forms* of practice (i.e., training alone and training with others) our results showed that PE was associated with different *contexts* of practice: those that are more socially prescribed (i.e., mandatory practice) and those that require more self-regulation (i.e., optional practice).

Our findings suggest that perseverance seems important in responding to expectations by others to practice, but it is also seemingly related to the recruitment of voluntary effort to engage in self-initiated activities. Research on sport expertise commonly holds that accumulated practice is a major causal mechanism for acquiring the highest levels in sport (Baker & Young, 2014). The current associations suggest that PE may be a dispositional tendency that is important for accruing training in DP but also across varied training contexts—this may partly explain why those who eventually became the most expert athletes show far more voluminous amounts of accumulated practice than those who did not reach this level (e.g., Helsen et al., 1998). Despite its association with both mandatory and optional training contexts, PE was not associated with unscheduled practice. Practicing outside scheduled training hours arguably requires even more self-regulatory resources than attending optional practice which is scheduled by a coach. It requires reflecting about one's weaknesses, proactively planning a practice session, and following through to implement the plan. Therefore, it is possible that other personal characteristics such as the dispositional tendency toward proactive behaviour (e.g., Bateman & Crant, 1993) or the self-regulatory abilities to proactively plan, self-monitor, and self-evaluate thoughts, feelings, and behaviours (e.g., Bartulovic, Young, & Baker, 2017) may have a greater bearing on athletes' engagement in unscheduled practice, compared to athletes' levels of PE. Overall, our findings corroborate Larkin et al.'s (2015) results on the positive associations

between grit and practice; however, whereas their findings depended on a single grit scale, we found this relationship pertains specifically to PE.

PE levels differed between incrementally-skilled groups of senior athletes, in line with our expectations derived from the expert performance framework. An inspection of trends showed concordance with skill groups, with PE levels increasing with each incremental skill grouping. In terms of statistical significance, both the Expert and Advanced athletic groups had higher levels of PE than their Basic/Intermediate counterparts (medium effect size), which may suggest that the ability to persevere through challenges toward long-term goals pays off for athletes pursuing the highest skill levels. These results suggest a more-elite advantage attributed to having higher PE. A preliminary inference, in concert with the aforementioned associations with practice measures, is athletes who display higher dispositional perseverance are presumably better able to persist through challenges to reach higher skill levels.

Still to be explained is the lack of significant skill group differences in PE among juniors. We speculate that because sessions become more frequent and longer as athletes develop, training demands are greater in senior compared to junior sport. Thus, seniors would require a greater ability to persevere through challenges and obstacles faced under more intense training conditions (e.g., extreme fatigue, shorter recovery periods, and more injuries). Moreover, there may be more constant external support around junior athletes with respect to their training (e.g., encouraging parents, supportive coaches) meaning that younger athletes can rely on others to motivate them during setbacks in training and higher levels of PE may not be required. With respect to seniors, they may be expected to take on more agency for their learning (Glaser, 1996), and possibly more self-regulated rather than externally-supported training conditions may favour aspiring athletes with higher PE.

Consistency of Interests

CI did not distinguish between skill groups and thus failed to satisfy an important criterion of the expert performance framework. Moreover, unlike PE which had associations with practice measures, CI did not, but instead had interesting associations with commitment-related measures. Athletes' levels of CI were inversely related to the frequency of thinking about switching out and quitting one's main sport. These results suggest that the dispositional tendency to sustain interest on long-term projects may possibly help individuals avert threatening conditions to their main sport commitment. Baker and Côté (2003) suggested that "the key to amassing the quantity of training required for developing expert-level skill is sustaining commitment across years of involvement in a domain" (p. 139), thus commitment "may be the most important attribute for the acquisition of expertise in sport" (p. 139). Taken together with the null findings in skill-group differences in CI, it may be that higher consistency in one's interests is a "necessary but insufficient" variable that leads to discrepancies in accrued practice amounts and eventually discrepancies in attained competitive levels. CI may indeed be important for overall athletic development by allowing athletes to remain involved in their sport for sustained periods, especially considering that attractive alternative activities to one's main sport (Young & Medic, 2008), interest in other activities, and conflict of interest have been cited among the major reasons for youth sport attrition (Rottensteiner, Laakso, Pihlaja, Konttinen, 2013).

The differential roles attributed to CI and PE in the current findings are consistent with Duckworth et al.'s (2007) contention that CI represents the *direction*, while PE represents the *duration* of an individual's efforts toward a goal. While the duration would be related to how long an individual pursues a goal (e.g., short vs. a long period of time), the direction would be

related to whether someone chooses to devote their time to one domain as opposed to exploring multiple domains. The path for expert sport development requires athletes to move over many years from sampling several different sports, to specializing in one or two of these sports, and later to investing in one of these sports (Côté et al., 2003). Within this developmental path, an individual's propensity to consistently direct their efforts to one of the initially sampled sports over time would be an indicator of their decision to deepen expertise in one sport rather than to keep exploring/sampling alternative sports or domains. Duration of effort, however, would be more predictive of an athlete's perseverance at accumulating training. However, they are interrelated in that sustained direction of commitment is a precondition to expert skill development enabling individuals to direct their efforts at accruing DP.

Finally, although the predictive relations found in the current study are significant and sizeable, there remains a significant portion of variance to be explained in the outcome variables, including DP. Un-modeled factors may include both personal and environmental variables. For example, athletes' "desire" and "good coaching" were ranked by both athletes and coaches as the first and second factors, respectively, in terms of importance for achieving success in figure skating (Starkes, Deakin, Allard, Hodges, & Hayes, 1996). Highly motivated athletes with access to quality coaching are likely to engage in more DP, to engage more in different contexts of practice, and to sustain a longer commitment to their sport.

Limitations and Future Research

Although we followed a two-step approach to validating the two-factor structure of the Grit Scale, future work to further confirm our refined model in sport is necessary. Second, our results relied on self-report measures including a single-item to assess DP and a relatively subjective measure of skill level; despite athletes responding anonymously in a non-testing

environment, future research might include a social desirability scale. Third, this study is limited by a cross-sectional design, thus we refrain from discussing causality; future work should examine PE and CI as they relate to practice behaviours over time. Finally, although we investigated prominent tenets of the expert performance and the DP frameworks (i.e., skill-group differences, and associations with DP) as they have been applied in studies of long-term development in sport (e.g., Baker & Young, 2014), we did not explore the possibility that DP might mediate the relationship between individual differences in grit variables and achievement levels (e.g., Duckworth et al., 2011). Future research might examine this mediational path using a longitudinal design, which would enhance our understanding of whether grit may be considered an important precursor of or even a precondition for athletes' expertise development through its impact on DP.

Conclusion

This was the first sport study to examine grit at the subscale level and to successfully show the predictive validity of grit subscales for sport expertise outcomes. In sum, we found skill-group differences on PE, associations between PE and practice measures, and inverse associations between CI and measures representing threats to commitment. Although we expected PE and CI to have differences in the strength of their associations with practice-related measures, in fact, we found that the two grit variables showed different associations with our outcome measures. These findings suggest that while the dispositional consistency of one's interests may help athletes remain committed to their sport, the tendency to work hard toward long-term goals might enable them to persist with practice activities that are pivotal to expertise development.

References

Abernethy, B., Thomas, K. T., & Thomas, J. T. (1993). Strategies for improving understanding of motor expertise [or mistakes we have made and things we have learned!!]. *Advances in Psychology, 102,* 317-356.

Arbuckle, J. L. (2009). Amos (Version 18.0) [Computer Program]. Chicago: IBM SPSS.

Baker, J., & Côté, J. (2003). Resources and commitment as critical factors in the development of 'gifted' athletes. *High Ability Studies, 14*, 139-140. doi: 10.1080/1359813032000163816

Baker, J., & Young, B. W. (2014). 20 years later: Deliberate practice and the development of expertise in sport. *International Review of Sport & Exercise Psychology, 7*, 135-157. doi: 10.1080/1750984X.2014.896024

Bartulovic, D., Young, B. W., & Baker, J. (2017). Self-regulated learning predicts skill group differences in developing athletes. *Psychology of Sport and Exercise, 31,* 61-69. doi:10.1016/j.psychsport.2017.04.006

Bateman, T. S., & Crant, J. M. (1993). The proactive component of organizational behavior: A measure and correlates. *Journal of Organizational Behavior, 14*, 103-118.

Bentler, P. M., & Chou, C.-P. (1987). Practical issues in structural equation modeling. *Sociological Methods & Research, 16,* 78-117.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge/Taylor & Francis.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89–110). Champaign, IL: Human Kinetics.

Credé, M., Tynan, M. C., & Harms, P. D. (2016, June 16). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality & Social Psychology*. Advance online publication. doi:10.1037/pspp0000102

Duckworth, A. L., Kirby, T. A., Tsukayama, E., Berstein, H., & Ericsson, K. A. (2011). Deliberate practice spells success: Why grittier competitors triumph at the National Spelling Bee. *Social Psychological & Personality Science, 2*, 174-181. doi:10.1177/1948550610385872

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality & Social Psychology, 92,* 1087-1101. doi:10.1037/0022-3514.92.6.1087

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* 363-406.

Ericsson, K. A., & Smith, J. (1991). *Toward a general theory of expertise: Prospects and limits*. New York, NY: Cambridge University Press.

Glaser, R. (1996). Changing the agency for learning: Acquiring expert performance. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 303-311). Hillsdale, NJ: Erlbaum.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport & Exercise Psychology, 20*, 12-34.

Hopwood, M. J. (2013). *The developmental history of athletes questionnaire: Towards a comprehensive understanding of the development of sport expertise.* (Doctoral dissertation). Retrieved from http://vuir.vu.edu.au/22353/

Larkin, P., O'Connor, D., & Williams, A. M. (2015). Does grit influence sport-specific

engagement and perceptual-cognitive expertise in elite youth soccer? *Journal of Applied Sport Psychology, 28,* 129-138. doi:10.1080/10413200.2015.1085922

Reed, J., Pritschet, B. L., & Cutton, D. M. (2013). Grit, conscientiousness, and the transtheoretical model of change for exercise behavior. *Journal of Health Psychology, 18,* 612-619.

Rottensteiner, C., Laakso, L., Pihlaja, T., & Konttinen, N. (2013). Personal reasons for withdrawal from team sports and the influence of significant others among youth athletes. *International Journal of Sports Science & Coaching, 8,* 19-32.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 81-106). Hillsdale, NJ: Erlbaum.

Young, B. W., & Medic, N. (2008). The motivation to become an expert athlete: How coaches can promote long-term commitment. In D. Farrow, J. Baker, & C. MacMahon (Eds.), *Developing elite sports performers: Lessons from theory and practice* (pp. 43-59). New York: Routledge.

Table 1

Factor Loadings of Grit Scale Items in the Exploratory Factor Analysis (SPSS) with the Calibration Sample and the Re-estimation of Model Fit (AMOS) With the Validation Sample

	SPSS		AMOS	
	CI	PE	CI	PE
I have difficulty maintaining my focus on projects that take more than a few months to complete.[a]	**.70**	.07	**.58**	–
I have been obsessed with a certain idea or project for a short time but later lost interest.[a]	**.69**	.09	**.71**	–
New ideas and projects sometimes distract me from previous ones.[a]	**.68**	-.07	**.71**	–
I often set a goal but later choose to pursue a different one.[a]	**.60**	.06	**.74**	–
My interests change from year to year.[a]	**.57**	.07	**.61**	–
I become interested in new pursuits every few months.[a]	**.46**	-.09	**.43**	–
I am a hard worker.	.20	**.57**	–	**.73**
I have overcome setbacks to conquer an important challenge.	-.06	**.54**	–	**.72**
I am diligent.	-.06	**.52**	–	**.66**
I have achieved a goal that took years of work.	.09	**.44**	–	**.57**
Cronbach's alpha	.79	.59	.81	.75

Note. AMOS columns display standardized regression weights. Factor loadings > .40 are bolded.

[a] Reverse-scored items.

Table 2

Means, Standard Deviations, and Correlations Between all Studied Variables

	M (*SD*)	1	2	3	4	5	6	7	8	9
1. Age	22.11 (6.89)	–								
2. CI[a]	3.58 (.78)	.09	–							
3. PE[a]	4.30 (.62)	.16*	.29***	–						
4. DP[b]	14.25 (8.13)	.12	.15*	.28***	–					
5. MP[c]	6.64 (.65)	-.04	.21**	.32***	.25***	–				
6. OP[c]	5.76 (1.39)	-.01	.15*	.22**	.09	.53***	–			
7. UP[c]	4.56 (1.79)	.04	.05	.09	-.14*	.20**	.42***	–		
8. Switch[c]	2.73 (1.50)	.04	-.34***	-.21**	-.14*	-.10	-.04	.05	–	
9. Quit[c]	1.97 (1.16)	.16*	-.26***	.03	.22**	-.14*	-.14*	-.13	.33***	–

Note. $N = 218$. CI = Consistency of interests, PE = Perseverance of effort, DP = Deliberate practice, MP = Mandatory practice, OP = Optional practice, UP = Unscheduled practice, Switch = Think switching, Quit = Think quitting. [a] Measured on a 5-point Likert scale. [b] Hours per week. [c] Measured on a 7-point Likert scale.

*$p < .05$. **$p < .01$. ***$p < .001$.

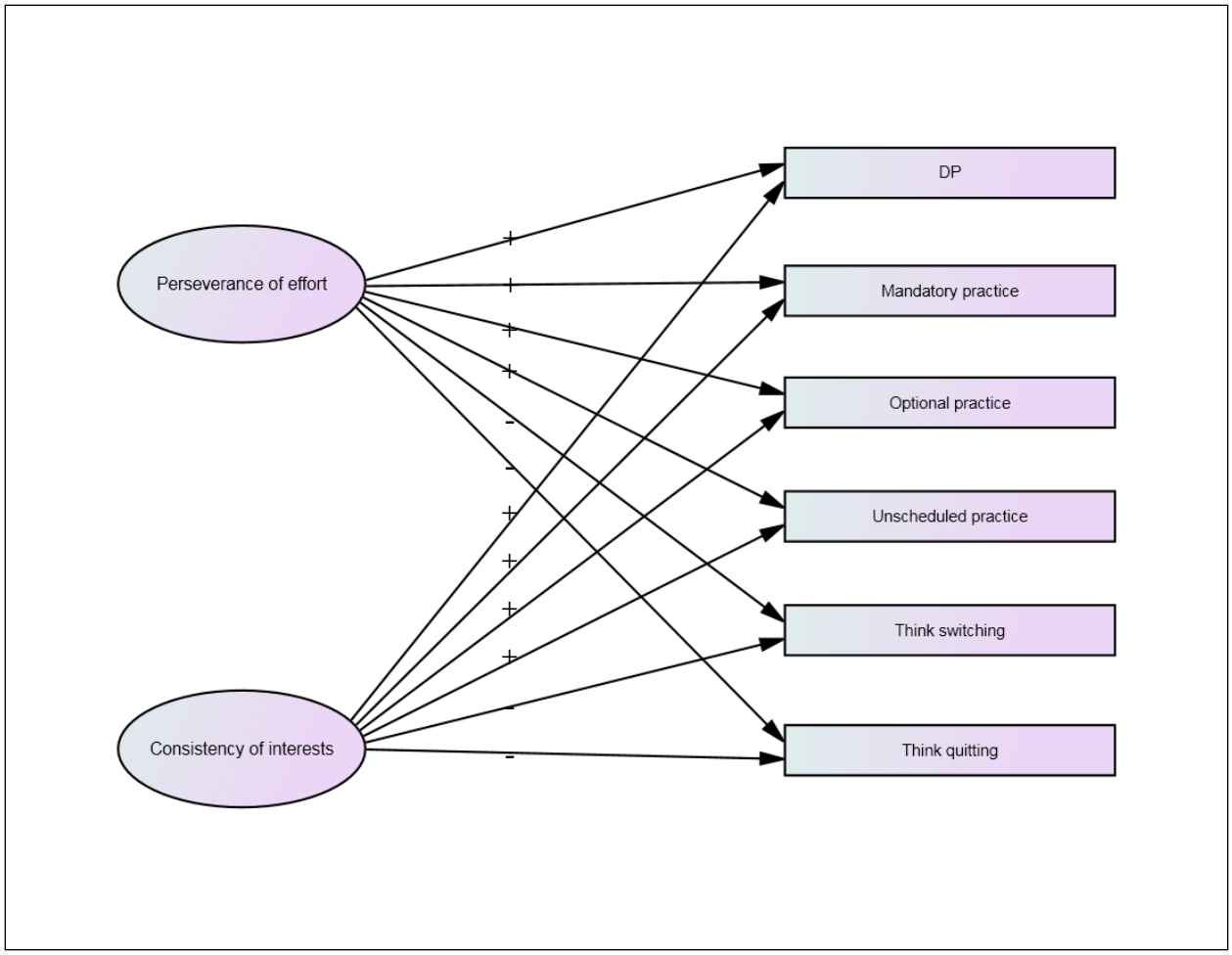

Figure 1. Hypothetical model. Relations between grit variables, practice and commitment-related measures. Age was a covariate in the analyses, but is not depicted for better visualization. DP = Deliberate practice.

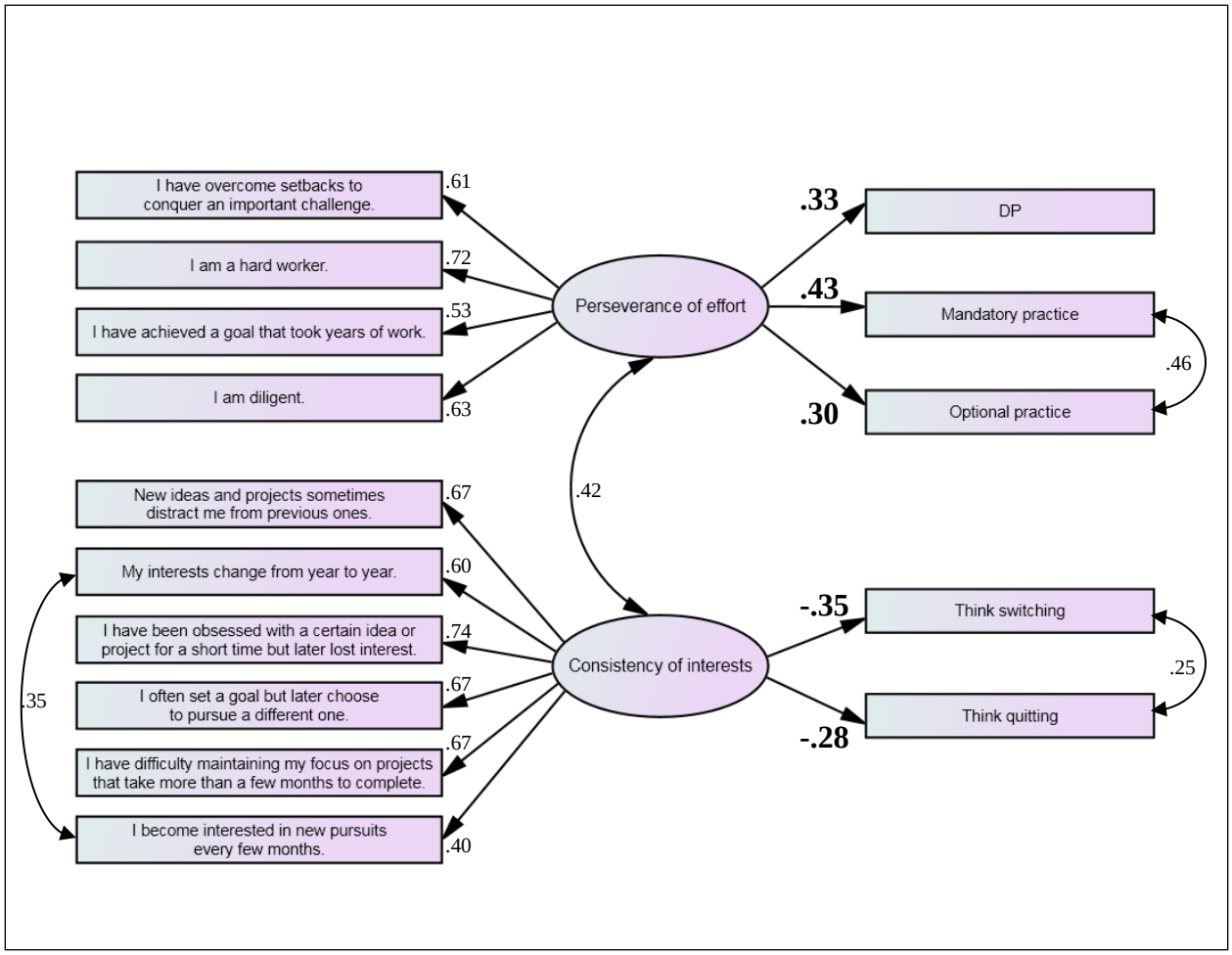

Figure 2. Final parsimonious full latent variable model (grit indicators on the left and outcomes on the right). Age was a covariate in the analyses, but is not depicted for better visualization. For all parameters displayed, $p < .001$.

Chapter IV: Article 3

Tedesqui, R. A. B., & Young, B. W. (2018). Comparing the contribution of conscientiousness, self-control, and grit to key criteria of sport expertise development. *Psychology of Sport & Exercise, 34*, 110-118. doi:10.1016/j.psychsport.2017.10.002

(Running head: CONSCIENTIOUSNESS, SELF-CONTROL, & GRIT IN SPORT)

Abstract

In order to develop expertise, athletes need to amass a high volume of deliberate practice activities over a long period of time. Three personality traits that conceptually relate to long-term goal pursuits and that have been linked to achievement outside sport are conscientiousness, self-control, and grit. This investigation examined how conscientiousness, alone (Study 1) and compared to self-control and grit (Study 2), explained criteria related to sport expertise development. Athletes (N = 270, 125 female, M_{age} = 21.27, SD = 6.91) ranging in skill level (local to international) completed surveys for personality, deliberate practice (DP), engagement in practice contexts (mandatory and optional), and threats to commitment (thoughts about quitting or switching out of one's sport). In Study 1, broad conscientiousness predicted engagement in both contexts of practice and fewer threats to commitment. At the facet-level, achievement-striving was the best predictor of DP and engagement in practice contexts. No conscientiousness facets predicted threats to commitment or higher skill group membership. In the comparative analyses between facets of conscientiousness, self-control, and grit (Study 2), grit variables performed best: *perseverance of effort* explained deliberate practice and higher skill group membership and *consistency of interests* associated with less thoughts of quitting/switching out of sport. Achievement-striving, dutifulness and self-discipline also showed effects associated with key criteria. These findings suggest, for example, that screening for perseverance of effort may help talent selectors identify which athletes have a personality advantage to persevere through the highly effortful conditions of DP. Other talent identification and development implications are discussed.

Keywords: personality, deliberate practice, perseverance of effort, consistency of

interests, talent identification and development

Comparing the Contribution of Conscientiousness, Self-Control, and Grit to Key Criteria of Sport Expertise Development

To develop sport expertise and reach the highest levels of talent, an athlete needs to apply a great deal of perseverance, discipline, and work ethic towards their sport practice and an enduring commitment to a sport. Much literature on expertise development in sport subscribes to postulates of the deliberate practice (DP) framework (Ericsson, Krampe, & Tesch-Römer, 1993). It contends that, to reach the highest levels, athletes need a long-term engagement in DP, defined as taxing, effortful practice activities designed to improve current performance. Ericsson et al. (1993) considered at least two kinds of limitations to individuals' ability to accumulate great amounts of DP activities. Because of the demanding and effortful nature of DP, Ericsson and colleagues proposed the *effort constraint*, explaining that individuals can sustain DP only for a limited amount of time each day before necessitating appropriate rest and recovery. They also proposed the *motivation constraint*, contending that DP is not inherently motivating per se; instead, individuals' satisfaction would derive from the improvement observed as a result of practice (cf. Hodges & Starkes, 1996). In regards to overcoming these constraints, Ericsson et al. noted that some individuals might be dispositionally equipped to work hard, suggesting that some athletes might be more motivated to expend extra effort in order to amass more DP activities than others.

According to a review by Baker and Young (2014), sport research has consistently shown that expert athletes accumulate more DP than less-experts at successive points in a career regardless of whether it may take less than 4000 (e.g., field hockey; Baker, Côté, & Abernethy, 2003) or over 18000 (e.g., gymnastics; Law, Côté, & Ericsson, 2007) hours of DP for athletes to develop expertise. Irrespective of recent disputes over the effect sizes attributed to DP with

respect to expertise development (e.g., Ericsson, 2016; Macnamara, Moreau, & Hambrick, 2016), it is generally accepted that expertise development typically involves a long-term engagement in dedicated practice, often characterized by increasing DP in a prioritized sport, as an aspiring athlete progressively shifts from sampling multiple sports/leisure hobbies to commit to one sport (Côté, Baker, & Abernethy, 2003). Although there is much support for these postulates within the sport domain, less research has examined the key personality characteristics that might help athletes amass more DP, that underpin desired striving behaviours toward long-term goal pursuits in sport, and that might explain the practice and commitment advantages of experts.

Research on sport talent identification and development (TID; e.g., Rees et al., 2016) provides a precedent for uncovering personality predictors of sport talent. For example, Gulbin, Oldenziel, Weissensteiner, and Gagné (2010) examined the Australian high performance sporting system and identified two key personality characteristics for TID: an early and enduring passion for the sport and resilience to setbacks. Piedmont, Hill and Blanco (1999) found conscientiousness to be an important predictor of soccer performance over time, and Toering and Jordet (2015) found that soccer players with higher levels of self-control had greater odds of being chosen for the Norwegian national team. Although such studies make a case for the import of individual difference variables for talent screening purposes, none specifically tested personality variables explicitly in relation to key tenets of an expertise development framework (EDF; e.g., Abernethy, Thomas, & Thomas, 1993; Ericsson & Smith, 1991).

Three personality traits that conceptually relate to long-term goal pursuits and may explain why some athletes accumulate more DP than others are: (a) *conscientiousness*, the tendency to control behaviours in service of personal goals (McCrae & Löckenhoff, 2010); (b)

grit, the tendency to pursue long-term goals with perseverance and passion (Duckworth, Peterson, Matthews, & Kelly, 2007); and (c) *self-control* (SC), the ability to control thoughts and emotions, and resist temptations in order to perform desired and inhibit undesired behaviours (Tangney, Baumeister, & Boone, 2004). These traits have been consistently linked to achievement in the school, work, and military domains (for meta-analytic reports on grit, SC, and conscientiousness, respectively, see Credé, Tynan, & Harms, 2017; De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Poropat, 2014). Although grit and SC emerged from different bodies of research and are not part of the five broad personality dimensions outlined by McCrae and John (1992), contemporary personality researchers contend that grit and SC share notable conceptual parallels with conscientiousness and thus "should be viewed as part of the family of conscientiousness constructs, if not seen as measuring facets of the [conscientiousness] trait" (Roberts, Lejuez, Krueger, Richards, & Hill, 2014, p. 1319)[4]. Still, research outside sport shows they can have different effects, depending on the context or task.

Emerging research suggests that grit (e.g., Larkin, O'Connor, & Williams, 2015; Tedesqui & Young, 2017b) and SC (e.g., Tedesqui & Young, 2017a; Toering & Jordet, 2015) are related to key aspects of athletes' development, including amounts of training and higher skill level. Although conscientiousness predicts performance among soccer players (Piedmont et al., 1999) and distinguishes between athletes and non-athletes (Malinauskas, Dumciene, Mamkus, & Venckunas, 2014), no prior studies have investigated conscientiousness, nor have

[4] Although self-control has been studied as a psychological construct independently of conscientiousness (e.g., Muraven & Baumeister, 2000), personality psychologists consider self-control to be a primary facet of conscientiousness (e.g., Roberts et al., 2014; Tangney et al., 2004). Thus, within the personality literature, "as it is typically conceived and measured, self-control should be viewed as lying within the domain of conscientiousness" (Roberts et al., 2014, p. 1320). Similarly, Duckworth et al. (2007) defined grit as a trait and a personal quality, specifically contrasting its predictive ability against that of conscientiousness and self-control, indicating their preference that grit be equally construed as a personality variable.

any contrasted the roles of conscientiousness, grit, and SC, within an EDF (e.g., Abernethy et al., 1993; Ericsson & Smith, 1991). To gauge the applicability of a variable of interest (i.e., personality traits) within an EDF, the DP (Ericsson et al., 1993) and the expert performance (Abernethy et al., 1993; Ericsson & Smith, 1991) frameworks, as well as a consequent body of research on sport expertise development (for a review, see Baker & Young, 2014) suggest that it is first necessary to assess whether a trait is associated with athletes' weekly amount of DP (e.g., Ward, Hodges, Starkes, & Williams, 2007) as well as its association with engagement in mandatory and optional practice contexts (e.g., Tedesqui & Young, 2017a). Further, it is important to determine whether a trait is associated with measures of athletes' commitment, or inversely, thwarts threats to one's sport commitment. Finally, it is critical to know whether a trait can distinguish between more and less-skilled groups (Abernethy et al., 1993; Baker, Wattie, & Schorer, 2015).

Thus, the current investigation aimed to examine the associations of conscientiousness, grit, and SC with criterion measures for (a) engagement in various practice contexts (including DP) and (b) commitment-related measures, as well as how (c) these traits could discriminate escalating skill groups in sport. In Study 1, we began by examining conscientiousness alone. In Study 2, informed by results from Study 1, we advanced key facets of conscientiousness to further analyses wherein their relative contribution could be contrasted with contributions from key facets of grit and SC. Overall, we sought to systematically identify the best personality predictors (in combination, and the best alone) of criteria associated with athletes' expertise development. Our decision to present two consecutive studies was guided by a parsimonious approach (i.e., selecting the fewest predictors that could explain the maximal amount of variance; Paulhus, Robins, Trzesniewski, & Tracy, 2004) for two reasons. From a research perspective,

parsimony helps avoid the risk of artificially inflating amounts of explained variance, which happens when too many variables are arbitrarily included as predictors. From an applied standpoint, it allows one to determine measures for TID screening that are most relevant.

Study 1

Conscientiousness is one of five broad personality dimensions in the five-factor model (McCrae & John, 1992). It comprises six facets: (a) competence, the degree to which individuals are effective, efficient, and prepared; (b) order, a preference for neatness, organization, and structure; (c) dutifulness, the tendency to be governed by rules and to adhere to principles; (d) achievement striving (AS), the tendency to set more challenging goals and to work harder to accomplish them; (e) self-discipline, the ability to begin and complete tasks despite boredom and distractions; and (f) deliberation, the tendency to interpose thought before an impulse to act (McCrae & Löckenhoff, 2010). Conscientiousness has been consistently linked to academic and job achievement (e.g., Poropat, 2014). It also distinguished between athletes and non-athletes (Malinauskas et al., 2014), and was associated with gymnasts' quality of preparation (Woodman, Zourbanos, Hardy, Beattie, & McQuillan, 2010) and with soccer performance (Piedmont et al., 1999). In these studies, conscientiousness was assessed at the broad, but not at the facet level. However, research is needed to examine conscientiousness facets, particularly because predictive validity tends to increase when lower-order facets are assessed (Paunonen & Ashton, 2001).

Conscientiousness has yet to be examined in the context of sport expertise development in a detailed and systematic manner at the facet level. This research is needed, especially considering that the six facets have curious parallels to how athletes may direct effort to DP (Ericsson et al., 1993; Tedesqui & Young, 2015). For example, athletes lower in self-discipline may be less likely to complete required amounts of DP during the off-season, when there is less

structure to their training, less obligations to others (e.g., coach), and more distractions. Those higher in deliberation might be better able to inhibit impulses that tempt them to skip effortful practice sessions. Therefore, the purpose of Study 1 was to test whether conscientiousness (both broad and facets) was associated with athletes' weekly amounts of DP, engagement in different practice contexts, and threats to commitment; and whether it predicted skill-group membership.

Method

Participants and Procedure

Participants were recruited mainly from national and provincial sport organizations in Canada and included 270 athletes (125 female; M_{age} = 21.27, *SD* = 6.91) mostly from individual sports (73.7%; e.g., swimming, athletics), who on average reported 14.05 (*SD* = 8.04) weekly hr of DP and 7.86 (*SD* = 5.29) years of training. A similar participant pool had been analyzed in our prior formative publications on SC and grit. However, because our research program is ongoing, more recent data collection has added participants beyond those in Tedesqui and Young (2017a; *N* = 244) and Tedesqui and Young (2017b; *N* = 250). All participants completed an online survey hosted by FluidSurveys. Informed/parental consent was obtained for participants under 18 years of age. The host university ethics board approved all procedures.

Instruments

In addition to demographic questions (i.e., sex and age) and general sport questions (e.g., one's main sport), the online survey included practice and commitment-related questions, questions about athletes' skill level, and a questionnaire assessing conscientiousness facets.

Practice and commitment-related measures. To assess athletes' engagement in weekly DP hours, they responded to the following question (adapted from Hopwood, 2013): "During a typical mid-season week, how many hours per week do you spend in individual or team

practice (activities deliberately designed to improve performance such as technical and tactical training)?" They also responded to four questions on a Likert scale ranging from 1 (never) to 7 (always) assessing engagement in different practice contexts (i.e., how often they attended mandatory practice; attended optional practice) and threats to their commitment (i.e., how often they thought about playing a different sport; thought about quitting their main sport).

Skill level. Athletes reported their highest level of competition in their main sport in one of six categories from (1) local, (2) city, (3) regional, (4) provincial, (5) national, to (6) international. Athletes who reported levels 1 to 4 were combined into the *Beginner/Intermediate* (*BI*) group, level 5 constituted the *Advanced* group, and level 6 formed the *Expert* group.

Conscientiousness facets. Participants completed the IPIP conscientiousness subscales (IPIP, n.d.) which have shown high convergent validity with Costa and McCrae's (1992) NEO-PI-R conscientiousness subscales and acceptable reliability and criterion validity (Goldberg, 1999). It comprises 60 items assessing six facets: self-efficacy (e.g., "I excel in what I do"; α = .79), orderliness (e.g., "I like order"; α = .81), cautiousness (e.g., "I stick to my chosen path"; α = .81), achievement-striving (e.g., "I work hard"; α = .77), self-discipline (e.g., "I carry out my plans"; α = .87), and dutifulness (e.g., "I keep my promises"; α = .76). Despite some differences in terminology, these six IPIP conscientiousness subscales are conceptually meant to assess the same traits assessed by Costa and McCrae's (1992) subscales: competence, order, deliberation, achievement striving, self-discipline, and dutifulness, respectively. Participants rated the degree to which items corresponded to their typical behaviour on a Likert-scale from 1 (not at all) to 5 (very much). To obtain the broad conscientiousness score (α = .94), we computed the mean of the subscales scores (Paunonen & Ashton, 2001).

Data Analysis

The associations that conscientiousness scores had with the five practice and commitment-related criterion measures were tested through two separate path analyses in AMOS 18 (Arbuckle, 2009). In one path analysis, we specified broad conscientiousness as a predictor of the criterion measures, i.e., weekly DP hours, frequency of attendance at mandatory and optional practice, thoughts of switching and quitting one's sport. In the other path analysis, we specified the six facet scores as predictors of the five criterion measures. We conducted multinomial logistic regressions to test whether athletes' scores on conscientiousness predicted membership in two progressively skilled groups (i.e., Advanced and Expert) relative to the BI (reference) group. We conducted binary logistic regressions to inspect whether conscientiousness facets predicted the likelihood of athletes belonging to the Expert group compared to the Advanced (reference) group. Logistic regressions were conducted separately for junior (< 18 years; $n = 96$) and senior (18 and older; $n = 174$) athletes as it is inappropriate to collapse skill groups across age divisions (e.g., an international-level junior athlete with an international-level senior athlete). The same multinomial and binomial regressions were performed, separately by age division, with the broad conscientiousness score as a predictor in lieu of the six facet scores. Power analyses indicated sufficient sample size for all planned analyses at alpha = .05, power > .80.

Results

Preliminary Analyses

We excluded a participant's responses whenever there were missing values for two or more items on any of the six conscientiousness subscales ($n = 16$). Subsequent missing values analyses indicated that data were missing at random, Little's MCAR test: $p = .29$. We used expectation maximization to input missing values for the six conscientiousness subscales and only participants who had full data for the criterion measures were included in the main analyses.

Preliminary analyses were conducted to check for possible covariates. Age was positively correlated with four conscientiousness facets: self-efficacy, dutifulness, achievement-striving (AS), and cautiousness (see Table 1 in supplemental material, for a correlation matrix). Chi-square analysis among senior athletes revealed relatively more females in the Expert group and relatively more males in the BI group, χ^2 (2, N = 175) = 6.74, $p < .05$. In addition, overall, females (M = 3.88, SD = .44) had higher broad conscientiousness than males (M = 3.76, SD = .44, $t(268) = 2.09$, $p < .05$, $d = .25$). Thus, we included age and sex as covariates in all analyses.

Practice and Commitment-Related Measures

The associations between conscientiousness scores and each of the practice and commitment-related measures, while controlling for age and sex, are presented in Figure 1a (broad conscientiousness alone) and Figure 1b (the six facets), respectively.

Skill Group Membership Analyses

Broad conscientiousness. Among *juniors*, the multinomial logistic regression comparing the Advanced and Expert groups to the BI group was significant, $\chi^2(6) = 39.05$, $p < .001$. The deviance coefficient indicated good fit to the data, $\chi^2(178) = 160.90$, $p = .82$, and Nagelkerke $R^2 = .39$. Likelihood ratio tests indicated age was a significant predictor, $\chi^2(2) = 37.34$, $p < .001$, $b_{\text{Advanced}} = 1.01$, Wald $p < .001$, $b_{\text{Expert}} = 1.44$, Wald $p < .001$; however, broad conscientiousness was not, $\chi^2(2) = 2.17$, $p = .34$. The binary logistic regression model comparing the Expert to the Advanced group was non-significant, $\chi^2(2) = 3.21$, $p = .20$.

Among *seniors*, the model comparing the Advanced and Expert groups to the BI group was significant, $\chi^2(6) = 28.32$, $p < .001$, with a good fit, $\chi^2(326) = 308.29$, $p = .75$, Nagelkerke $R^2 = .18$. Age was a predictor, $\chi^2(2) = 15.50$, $p < .001$, $b_{\text{Advanced}} = 0.04$, Wald $p = .43$, $b_{\text{Expert}} = 0.14$, Wald $p < .01$, as was sex, $\chi^2(2) = 10.72$, $p < .01$, $b_{\text{Advanced}} = 1.09$, Wald $p < .05$, $b_{\text{Expert}} = 1.48$,

Wald $p < .01$; however, broad conscientiousness was not, $\chi^2(2) = 0.48$, $p = .79$. The model comparing the Expert group to the Advanced group was significant, $\chi^2(3) = 9.41$, $p < .05$, Nagelkerke $R^2 = .09$. However, only age was a predictor, $b = 0.09$, Wald $p < .01$; broad conscientiousness was not, $b = 0.03$, Wald $p = .95$.

Conscientiousness facets. Among *juniors*, the multinomial regression model was significant, $\chi^2(16) = 48.71$, $p < .001$, with good fit to the data, $\chi^2(170) = 151.24$, $p = .85$, Nagelkerke $R^2 = .46$. Age was a predictor, $\chi^2(2) = 36.79$, $p < .001$, $b_{Advanced} = 1.02$, Wald $p < .001$, $b_{Expert} = 1.61$, Wald $p < .001$; however, conscientiousness facets were not predictors, with likelihood ratio tests ranging from $\chi^2_{Orderliness}(2) = 4.19$, $p = .12$ to $\chi^2_{Cautiousness}(2) = 0.002$, $p = .99$. The binary logistic regression model was non-significant, $\chi^2(8) = 11.23$, $p = .19$.

For *seniors*, the multinomial logistic regression was significant, $\chi^2(16) = 38.99$, $p < .01$, with a good fit to the data, $\chi^2(320) = 297.62$, $p = .81$, Nagelkerke $R^2 = .24$. Age was a predictor, $\chi^2(2) = 14.72$, $p < .01$, $b_{Advanced} = 0.03$, Wald $p = .54$, $b_{Expert} = 0.13$, Wald $p < .01$, as was sex, $\chi^2(2) = 10.33$, $p < .01$, $b_{Advanced} = 1.16$, Wald $p < .05$, $b_{Expert} = 1.58$, Wald $p < .01$; however, no conscientiousness facets were predictors, with likelihood ratio tests ranging from $\chi^2_{AS}(2) = 3.38$, $p = .18$ to $\chi^2_{Cautiousness}(2) = 0.17$, $p = .92$. Finally, the binary logistic regression model was significant, $\chi^2(8) = 15.77$, $p < .05$, Nagelkerke $R^2 = .15$. However, only age was a predictor, $b = .10$, Wald $p < .01$; no conscientiousness facets predicted the likelihood of athletes belonging to the higher skill group, bs $\leq |0.98|$, ps $\geq .12$.

Discussion

Engagement in Various Practice Contexts

Whereas broad conscientiousness did not prove significant, AS (positively) and dutifulness (inversely) were associated with weekly DP. This suggests that the specific tendency

to set higher goals and to work harder to reach those goals may be instrumental. Achievement-oriented people are "more focused and willing to pull all stops to accomplish their goals" (Roberts, Chernyshenko, Stark, & Goldberg, 2005, p. 125), meaning they might be better able to use all their resources to accomplish their goal of accruing greater DP in the pursuit of higher skill. In contrast, when athletes reported greater tendency to be governed by rules of conduct and principles, they also reported *fewer* weekly DP hours. Moon (2001) conceptualized dutifulness and AS as the "two faces of conscientiousness" (p. 534), presenting dutifulness as an other-centered construct and AS as a self-centered construct. In an organizational context, dutifulness explains a concern for the welfare of the department, whereas AS explains one's concern with their own career advancement. Considering that engaging in higher amounts of DP demands a selfish orientation towards improvement (Farrow, in press), it makes sense that AS would relate to increased DP. Conversely, dutiful athletes who may be more concerned with helping the coach and other team members may fail to maximize their own preparatory activity. Further, because dutiful individuals are methodical and rule-following (Moon, 2001), they may take extra time in *setting the conditions* for practice before actually *beginning* DP. Finally, more-dutiful athletes may be more reluctant to forfeit social responsibilities to family/community in order to find time to amass DP (Roberts et al., 2005; Tedesqui & Young, 2015).

Broad conscientiousness and AS were each associated with more frequent engagement in mandatory and optional practice. Thus, the tendency to control one's behaviour in the service of personal goals and to set and strive for higher goals may help athletes regularly engage in socially-prescribed and self-regulated forms of practice. Achievement-strivers' higher tendency to engage in more mandatory and optional practice fits well with previous work showing achievement-oriented individuals exhibiting higher goal commitment, regardless of whether

goals are self-set or socially prescribed (Hollenbeck, Williams, & Klein, 1989). Because conscientious people tend to control their behaviours to reach their goals, conscientious athletes may be better able to forfeit alternative activities (e.g., socializing) to attend optional practice (Tedesqui & Young, 2015). Interestingly, athletes who reported preferences for neatness, organization, and structure in life (i.e., orderliness) also reported a reduced engagement in optional practice. Contrasting associations for AS and orderliness were also reported by Roberts et al. (2005) who found 'order' was negatively associated with work dedication whereas industriousness, an achievement-oriented aspect, showed a positive association. In contrast to mandatory practice, optional practice arguably requires recruitment of more self-regulation to "go out of one's way" to get to training. We posit that orderly individuals would prioritize activities which are already part of one's routine (e.g., regular practice sessions), as opposed to extra activities (e.g., optional practice sessions) which may require reorganizing one's priorities and rescheduling of activities that were already in one's calendar.

Threats to Commitment

Only broad conscientiousness scores were associated with athletes' thinking less about switching out of, or quitting, their sport. Due to a greater ability to control their behaviours, conscientious athletes might be better able to stay committed on the developmental road to expertise whenever faced with difficult situations (e.g., extreme fatigue from a tough DP session) that might prompt them to think about alternative pursuits (e.g., playing a different sport) or to think about abandoning their sport. In regards to the lack of prediction by conscientiousness facets, each facet showed some degree of negative correlation with thoughts about quitting one's sport (see Table 1); however, when pitted against each other in the path model, no facet explained enough unique variance to reach statistical significance.

Broad Conscientiousness vs. Specific Facets

The parallel assessment of conscientiousness at broad and facet levels is a strength of Study 1. Broad conscientiousness explained outcomes related to how one directed their thinking towards their sport commitment, and possibly departing (quitting, switching) their sport. Although broad conscientiousness had associations with measures reflecting frequency of behavioural engagement in practice, the facet scores showed stronger associations with these measures, and especially with the most intensive measure of behavioural engagement, i.e. DP. Our findings demonstrate the importance of assessing facets, affirming work by Paunonen and Ashton (2001) who found that specific facets increased the average amount of criterion variance explained in sport participation. Had we not assessed conscientiousness at the facet-level, we could have mistakenly concluded that elements of conscientiousness were not relevant for understanding higher engagement in DP.

What Does this Mean for the Tenets of the Expertise Development Framework?

In sum, our findings corroborate prior research showing a key role of conscientiousness for athletes' quality of training (Woodman et al., 2010). Specifically, we found AS, dutifulness, and orderliness as facets that may be important for athletes' practice and commitment variables related to sport expertise, offering preliminary evidence of predictive validity with respect to practice and commitment tenets of an EDF. Regarding the remaining tenet, i.e., relations to incrementally-skilled group status, neither broad nor facet-level conscientiousness performed well. Collectively, results from Study 1 suggest that although conscientiousness might not be directly related to athletes' skill levels, it may indirectly impact athletes' development through associations with practice activities (e.g., DP) which are instrumental for reaching expert levels.

Study 2

In Study 2, we aimed to compare the associations that facets of self-control (SC), grit, and conscientiousness had with criterion measures for practice and commitment, as well as skill group status. In achievement domains outside of sport, researchers have begun to test the relative importance of these traits as they relate to performance and striving. For example, compared to SC and conscientiousness, grit more powerfully predicted college success, cadets' persistence over a summer training program, and spelling bee competitors' performance (Duckworth et al., 2007). Dumfart and Neubauer (2016) compared several traits including conscientiousness, grit, and SC, and concluded that conscientiousness best predicted adolescent school achievement. Muenks, Wigfield, Yang, and O'Neal (2016) compared grit, conscientiousness, SC and other self-regulation variables for how they predicted college students' grades. Conscientiousness and other self-regulation variables were most strongly associated with grades, yet perseverance of effort—a grit subscale—also had significant associations. There is no consensus on the relative importance of the three traits for educational outcomes. More importantly, no research has contrasted these variables as they relate to critical outcomes within an expertise development framework (EDF).

In Study 1, we assessed the contribution of conscientiousness within an EDF. In prior work in our research program, we had systematically tested the contributions of SC and grit separately. Tedesqui and Young (2017a) investigated constructs relating to Tangney et al.'s (2004) conceptualization of SC and found that *self-discipline*—SC subscale—was linked to weekly DP and frequent engagement in mandatory and optional practice. A second subscale, *impulse control*, was positively associated with athletes' frequent engagement in optional practice. Self-discipline also had significant inverse associations with thoughts of switching and

quitting one's main sport, whereas athletes who reported lower impulse control reported significantly more thoughts of quitting, and more thoughts of switching at a level approaching significance. In subsequent work on grit (Tedesqui & Young, 2017b), *perseverance of effort*—a grit subscale—significantly predicted weekly deliberate practice (DP; b = .33), mandatory practice (b = .43), and optional practice (b = .30); *consistency of interests*—a second subscale—significantly predicted thoughts of switching (b = -.35) and thoughts of quitting (b = -.28) one's main sport. In addition to testing each trait's associations with criterion measures, these prior works also described the reliability and structural validity of the measures to understand whether the subscales were sound in sport.

In light of these works, the purpose of Study 2 was to identify: (a) the parsimonious combination of these traits that could explain the maximal amount of variance in criterion measures of sport expertise development; (b) their unique and additive contributions to explained variance on these criterion measures; (c) the single best predictor of variance in each criterion measure; and (d) which traits explained higher skill-group membership. Study 2 included personality facets that were selected based on results for conscientiousness (Study 1, this manuscript), as well as results for SC (Tedesqui & Young, 2017a) and grit (Tedesqui & Young, 2017b). The analyses in these prior works were critical for eliminating any subscales from our ultimate contrasting analysis in Study 2. Having prior results inform our variable selection for Study 2 ensured that we did not indiscriminately add variables to our predictive model, thereby helping us avoid artificially inflating variance explained, and allowing us to heed Tabachnick and Fidell's (2013, p. 5) "garbage in, roses out" cautionary advice on the selection of predictors.

Method

Participants and Procedure

Study 2 employed the same sample from Study 1. In addition to questions pertaining to conscientiousness and the same criterion measures, participants also completed measures assessing SC and grit. Participants were retained if they completed all pertinent measures for conscientiousness, grit, and SC subscales on a list-wise basis (270 participants total).

Survey Measures. The Brief Self-Control Scale (Tangney et al., 2004; Toering & Jordet, 2015) assessed two SC facets: (a) *self-discipline* (SD; $\alpha = .80$), the ability to be self-disciplined and work toward goals; and (b) *impulse control* ($\alpha = .71$), the ability to control impulses and resist temptations (see Tedesqui & Young, 2017a, for structural validity). The Grit Scale (Duckworth et al., 2007) measured two facets: (a) *consistency of interests* (CI; $\alpha = .78$), the tendency to remain interested in the same goals over time; and (b) *perseverance of effort* (PE; $\alpha = .68$), the ability to sustain effort in the face of adversity (see Tedesqui & Young, 2017b, for structural validity). All Likert scale ratings ranged from 1 (not at all) to 5 (very much).

Data Analysis

Regressions for Criterion Measures. We conducted five analyses, regressing pertinent facet variables separately on: (a) DP, (b) mandatory practice, (c) optional practice, (d) thoughts of switching, and (e) thoughts of quitting. For each criterion dependent variable (DV), age and sex were entered as covariates in the first block, and were kept in the model in all subsequent steps. In a second block, we added facets as independent variables (IVs) in a manner informed by our prior results. The selection of these IVs for each analysis is indicated in the left-hand column of Table 2. From the second block, we used a backward deletion approach, deleting IVs from the model, one at a time, if they were not contributing significantly to the model (Tabachnick & Fidell, 2013). Non-significant IVs having the lowest standardized beta weights were removed first. We proceeded until only significant predictors remained. This approach allowed us to

determine the parsimonious combination of facets that best predicted each DV and the unique (i.e., partial R^2) and additive (i.e., adjusted R^2) contributions of facets. As a final step, among the retained significant predictors, we iteratively removed those IVs affording the lowest amount of unique contribution to the prediction (i.e., the significant predictors with the lowest standardized beta weights). We proceeded until only one facet predictor remained, which enabled us to identify the best personality predictor for each DV (see right-hand column of Table 2).

Regressions for Skill Group Membership. To inspect which of the seven facets (two grit subscales—PE, CI; two SC subscales—SD, impulse control; and three conscientiousness subscales—achievement-striving [AS], dutifulness, orderliness) would predict skill group membership, we conducted multinomial logistic regressions (to compare Advanced and Expert groups to the Beginner-Intermediate [BI] reference group) and binomial regressions (to compare the Expert to the Advanced reference group) as we did in Study 1. Analyses were performed separately for junior and senior athletes. Power analyses indicated sufficient sample size for all planned analyses at alpha = .05, power > .80.

Results

Regressions for Criterion Measures

Correlations between athletes' scores on the facets and various criterion measures can be found in Table 1. Results for the regressions on criterion measures are summarized in Table 2.

With respect to analyses pertaining to athletes' weekly amounts of DP, there were unique circumstances that required further exploration beyond the steps outlined in the planned analyses. In search of a parsimonious combination of personality predictors of DP, three of the four initially inserted facets remained significant. PE and AS *positively* predicted DP, while dutifulness was a *negative* predictor. A careful interpretation of the zero-order correlations

(Tabachnick & Fidell, 2013) showed that dutifulness, PE, and AS were positively correlated with each other (see Table 1). However, whereas both PE and AS showed significant *positive* correlations with DP (r = .30 and r = .22, respectively), dutifulness showed a trend in the opposite direction (r = -.07). The fact that dutifulness became significant when assessed together with other correlated predictors (AS, PE), combined with the observation that the predictors had betas in opposite directions suggested the existence of a suppressor situation.

We suspected that dutifulness was acting as a suppressor variable. To confirm, as per recommendations by Paulhus et al. (2004), we performed three separate, post-hoc, standard multiple regression analyses for DP, treating different pairings of the three IVs (i.e., PE, AS, and dutifulness) against their predictive contribution alone (age and sex remained as covariates). In a model including dutifulness and PE, their predictive contributions were stronger (β_{Dut} = -.20 and β_{PE} = .35) compared to when they were assessed separately (β_{Dut} = -.10 and β_{PE} = .28). Similarly, the predictive contributions of dutifulness and AS were stronger (β_{Dut} = -.25 and β_{AS} = .31) compared to when they were assessed separately (β_{Dut} = -.10 and β_{AS} = .20). Finally, the predictive contributions of PE and AS were weaker (β_{PE} = .25 and β_{AS} = .05) compared to when they were assessed separately (β_{PE} = .28 and β_{AS} = .20). These analyses confirmed that dutifulness was suppressing irrelevant variance between PE and DP and between AS and DP. The shared variance between the predictors which did not help explain DP was eliminated or controlled for, thereby increasing the predictive contribution of the facets (Paulhus et al., 2004).

Regressions for Skill Group Membership

Juniors. The multinomial regression model using the BI reference group was significant, $\chi^2(18) = 53.92$, $p < .001$. The deviance coefficient indicated good fit to the data, $\chi^2(168) = 146.03$, $p = .89$, Nagelkerke $R^2 = .50$. Age was the only significant predictor, $\chi^2(2) = 34.28$, $p <$

.001, $b_{Advanced}$ = 1.02, Wald p < .001, b_{Expert} = 1.55, Wald p < .001. The binary logistic regression model comparing the Expert to the Advanced group was non-significant, $\chi^2(9) = 14.32$, $p = .11$.

Seniors. The multinomial regression model using the BI reference group was significant, $\chi^2(18) = 46.21$, $p < .001$, with good fit, $\chi^2(318) = 290.40$, $p = .87$, Nagelkerke $R^2 = .28$. Both age and sex were predictors: for age, $\chi^2(2) = 11.81$, $p < .01$, $b_{Advanced} = .03$, Wald $p = .54$, b_{Expert} = 0.12, Wald $p < .05$; for sex, $\chi^2(2) = 7.11$, $p < .05$, $b_{Advanced} = .95$, Wald $p = .08$, $b_{Expert} = 1.30$, Wald $p < .05$. PE was also a predictor, $\chi^2(2) = 6.10$, $p < .05$, predicting the likelihood of an athlete belonging to the Expert compared to the BI group, $b_{Expert} = 1.15$, Wald $p < .05$. As senior athletes scored one standard deviation higher in PE, their odds of belonging to the Expert group were 3.18 times larger. PE did not predict the likelihood of an athlete belonging to the Advanced compared to the BI group, $b_{Advanced} = .89$, Wald $p = .09$. The binary logistic regression model comparing the Expert to the Advanced group was non-significant, $\chi^2(9) = 14.74$, $p = .10$.

General Discussion

In Study 2, we compared the relative contribution of several previously poignant personality facets (see Study 1, this manuscript; Tedesqui & Young, 2017a, 2017b) to the explanation of variance in five criterion measures relating to sport expertise development. We were interested in identifying the most parsimonious combination of facets, as well as the best predictor, for each criterion measure. We also sought to identify which facets, when pitted against each other, would be able to predict the likelihood of athletes belonging to higher skill groups. Overall, we discovered parsimonious combinations of personality facets that explained between 9% and 13% of variance in each of the five criterion measures, and specifically 12% of variance for DP, which corresponds to small to medium effect sizes (Cohen, 1992). Different personality characteristics had predictive roles depending on the criterion measure. Only PE

discriminated between low and higher skill groups.

Engagement in Various Practice Contexts

PE was most strongly associated with weekly amount of DP. Thus, the more strongly athletes identified with hard work and diligence, acknowledged working at a goal for years, and overcoming setbacks to finish whatever they start, the more likely they were to report the highest DP. This suggests that athletes' disposition to sustain effort despite adversity is a valuable attribute for maximizing DP. Screening for PE may help identify which athletes have a personality advantage to persevere through the highly effortful conditions of DP (Ericsson et al., 1993). The suppression results suggest that, for the purpose of maximizing DP, having lower dutifulness may be beneficial for athletes who *also* show high AS and/or PE. Dutiful individuals are more likely to feel bound to promises to others or constrained by others' instructions, which Moon (2001) described as an other-centered focus, whereas those high in AS would have a more self-centered focus. Thus, athletes with a predisposition to persevere through setbacks (high PE) and/or strive for higher goals (high AS), who also show a lower consideration to social duties (low dutifulness), may display the "selfish" profile which is a marker of super-elite athletes who fully focus on their own improvement (Farrow, in press). Such athletes might be predisposed, for example, to engage in both necessary *and* additional DP in spite of other time commitments in one's family (e.g., home chores) or school (e.g., homework). In the context of talent identification and development (TID), including a measure of dutifulness might allow talent screeners to select, amongst athletes with high AS/PE, those with a greater disposition to maximize DP due to a disregard for competing social 'duties'.

PE was also most positively associated with engagement in mandatory practice while AS most positively related to optional practice. This finding may be due to nuanced conceptual

distinctions between the traits. AS refers to pursuing goals that are self-set (McCrae & Löckenhoff, 2010), a subtlety not captured by PE items (Duckworth et al., 2007). It may be that AS helps athletes engage in goal-oriented practice they voluntarily set for themselves (e.g., deciding to attend optional practices) whereas higher PE allows athletes to persist through challenges encountered in the context of DP and prescribed practice (e.g., complying to a coach's expectations to attend/complete a practice session despite exhaustion/soreness). Finally, the presence of SD (SC subscale) in parsimonious models predicting both mandatory and optional practice suggests that athletes who more strongly acknowledge that they have iron SD and that they avoid pleasure and fun in order to get things done, are also more likely to attend practice regardless of whether this attendance reflects an act of compliance or volition.

Threats to Commitment

CI was the only significant predictor of thoughts about switching out of one's main sport and was the strongest predictor of thoughts about quitting. Thus, individuals who reported the least threatening thoughts with respect to their sport commitment also were the athletes who reported personal tendencies to set a goal and not deviate to alternative goals, to maintain stable interests year to year, and to be obsessed about a project without relinquishing interest. Screening for CI may help identify which athletes have a personality advantage conducive to maintaining interest in a primary sport over time. Staying committed to, and becoming increasingly invested in one sport over many years, while one progressively weans activity in alternative pursuits characterizes the long-term development path of many experts (Côté et al., 2003; Young & Medic, 2008) and likely affords them advantages with respect to prolonged engagement in DP (Helsen et al., 1998). Also, results showed that athletes reporting higher self-disciplined tendencies (SC subscale) also thought less about quitting. Perhaps more self-disciplined athletes

think less about quitting their sport because they tend to develop good practice habits and routinize how they regulate their lives around training (De Ridder et al., 2012; Tedesqui & Young, 2017a), such that they encounter fewer situations that actually pose threats to their commitment.

Skill Group Membership

PE was the sole predictor of higher skill group membership; senior athletes scoring higher in PE were more than three times as likely to belong to the Expert compared to the BI group. Athletes with a higher dispositional tendency to persevere through setbacks might have greater odds of advancing through higher skill levels. It is worth noting that this finding was only observed among seniors, possibly because training demands/intensity are greater at the senior category, so the ability to persist through challenges would prove more beneficial.

Overall, considering the tenets of an EDF, our findings demonstrate a prominent role for grit. Grit variables best predicted four out of the five practice and commitment outcomes, and discriminated skill groups. Thus, Study 2 extends Duckworth et al.'s (2007) conclusions on the critical role of grit (compared to traits such as SC and conscientiousness) for achievement and retention outcomes to elite sport. However, whereas Duckworth et al. assessed grit, conscientiousness, and SC variables broadly (i.e., a global score for each of the traits), our results provide more nuance by identifying the contribution of specific facets. Specifically, PE was the best predictor of weekly DP and engagement in mandatory practice, and the sole predictor of skill group membership, making it the only facet that satisfied both tenets of the EDF.

Theoretical and Practical Implications

We took a systematic approach in our investigations, starting with 10 personality facets derived from the conscientiousness family, examining the contribution of SC, grit and

conscientiousness uniquely, and then advancing pertinent facets to maximize prediction while using the fewest conceptually-related traits possible. Although our results require replication, the current work advances findings that could have important implications for researchers and practitioners in TID. Our results point to some individual difference variables that may help athletes overcome the motivation and effort constraints outlined in the DP framework (Ericsson et al., 1993) in order to maximize DP. Specifically, athletes with higher levels of PE may be better equipped to endure the hard work required in effortful DP activities, and those with higher levels of CI may be better able to sustain their motivation in the same expertise pursuit over a long period of time. Consequently, some personality facets may be regarded as important assets for athletes' successful circumvention of DP constraints in order to maximize their performance levels. Our research project culminates in the identification of PE and CI as priority target personality characteristics, and AS, dutifulness, and SD as three further pertinent facets for TID programs. These findings add to prior literature acknowledging the role of passion and resilience for athletes aspiring to reach the most elite levels (Gulbin et al., 2010). By pinpointing these critical traits using our parsimonious analytic strategy, our results indicate which conscientiousness-related traits deserve more attention in future TID programs. TID work often relies on self-report surveys to screen athletes and our results should impart some focus to efforts thereby reducing participant burden (e.g., avoiding long evaluation times) and minimizing resource demands (e.g., avoiding the need of multiple assessment tools).

Limitations and Future Research

Due to the fact that our sample predominantly constituted individual sport athletes and that we did not control for type of sport in our analyses, caution should be exercised in generalizing the findings to team sport athletes. Also, our findings are based on cross-sectional

and self-report data, which demands caution in interpretations of causation/directionality and raises concerns about social desirability. However, because athletes responded voluntarily and anonymously in a non-testing environment, we have little reason to believe that social desirability played a part (e.g., Roberts et al., 2005). On the other hand, because this investigation occurred in a non-testing setting, little insight was obtained regarding whether these facets would remain significant if used as part of screening tools in an ecologically-valid TID context. Future research might submit these variables to tests of validity in such TID contexts to further position them as viable predispositions to future expertise. Future studies might also explore the possibility that the investigated facets may differentially impact variable conditions of DP (e.g., alone or with others, with or without coach supervision; Bartulovic, McCardle, Baker, & Young, 2016) and whether different profiles (i.e., different permutations of personality facets, including the facets identified in the current findings) could have implications for TID depending on specific contexts. In addition, future research might explore whether other personality characteristics that were not investigated in the current study have an impact on expertise development, depending on the sport. For example, openness to experience, a trait consistently related to creative achievement (e.g., Kaufman et al., 2016), may be important for athletes in artistic sports. Future research might also attempt to investigate how these traits are manifested in athletes' daily *quality* practice, not only quantities/frequencies of practice, and whether/how these optimal characteristics could be fostered in developing athletes as well as how they interact with state-like psychological skills and competencies (e.g., self-regulation; McCrae & Löckenhoff, 2010; self-regulated learning in sport; Bartulovic, Young, & Baker, 2017). Finally, although the facet related to trait competence (i.e., self-efficacy subscale) was non-significant in this investigation, self-efficacy researchers who follow the tradition of

Bandura's (1997) social cognitive theory may wish to specifically examine state self-efficacy as it relates to striving and efforts during specific situations of DP.

Conclusion

In sum, our results suggest that while SC and conscientiousness facets may have an influence on athletes' practice and commitment-related measures, grit variables seem to be the most influential, being the best predictors of four out of the five criterion measures. In particular, PE was the only facet that satisfied both tenets of the EDF. Our findings also suggest that the investigated facets have differential roles in predicting athletes' expertise development, related to directing and sustaining efforts on developmental pursuits and focus on preparatory tasks. More specifically, (a) PE was the best predictor of DP, mandatory practice, and skill group membership, (b) AS was the best predictor of optional practice, and (c) CI was the best predictor of thoughts of switching and quitting one's sport.

Acknowledgments

This work was supported initially (2013-2016) by the Social Sciences and Humanities Research Council of Canada (SSHRC) through a Joseph-Armand Bombardier Canada Graduate Scholarship (767-2013-2136), and subsequently (2016-2017) by an Ontario Graduate Scholarship.

References

Abernethy, B., Thomas, K. T., & Thomas, J. T. (1993). Strategies for improving understanding of motor expertise [or mistakes we have made and things we have learned!!]. *Advances in Psychology, 102,* 317-356.

Arbuckle, J. L. (2009). Amos (Version 18.0) [Computer Program]. Chicago: IBM SPSS.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Baker, J., Côté, J., & Abernethy, B. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology, 15,* 12–25. doi:10.1080/10413200305400

Baker, J., Wattie, N., & Schorer, J. (2015). Defining expertise: A taxonomy for researchers in skill acquisition and expertise. In J. Baker & D. Farrow (Eds.), *The Routledge handbook of sport expertise* (pp. 145-155). London: Routledge.

Baker, J., & Young, B. W. (2014). 20 years later: Deliberate practice and the development of expertise in sport. *International Review of Sport & Exercise Psychology, 7,* 135-157.

Bartulovic, D., McCardle, L., Baker, J., & Young, B. W. (2016). Engaging in more deliberate practice: The role of self-regulated learning for competitive athletes. *Journal of Exercise, Movement, & Sport: Proceedings of the Canadian Society for Psychomotor Learning & Sport Psychology, 48*(1), 64. Retrieved from: http://www.scapps.org/jems/index.php/1/article/view/1317

Bartulovic, D., Young, B. W., & Baker, J. (2017). Self-regulated learning predicts skill group differences in developing athletes. *Psychology of Sport & Exercise, 31,* 61-69. doi:10.1016/j.psychsport.2017.04.006

Cohen, J. (1992). A power primer. *Psychological Bulletin,* 112, 155-159.

Costa, P. T. Jr., & McCrae, R. R. (1992). *The Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) Professional Manual*. Odessa, FL: Psychological Assessment Resources.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89-110). Champaign, IL: Human Kinetics.

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality & Social Psychology, 113,* 492-511. doi:10.1037/pspp0000102

De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality & Social Psychology Review, 16,* 76-99.

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality & Social Psychology, 92,* 1087-1101. doi:10.1037/0022-3514.92.6.1087

Dumfart, B., & Neubauer, A. C. (2016). Conscientiousness is the most powerful noncognitive predictor of school achievement in adolescents. *Journal of Individual Differences, 37,* 8-15. doi:10.1027/1614-0001/a000182

Ericsson, K. A. (2016). Summing up hours of any type of practice versus identifying optimal practice activities: Comments on Macnamara, Moreau, and Hambrick (2016). *Perspectives on Psychological Science, 11,* 351–354. doi:10.1177/1745691616635600

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the

acquisition of expert performance. *Psychological Review, 100,* 363-406.

Ericsson, K. A., & Smith, J. (1991). *Toward a general theory of expertise: Prospects and limits*. New York, NY: Cambridge University Press.

Farrow, D. (2017). Super-elite athletes: Some complimentary observations from Australia and some lessons for sports expertise research: Comment on Hardy et al. *Progress in Brain Research, 232,* 191-195. doi:10.1016/bs.pbr.2017.02.005

Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality Psychology in Europe* (pp. 7-28). Tilburg, Netherlands: Tilburg University Press.

Gulbin, J. P., Oldenziel, K. E., Weissensteiner, J. R., & Gagné, F. (2010). A look through the rear view mirror: Developmental experiences and insights of high performance athletes. *Talent Development & Excellence, 2,* 149-164.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport & Exercise Psychology, 20,* 12-34.

Hodges, N. J., & Starkes, J. L. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe, and Tesch-Römer's (1993) Theory of "Deliberate Practice". *International Journal of Sport Psychology, 27,* 400-424.

Hollenbeck, J. R., Williams, C. R., & Klein, H. J. (1989). An empirical examination of the antecedents of commitment to difficult goals. *Journal of Applied Psychology, 74,* 18-23.

Hopwood, M. J. (2013). The developmental history of athletes questionnaire: Towards a comprehensive understanding of the development of sport expertise. (Doctoral dissertation). Retrieved from http://vuir.vu.edu.au/22353/

International Personality Item Pool. (n.d.). The Items in Each of the Preliminary IPIP Scales Measuring Constructs Similar to Those in the 30 NEO-PI-R Facet Scales. Retrieved from http://ipip.ori.org/newNEOFacetsKey.htm

Kaufman, S. B., Quilty, L. C., Grazioplene, R. G., Hirsh, J. B., Gray, J. R., Peterson, J. B., & DeYoung, C. G. (2016). Openness to experience and intellect differentially predict creative achievement in the arts and sciences. *Journal of Personality, 84*, 248–258. doi:10.1111/jopy.12156

Larkin, P., O'Connor, D., & Williams, A. M. (2015). Does grit influence sport-specific engagement and perceptual-cognitive expertise in elite youth soccer? *Journal of Applied Sport Psychology, 28*, 129-138. doi:10.1080/10413200.2015.1085922

Law, M. P., Côté, J., & Ericsson, K. A. (2007). Characteristics of expert development in rhythmic gymnastics: A retrospective study. *International Journal of Exercise and Sport Psychology, 5*, 82–103. doi:10.1080/1612197X.2008.9671814

Macnamara, B. N., Moreau, D., & Hambrick, D. Z. (2016). The relationship between deliberate practice and performance in sports: A meta-analysis. *Perspectives on Psychological Science, 11*, 333–350. doi:10.1177/1745691616635591

Malinauskas, R., Dumciene, A., Mamkus, G., Venckunas, T. (2014). Personality traits and exercise capacity in male athletes and non-athletes. *Perceptual & Motor Skills: Motor Skills & Ergonomics, 118*, 145-161. doi:10.2466/29.25.PMS.118k13w1

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality, 60*, 175-215.

McCrae, R. R., & Löckenhoff, C. E. (2010). Self-regulation and the five-factor model of personality traits. In R. H. Hoyle (Ed.), *Handbook of personality and self-regulation* (pp.

145-168). Hoboken, NJ: Wiley InterScience.

Moon, H. (2001). The two faces of conscientiousness: Duty and achievement striving in escalation of commitment dilemmas. *Journal of Applied Psychology, 86,* 533-540. doi:10.1037//0021-9010.86.3.533

Muenks, K., Wigfield, A., Yang, J. S., & O'Neal, C. R. (2017). How True Is Grit? Assessing Its Relations to High School and College Students' Personality Characteristics, Self-Regulation, Engagement, and Achievement. *Journal of Educational Psychology, 109,* 599-620. doi:10.1037/edu0000153

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*(2), 247-259.

Paulhus, D. L., Robins, R. W., Trzesniewski, K. H., & Tracy, J. L. (2004). Two replicable suppressor situations in personality research. *Multivariate Behavioral Research, 39,* 301-326.

Paunonen, S. V., & Ashton, M. C. (2001). Big Five factors and facets and the prediction of behavior. *Journal of Personality & Social Psychology, 81,* 524-539.

Piedmont, R. L., Hill, D. C., & Blanco, S. (1999). Predicting athletic performance using the five-factor model of personality. *Personality & Individual Differences, 27,* 769-777.

Poropat, A. E. (2014). Other-rated personality and academic performance: Evidence and implications. *Learning & Individual Differences, 34,* 24-32. doi:10.1016/j.lindif.2014.05.013

Rees, T., Hardy, L., Güllich, A., Abernethy, B., Côté. J., Woodman, T., … Warr, C. (2016). The great British medalists project: A review on the development of the world's best sporting talent. *Sports Medicine, 46,* 1041-1058. doi:10.1007/s40279-016-0476-2

Roberts, B. W., Chernyshenko, O. S., Stark, S., & Goldberg, L. R. (2005). The structure of conscientiousness: An empirical investigation based on seven major personality questionnaires. *Personnel Psychology, 58*, 103-139.

Roberts, B. W., Lejuez, C., Krueger, R. F., Richards, J. M., & Hill, P. L. (2014). What is conscientiousness and how can it be assessed? *Developmental Psychology, 50*, 1315-1330. doi:10.1037/a0031109

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics*. Boston: Pearson.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271-324.

Tedesqui, R. A. B., & Young, B. W. (2015). Perspectives on active and inhibitive self-regulation relating to the deliberate practice activities of sport experts. *Talent Development & Excellence, 7*, 29-39.

Tedesqui, R. A. B., & Young, B. W. (2017a). Associations between self-control, practice, and skill level in sport expertise development. *Research Quarterly for Exercise and Sport, 88*, 108–113. http://dx.doi.org/10.1080/02701367.2016.1267836.

Tedesqui, R. A. B., & Young, B. W. (2017b). Investigating grit variables and their relations with practice and skill groups in developing sport experts. *High Ability Studies, 28*, 167-180. doi:10.1080/13598139.2017.1340262.

Toering, T., & Jordet, G. (2015). Self-control in professional soccer players. *Journal of Applied Sport Psychology, 27*, 335-350. doi:10.1080/10413200.2015.1010047

Ward, P., Hodges, N. J., Starkes, J. L., & Williams, M. A. (2007). The road to excellence: Deliberate practice and the development of expertise. *High Ability Studies, 18*, 119-153.

doi:10.1080/13598130701709715

Woodman, T., Zourbanos, N., Hardy, L., Beattie, S., & McQuillan, A. (2010). Do performance strategies moderate the relationship between personality and training behaviors? An exploratory study. *Journal of Applied Sport Psychology, 22*, 183-197. doi:10.1080/10413201003664673

Young, B. W., & Medic, N. (2008). The motivation to become an expert athlete: How coaches can promote long-term commitment. In D. Farrow, J. Baker, & C. MacMahon (Eds.), *Developing elite sports performers: Lessons from theory and practice* (pp. 43-59). New York: Routledge.

Table 1

Correlations between all Independent and Dependent Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age	–															
2. PE	.21	–														
3. CI	.09	.27	–													
4. SD	.18	.44	.56	–												
5. IC	.09	.24	.40	.58	–											
6. SE	.20	.40	.32	.56	.37	–										
7. Ord	.06	.23	.20	.35	.29	.29	–									
8. Dut	.22	.35	.39	.47	.51	.53	.42	–								
9. AS	.15	.61	.40	.64	.41	.65	.41	.49	–							
10. CSD	.11	.44	.44	.76	.51	.58	.52	.52	.67	–						
11. Cau	.19	.24	.38	.50	.61	.49	.40	.65	.42	.51	–					
12. Consc	.19	.49	.46	.72	.59	.74	.69	.76	.78	.84	.75	–				
13. DP	.11	.30	.12	.15	-.04	.10	-.02	-.07	.22	.12	.02	.08	–			
14. MP	.04	.34	.23	.30	.15	.20	.16	.22	.34	.27	.19	.30	.21	–		
15. OP	.06	.25	.17	.29	.20	.15	.05	.15	.29	.25	.17	.23	.07	.56	–	
16. Switch	-.01	-.19	-.33	-.22	-.14	-.09	-.12	-.18	-.17	-.15	-.17	-.19	-.13	-.12	-.10	–
17. Quit	.12	.00	-.28	-.24	-.22	-.20	-.12	-.21	-.22	-.22	-.19	-.25	.20	-.19	-.19	.37

Note. PE = Perseverance of effort, CI = Consistency of interests, SD = Self-discipline (SC subscale), IC = Impulse control, SE = Self-efficacy, Ord = Orderliness, Dut = Dutifulness, AS = Achievement-striving, CSD = Self-discipline (conscientiousness), Cau = Cautiousness, Consc = Broad conscientiousness, DP = Deliberate practice, MP = Mandatory practice, OP = Optional practice, Switch = Think switching, Quit = Think quitting.
Where $r \geq |.12|$, $p < .05$. Where $r \geq |.16|$, $p < .01$. Where $r \geq |.21|$, $p < .001$.

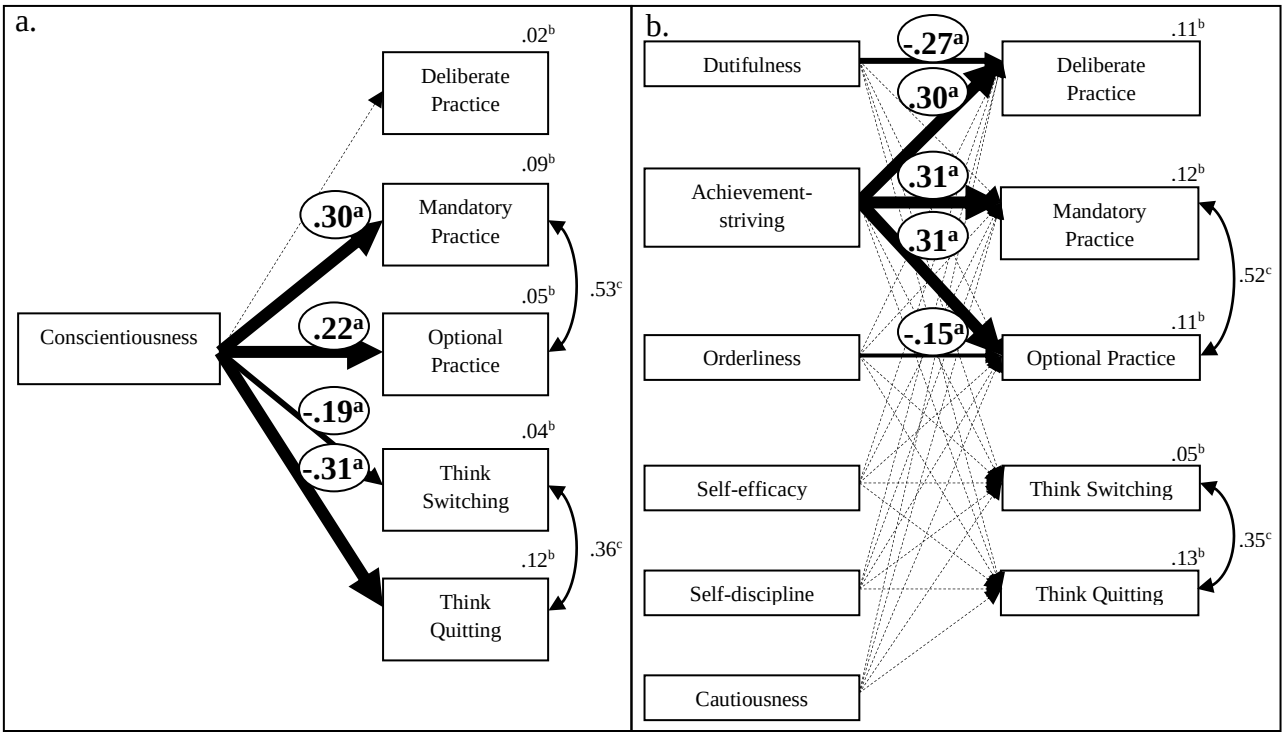

Figure 1. Path model *(a)* depicting the links between broad conscientiousness and the criterion measures; model fit statistics were χ^2 (9, N = 270) = 46.32, p < 0.001, CFI = 0.85, SRMR = 0.06, RMSEA = 0.12 (90% CI = 0.090 - 0.161). Path model *(b)* depicting links between conscientiousness facets and criterion measures; model fit statistics were χ^2 (8, N = 270) = 47.98, p < 0.001, CFI = 0.96, SRMR = 0.04, RMSEA = 0.14 (90% CI = 0.101 - 0.175). Age and sex were control variables but are not depicted for better visualization. Estimates were omitted for non-significant paths which are depicted through dotted lines. Narrow, medium, and wide lines represent p < 0.05, 0.01, 0.001, respectively. [a]Standardized estimates for the structural paths. [b]Squared multiple correlations. [c]Added correlations between error terms as suggested by modification indices.

Table 2

Summary of Results of Multiple Regression Analyses for the Five Dependent Variables

Dependent variable (initial predictors)	Parsimonious combination	Unique contribution (partial R^2)	Adjusted R^2	*B*	*SE B*	β	Best predictor (β)[a]
Deliberate practice			.12***				
(PE, Dut, AS, SD)	PE	.04		3.32	0.93	.27***	.28***
	Dut	.05		-4.39	1.15	-.26***	
	AS	.01		2.45	1.18	.16*	
Mandatory practice			.13***				
(PE, SD, AS)	PE	.06		0.30	0.07	.27***	.35***
	SD	.03		0.18	0.06	.19**	
Optional practice			.09***				
(AS, SD, PE, IC, Ord)	AS	.02		0.48	0.20	.18*	.29***
	SD	.02		0.33	0.14	.18*	
Think switching			.11***				
(CI, SD, IC)	CI	.11		-0.66	0.12	-.33***	-.33***
Think quitting			.12***				
(CI, SD, IC)	CI	.03		-0.31	0.11	-.20**	-.29***
	SD	.02		-0.26	0.11	-.16*	

Note. PE = Perseverance of effort, CI = Consistency of interests, SD = Self-discipline (SC subscale), IC = Impulse control, Ord = Orderliness, Dut = Dutifulness, AS = Achievement-striving. Age and sex were included as control variables in all analyses, but they were not presented above for ease of interpretation. Age and sex were significant only for *Think quitting*. In the parsimonious model, β_{Age} = .16**, partial R^2 = .03, and β_{Sex} = -.14**, partial R^2 = .02 [a]Standardized beta weights of best predictors when assessed alone in the model.
*p < .05. **p < .01. ***p < .001.

Chapter V: Article 4

Tedesqui, R. A. B., & Young, B. W. (under review). Relationships between athletes' self-reported grit levels and coach-reported practice engagement over one sport season.

(Running head: GRIT & PRACTICE ENGAGEMENT)

Abstract

Grit is a personality characteristic conceptually related to hard work and dedication to one's athletic development. Research has yet to investigate the impact of athletes' grit levels on their practice engagement longitudinally. Furthermore, most sport studies have assessed grit as a composite score of its two subscales: perseverance of effort (PE) and consistency of interests (CI). We aimed to (a) investigate the association between athletes' grit levels and their practice engagement longitudinally, and (b) assess the differential associations of overall grit, PE, and CI. Thirteen canoe/kayak athletes (M_{age} = 17.40, SD = 2.99, weekly hr of sport-specific training = 10.46, SD = 6.34, highest competitive level: $n_{provincial}$ = 1, $n_{national}$ = 5, $n_{international}$ = 7) completed a survey assessing PE, CI, and overall grit at time 1; coaches judged athlete's practice engagement over three time points in a season (times 1, 2, and 3). PE was associated with practice engagement across all time points (r = .60, p < .05; r = .58, p < .05; r = .65, p < .05, respectively). CI and overall grit were not associated with practice engagement at any time point (ps > .05). Findings suggest that coaches may use an early season athlete self-report of PE to identify and intervene with athletes at risk for poorer quality training. We discuss methodological and practical implications of studying grit at the subscale level.

Keywords: perseverance of effort, consistency of interests, longitudinal, performance profiles

Relationships between athletes' self-reported grit levels and coach-reported practice engagement over one sport season

A coach's role is to optimize training conditions for his/her athletes, but also to strategically identify athletes who may be predisposed to self-manage their efforts to get the most out of training. *Engagement in quality practice* is a better predictor of acquired elite sport performance than years of experience (Ericsson, Krampe, & Tesch-Römer, 1993; Williams & Ford, 2008) and athletes' attitudes with regards to total preparation through training have effectively distinguished multiple medal-winners at major championships from non-medalists (Hardy, Barlow, Evans, Rees, Woodman, & Warr, 2017). Moreover, to get the most out of practice, and to sustain quality practice efforts across time, athletes need to show a great deal of perseverance, determination, and dedication in training (Starkes, Deakin, Allard, Hodges, & Hayes, 1996).

Grit is a personality characteristic related to persistent hard work and associated with success in various achievement domains (see Credé, Tynam, & Harms, 2017). Defined broadly as passion and perseverance for long-term goals (Duckworth, Peterson, Matthews, & Kelly, 2007), it comprises two facets: *consistency of interests* (CI; tendency to remain interested in the same goals over time) and *perseverance of effort* (PE; tendency to work hard despite adversity). In sport, PE was associated with athletes' weekly hours of quality, deliberate practice and with more frequent attendance at mandatory and optional practice; CI protected athletes from thinking about switching or quitting their sport (Tedesqui & Young, 2017). When contrasted against self-control and conscientiousness variables, grit variables best predicted quality practice and sport commitment outcomes (Tedesqui & Young, 2018). Grit has also been associated with better decision-making (Larkin, O'Connor, & Williams, 2015), higher skill level (Meyer, Markgraf, &

Gnacinski, 2016), and higher sport engagement (Martin, Byrd, Watts, & Dent, 2015).

Despite these works, research has yet to investigate the impact of athletes' grit levels on their practice engagement longitudinally. Also, no studies have examined whether athletes' self-reported grit scores can be reliably associated with their coach's ratings for practice quality. Cross-validating athletes' grit scores with coach's ratings for their practice is important given that astute coach's judgments (though subjective) might represent ecologically valid measures in a talent development/selection domain (Hendry, Williams, & Hodges, 2018). In this study, we examine whether an athlete's self-reported grit levels during early season might be considered proxy indicators for their *level* and *consistency* of practice engagement over the season.

Most sport studies on grit used one composite score of CI and PE subscales (e.g., Larkin et al., 2015; Martin et al., 2015), rather than examining differential associations with the facets. This is an important oversight as predictive validity tends to increase with use of facet subscales (Paunonen & Ashton, 2001) and differential effects have been attributed to PE and CI in sport (Tedesqui & Young, 2017) and in other domains (e.g., Credé et al., 2017). Given the mentioned gaps, this study aimed to: (a) assess relationships between athletes' grit levels and coach-reported quality practice indicators, longitudinally; and (b) assess which measure of grit (i.e., PE or CI facets, or composite grit) showed greater predictive validity for quality practice indicators.

Method

Survey data were collected over three time points across a season (start of outdoor season around May). At T1 (August/September), athletes completed a demographic questionnaire (e.g., age and sex) and the Grit Scale. Coaches independently rated their athletes' engagement in training at that point in the season (T1), then again around two months later (T2), and again four months after T1 (T3). The average interval between coaches' survey responses was 50.5 days

(range = 39-62) between T1 and T2, and 56.5 days (range = 53-60) between T2 and T3.

Participants

Participants were 13 canoe/kayak athletes (ages 13-23, M_{age} = 17.40, *SD* = 2.99), including three females and 10 males who competed at provincial (*n* = 1), national (*n* = 5), and international (*n* = 7) levels. All trained at one of two Eastern Canadian canoe/kayak clubs that had structured and competitive training programs. Eight athletes were from Club A and five were from Club B. On average, they reported 10.46 (*SD* = 6.34) weekly hr of sport-specific training.

Two coaches participated. Coach A (Club A) had worked for 10 years as a coach, had a master's degree in physical training, an MBA in sport management, and had been coaching the participants for 6 months for approximately 20 hr per week. Coach B (Club B) had been coaching for 8 years, was a kinesiologist, and had been coaching the participants for 12-18 months for 8 hr per week. Thus, the coaches were qualified and had been involved with athletes long enough to be able to rate their engagement in training. Adult participants gave informed consent; minors gave assent and had parental informed consent. The protocols were submitted to, and approved by, an institutional review board for testing of human subjects.

Surveys

The Grit Scale. At T1, athletes completed the Grit Scale (Duckworth et al., 2007), which measures: (a) perseverance of effort (4 items; α = .75), e.g., "I have achieved a goal that took years of work"; and (b) consistency of interests (6 items; α = .81), e.g., "My interests change from year to year." The structural validity of these 10 items was established by Tedesqui and Young (2017). Athletes' scores were computed for the perseverance of effort and consistency of interests subscales, and for overall grit (i.e., composite of perseverance of effort and consistency of interests).

Coach Rating of Practice Engagement. At each time point, coaches rated each of their athletes (who had completed the survey at T1) on a Likert scale ranging from 1 (not at all true) to 5 (very true) on six items indicating practice engagement and one item indicating attendance. Their coach rating form read, "At this point in the season, please use the scale below to rate each of your athletes on the degree to which he/she…": (a) perseveres through setbacks/difficulties, (b) is diligent with respect to training responsibilities, (c) invests extra time in training, (d) has a positive attitude toward training, (e) takes on new challenges, (f) consistently works hard, and (g) misses practice. We calculated athletes' overall level of practice engagement as an average of the first six items (a through f); the final item (g) was reverse-scored to represent attendance. Notably, coaches' and athletes' responses were independent—the athletes did not know how their practice engagement was rated by coaches, nor did coaches know athletes' grit scores.

Planned Data Analysis

We calculated Pearson correlations between each of the three grit scores and coach ratings (i.e., the seven items separately, and overall level of practice engagement) at each time point (see Table 1). To assess whether athletes' grit scores at T1 were related to stability of practice engagement over time, we computed an index of stability of practice engagement for each athlete. As recommended by Ram and Gerstoff (2009), we employed a commonly used index called the *intraindividual standard deviation* (iSD); this index is the standard deviation based on the distribution of scores obtained across repeated measurements for a single individual and represents the extent to which the individual's scores vary around the mean score for that individual. Thus, a large iSD indicates low stability in one's practice engagement relative to the person's mean whereas a small iSD indicates high stability. Finally, we inspected the Pearson correlations between athletes' grit scores and their iSD of practice engagement.

[Table 1 near here]

Results

Correlations and Longitudinal Trends

Table 1 shows correlations between grit and ratings of practice engagement. Table 2 shows mean scores on grit, ratings of practice engagement, and index of stability.

[Table 2 near here]

Across the three time points, perseverance of effort (PE) was positively related to overall practice engagement. Additionally, PE was positively related to diligence with responsibilities (T2 and T3), investment of extra time (T3), positive attitude (T3), and consistent hard work (T1 and T2), with trends pointing to an increase in these ratings over time (except for consistent hard work). PE was also positively related to attendance at T3. Consistency of interests (CI) was inversely related to positive attitude (T2) and openness to new challenges (T1). No significant associations were found between overall grit and ratings of practice engagement at any time point.

Neither CI (r = .40, p = .17) nor overall grit (r = -.15, p = .63) were significantly associated with indices of stability (iSD) over time. The association between PE and stability approached significance (r = -.54, p = .06). To follow up on this trend with PE and facilitate the visualization of variability around each sub-element of practice engagement, we plotted the coach ratings of practice engagement over time using performance profile cases or radar charts (Butler & Hardy, 1992). In particular, we were interested in visually depicting whether the association between PE and coach ratings over time were different for certain aspects of quality engagement than others.

To illustrate, we show the performance profiles for the three highest and the three lowest

scorers on PE (see Figure 1). The performance profiles show that athletes with the highest PE scores (IDs 2, 10, 3) cover a wider area of the graph, indicating greater practice engagement. Further, the overlap in T1, T2, and T3 lines suggest that high PE athletes also have stable practice engagement over time. Notably, athlete ID 3 showed the maximum level of practice engagement with no variability over time. Conversely, the profiles of athletes with the lowest PE (IDs 13, 12, 11) cover a smaller area and show little overlap between the lines indicating poorer quality and more variable practice engagement over time. The profiles also depict where athletes stand in each sub-element of practice engagement, allowing coaches to track progress (or the lack thereof) in specific indicators of practice engagement. For example, athlete ID 12 (lowest PE) showed a notable decrease in its diligence, time investment, and positive attitude over time.

[Figure 1 near here]

Discussion

We investigated the associations between athletes' grit scores (perseverance of effort, consistency of interests, and overall grit) and their practice engagement as rated by their coaches over time. Overall, we found that athletes' self-reported PE was the grit variable most related to coach ratings of athletes' practice engagement with large effect sizes (Cohen, 1992). Athletes who scored the highest on PE, thus who reported a tendency to sustain effort despite adversity, were also independently reported by their coaches to have shown a high level of practice engagement and to have sustained such high engagement longitudinally. The same could not be said of athletes who scored high on CI or overall grit, with both variables showing respectively little to no associations with practice engagement. These findings suggest that the higher an athlete's level of self-reported PE, the *higher* and the *more stable* their practice engagement (as assessed by their coach) is over time. Conversely, the lower an athlete's PE, the *lower* and the

more variable their practice engagement is over time.

Practical Implications

Our findings may have practical implications for coaches. Coaches could benefit from knowing whether a measure of an athlete's PE level at one point can predict the level and the fluctuation of their practice engagement as well as their attendance later in a season. From a developmental perspective, an assessment of athletes' PE levels may help coaches identify which athletes are likely to later show low and/or unstable practice engagement. Equipped with grit information, coaches would be in a better position to target preventive interventions to those athletes "at risk" (i.e., those low on PE) for showing less than optimal practice engagement or inconsistent practice habits. Early season assessment using athletes' self-report of grit, however, should be but one strategy among a repertoire of activities that coaches use to better understand their athletes. Additionally, our intent in showing the performance profiles was to demonstrate how coaches may apply the grit (especially PE) ratings with their athletes to help them reflect about changing aspects of their practice engagement over time. As recommended in applied interventions (e.g., Gill, Williams, & Reifsteck, 2017), coaches may engage their athletes in profiling, perhaps using multiple personal (within-athlete) profile instances over a season to track the impact of interventions designed to optimize their practice activities.

From a talent selection perspective, knowing athletes' level of PE might help coaches decide on which athletes to invest limited resources (e.g., spots in a team, access to quality training) to maximize the "returns on their investment" by choosing those who are more likely to get the most out of their training. This said, we are very cautious to make this recommendation based on this one study. Future research replicating the current trends in different contexts, especially with in situ measures of quality practice, would help continue this discussion.

Methodological Implications

Our results showed that only PE was related to overall practice engagement and that overall grit was not related to any measure of practice at any time point. Had we assessed grit only at the single scale level, we could have mistakenly concluded that grit is not associated with practice engagement. From a methodological angle, therefore, the current findings echo the recommendation that researchers inspect the predictive validity of the grit facets separately (e.g., Tedesqui & Young, 2017). Our findings are also consistent with Credé et al.'s (2017) meta-analytic interpretation outside sport that PE mostly predicts outcomes, not CI. The current findings suggest that PE is related to the *quality* of athletes' efforts in practice engagement over time, but that CI is not necessarily related to practice engagement. Notably, prior cross-sectional work (Tedesqui & Young, 2017) suggested that athletes' self-reported CI scores do not associate with the volume/quantity of athletes' practice, but rather with athletes' efforts to commit to practice. Specifically, athletes' higher CI was associated with the propensity to have fewer thoughts of switching out of, or quitting, a sport. Future research is needed to test a preliminary postulate, that is, CI associates with consistent attraction toward a sport and PE relates to quality practice engagement within sport practice. From a practical standpoint, coaches could benefit from knowing the grit measures they can rely upon to understand different athletic outcomes.

Strengths of this study include its prospective design and the collection of coaches' ratings independent of athletes' self-reported grit scores, which enhanced the validity of our findings. A limitation was the small sample size which prevented us from making stronger inferences. Future studies with a larger sample and a longer assessment period (e.g., across seasons) may confirm our findings and provide stronger evidence for the association between athletes' PE scores and the stability/variability of training.

Conclusion

This article is, to our knowledge, the first longitudinal investigation of the role of grit within sport. It sensitizes sport researchers and practitioners to the importance considering grit at the facet level in order to appropriately distinguish the contribution of each grit facet on sport outcomes. Notably, we identified perseverance of effort as the only grit variable associated with athletes' quality practice engagement. Finally, the associations between coach-reported practice engagement and self-reported grit scores may constitute evidence of external validity for the grit scale as it is currently applied in the sport domain. Specifically, this study was the first to find evidence that an early self-report measure of athlete's perseverance of effort might be considered a proxy indicator for their subsequent level and consistency of practice engagement over the course of the season.

Acknowledgments

This work was supported by the Social Sciences and Humanities Research Council of Canada (SSHRC).

References

Butler, R. J., & Hardy, L. (1992). The performance profile: Theory and application¸ *The Sport Psychologist, 6,* 253-264.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality & Social Psychology, 113,* 492–511. doi:10.1037/pspp0000102

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality & Social Psychology, 92,* 1087-1101. doi:10.1037/0022-3514.92.6.1087

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* 363-406.

Gill, D. L., Williams, L., & Reifsteck, E. J. (2017). Personality. In: *Psychological dynamics of sport and exercise* (4th ed., pp.37-55). Champaign, IL: Human Kinetics.

Hardy, L., Barlow, M., Evans, L., Rees, T., Woodman, T., & Warr, C. (2017). Great British medalists: Psychosocial biographies of Super-Elite and Elite athletes from Olympic sports. *Progress in Brain Research, 232,* 1-119. doi:10.1016/bs.pbr.2017.03.004

Hendry, D. T., Williams, M. A., & Hodges, N. J. (2018). Coach ratings of skills and their relations to practice, play and successful transitions from youth-elite to adult-professional status in soccer. *Journal of Sports Sciences.* Advance online publication. doi:10.1080/02640414.2018.1432236

Larkin, P., O'Connor, D., & Williams, A. M. (2015). Does grit influence sport-specific engagement and perceptual-cognitive expertise in elite youth soccer? *Journal of Applied*

Sport Psychology, 28, 129-138. doi:10.1080/10413200.2015.1085922

Martin, J. L., Byrd, B., Watts, M. L., & Dent, M. (2015). Gritty, hardy, and resilient: Predictors of sport engagement and life satisfaction in wheelchair basketball players. *Journal of Clinical Sport Psychology, 9*, 345-359. doi:10.1123/jcsp.2015-0008

Meyer, B. M., Markgraf, K. M., & Gnacinski, S. L. (2016). Examining the merit of grit in women's soccer: Questions of theory, measurement, and application. *Journal of Applied Sport Psychology, 29*, 353-366. doi:10.1080/10413200.2016.1255277

Paunonen, S. V., & Ashton, M. C. (2001). Big Five factors and facets and the prediction of behavior. *Journal of Personality & Social Psychology, 81*, 524-539.

Ram, N., & Gerstorf, D. (2009). Time-structured and net intraindividual variability: Tools for - examining the development of dynamic characteristics and processes. *Psychology and Aging, 24*, 778-791. doi:10.1037/a0017915

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K.A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts, sciences, sports and games* (pp. 81-106). Mahwah, NJ: Erlbaum.

Tedesqui, R. A. B., & Young, B. W. (2017). Investigating grit variables and their relations with practice and skill groups in developing sport experts. *High Ability Studies, 28*, 167-180. doi:10.1080/13598139.2017.1340262.

Tedesqui, R. A. B., & Young, B. W. (2018). Comparing the contribution of conscientiousness, self-control, and grit to key criteria of sport expertise development. *Psychology of Sport & Exercise, 34*, 110-118. doi:10.1016/j.psychsport.2017.10.002

Williams, A. M., & Ford, P. R. (2008). Expertise and expert performance in sport. *International*

Review of Sport and Exercise Psychology, 1, 4-18, doi:10.1080/17509840701836867

Table 1

Pearson Correlations Between Athletes' Grit Scores (Perseverance of Effort, Consistency of Interests, and Composite) and Coach Ratings of Practice Engagement Over Time

Indicators of Practice Engagement	Perseverance of Effort			Consistency of Interests			Grit		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
(a) Perseverance through setbacks	.36	.29	.25	-.55	-.37	.02	-.14	-.05	.25
(b) Diligence with responsibilities	.41	**.58***	**.59***	-.07	-.44	-.38	.32	.16	.22
(c) Investment of extra time	.33	.53	**.83*****	-.11	-.04	-.38	.21	.45	.44
(d) Positive attitude	.55	.55	**.79****	-.30	**-.62***	-.45	.25	-.03	.34
(e) Openness to new challenges	.28	-.05	-.24	**-.57***	-.22	.08	-.23	-.24	-.15
(f) Consistent hard work	**.60***	**.73****	.45	-.20	-.40	-.45	.39	.33	.03
Overall practice engagement[a]	**.60***	**.58***	**.65***	-.39	-.46	-.36	.22	.14	.29
(g) Attendance	.25	-.30	**.57***	-.08	.25	-.36	.16	-.07	.21

Note. Where $r \geq |.56|$, $*p < .05$. Where $r \geq |.69|$, $**p < .01$. Where $r \geq |.83|$, $***p < .001$.

Small, medium, and large effect sizes are respectively $r = .10$, $r = .30$, $r = .50$ (Cohen, 1992).

[a]Calculated as an average of items (a) through (f).

Table 2

Athletes' Mean Scores on Grit, Perseverance of Effort (PE), Consistency of Interests (CI), Coach Ratings of Practice Engagement, and Index of Stability (iSD)

				Coach Ratings of Practice Engagement			
Athlete	Grit	PE	CI	T1	T2	T3	iSD[a]
1	3.54	3.78	3.33	3.50	4.00	4.17	.35
2	4.58	5.00	4.17	4.50	4.33	4.67	.17
3	3.38	4.25	2.50	5.00	5.00	5.00	0
4	3.63	3.25	4.00	3.67	4.17	4.33	.35
5	3.88	4.25	3.50	3.17	3.67	3.50	.26
6	3.04	3.75	2.33	3.50	4.17	3.50	.39
7	3.21	3.75	2.67	3.33	3.17	3.33	.10
8	4.13	3.75	4.50	2.67	3.33	3.33	.39
9	3.17	3.00	3.33	3.50	4.17	4.17	.39
10	4.04	4.75	3.33	4.67	4.50	4.67	.10
11	3.38	2.75	4.00	3.50	3.50	3.83	.19
12	3.50	2.50	4.50	3.33	3.67	2.83	.42
13	3.42	2.50	4.33	3.00	2.50	2.50	.29

Note. Both the Grit Scale and Coach Ratings were assessed on a 5-point Likert Scale.

[a]Intraindividual standard deviation representing the index of stability of practice engagement over time. A lower iSD indicates lower variability (or greater stability) of their overall ratings of practice engagement across the three time points.

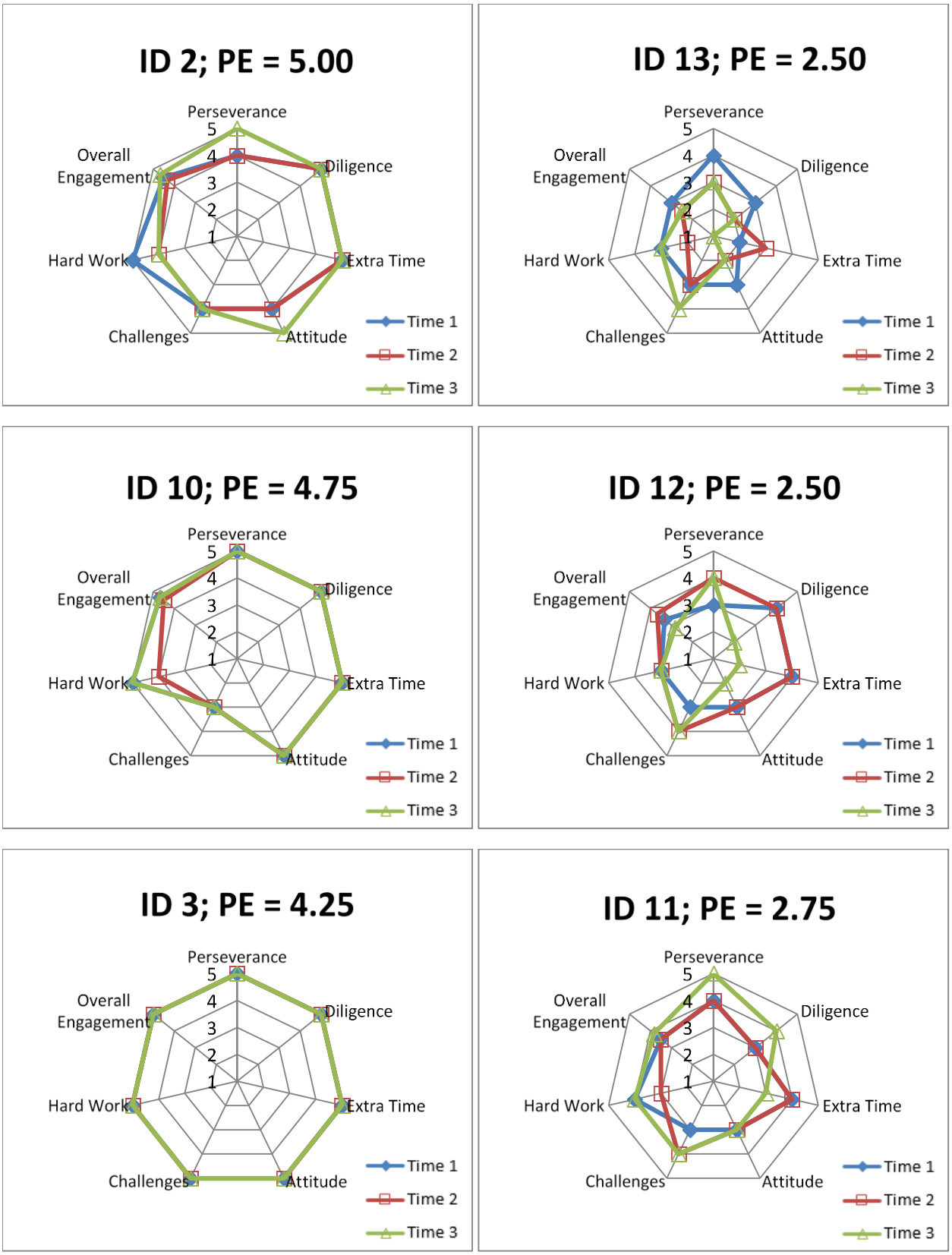

Figure 1. Practice engagement of athletes with highest (left) and lowest (right) scores on PE.

Chapter VI: Article 5

Tedesqui, R. A. B., & Young, B. W. (under review). How coaches see conscientiousness-related traits and their impact on athletes' training and expertise development.

(Running head: CONSCIENTIOUSNESS & EXPERT DEVELOPMENT)

Abstract

Conscientiousness, grit, and self-control are personality characteristics that have shown to differentially predict several criteria of expertise development, including athletes' deliberate practice and higher skill levels. However, little is known about coaches' views on (a) how these conscientiousness-related traits translate into behaviours within the daily training environment; or (b) the relevance of these traits for athletes' quantity and quality of practice and development toward expert levels of performance. To fill these gaps, semi-structured open-ended interviews were conducted with 11 high-performance coaches (9 male and 2 female) of individual and team sports, and national and international competitive levels. Interviews were analyzed using thematic analysis guidelines. Coaches' descriptions evidenced some overlap between the investigated traits and a partial view of these constructs. They generally believed grit, conscientiousness, and self-control play critical roles on athletes' quality practice and skill development. Notably, coaches highlighted the tendencies to persevere despite adversity and mindfully use self-regulated processes seem to be powerful predispositions for athletes' development toward expert performance levels. Results suggested potential mechanisms to help explain the observed relationship between conscientiousness-related traits and athletes' practice quality and skill development.

Keywords: grit, self-control, practice, behavioural indicators

How coaches see conscientiousness-related traits and their impact on athletes' training and expertise development

Most of an athlete's pathway to expertise is spent in training and preparatory activities. Over the long-term, athletes must remain committed to their sport and to quality practice, or deliberate practice (Baker & Young, 2014; Ericsson, Krampe, & Tesch-Römer, 1993). To get the most out of practice, athletes must display discipline, persevere despite adversity, and sustain demanding practice activities over time (Starkes, Deakin, Allard, Hodges, & Hayes, 1996).

Individual differences related to one's personality might "affect the inevitable differences in the capacity to engage in hard work (deliberate practice)" (Ericsson et al., 1993, p. 399) and "predispositions facilitate the completion of the required amounts of training" (Baker & Horton, 2004, p. 218). Recent studies showed that *conscientiousness* as well as related traits including *self-control* and *grit* are associated with important criteria of expertise development in sport, including higher amounts of deliberate practice, engagement in different forms of practice, commitment to one's sport, higher skills levels (e.g., Tedesqui & Young, 2017a, 2017b, 2018; Toering & Jordet, 2015; Woodman, Zourbanos, Hardy, Beattie, & McQuillan, 2010).

A series of quantitative studies by Tedesqui and Young (2017a, 2017b, 2018) systematically tested the relevance of conscientiousness-related traits with respect to key tenets of sport expertise development frameworks (e.g., Abernethy, Thomas, & Thomas, 1993; Ericsson et al., 1993). Of 10 specific facets of broad traits that were conceptually related to the tenets (e.g., conscientiousness; McCrae & Löckenhoff, 2010; grit; Duckworth, Petterson, Matthews, & Kelly, 2007; self-control; Tangney, Baumeister, & Boone, 2004), results showed that although facets of conscientiousness and self-control help explain different criteria of expertise, grit facets were better predictors. Those who scored higher on perseverance of effort (a

facet of grit; Duckworth et al., 2007) accumulated more weekly deliberate practice and belonged to more expert skill groups compared to less persevering athletes (Tedesqui & Young, 2017b). Athletes who scored higher on achievement-striving (a facet of conscientiousness; McCrae & Löckenhoff, 2010) showed higher engagement in mandatory and optional types of practice (Tedesqui & Young, 2018). Athletes reporting higher scores on impulse control (a facet of self-control; Maloney, Grawitch, & Barber, 2012) showed higher sport commitment, evidenced by fewer thoughts of quitting or switching out of their sport (Tedesqui & Young, 2017a). Finally, in a comparative analysis of facets of conscientiousness, grit, and self-control, grit facets performed best. Specifically, *perseverance of effort* explained deliberate practice and higher skill group membership and *consistency of interests*—also referred to as *passion* by Duckworth et al. (2007)—associated with variables assessing commitment to one's sport. Although this research has revealed insights about critical personality antecedents of several criteria of expertise development, currently missing from the literature on sport expertise development is information about how coaches can best identify, within the daily training environment, those athletes who are equipped with predispositions to work hard and sustain engagement toward their own development.

Despite these advancements in scientific knowledge, little is known about the particular behaviours gritty, conscientious, and self-controlled athletes display in the day to day training environment. Moreover, there is no research on coaches' perspectives for how these traits impact elite athletes' development. Finally, we do not know which of these traits coaches consider to be most relevant for optimizing athletes' practice efforts and their development. From a practical standpoint, it is important to explore coaches' perspectives about these conscientiousness-related traits because coaches' judgment of such traits may impact how they manage/make decisions

toward athletes during practice and may determine which athletes they identify for interventions.

Coaches of developing athletes spend much time observing and assessing their behaviours in order to tailor practice activities aimed at skill development. Thus, experienced coaches are in a privileged position and have a unique perspective to offer regarding athletes' behaviours in the daily training environment. However, coaches' perspectives on how athletes' conscientiousness-related traits are expressed in the daily training environment and on how these traits impact athletes' development have not been investigated. Relevant to the current study, Oliver, Hardy, and Markland (2010) explored the perspectives of coaches on relevant practice behaviours for the development of youth athletes. Among the critical practice behaviours for athletes' development, they found: (a) respect for teammates; (b) motivation; (c) working hard following failure; (d) commitment; (e) effort; (f) information seeking (for improvement); and (g) concentration. Behaviors that negatively impacted development included moaning and "messing around". Although Oliver et al. (2010) elucidated aspects of benevolent and malevolent practice behaviour, they did not specifically probe (a) which personality traits might predispose individuals to engage in those desirable training behaviours, or (b) how coaches see these traits being expressed through behaviours in the daily training environment.

Prior studies assessing the role of athletes' personality have predominantly used quantitative approaches (e.g., Tedesqui & Young 2017a). Further, in order to discover which of the traits from the family of conscientiousness have a greater impact on different criteria for expertise development, comparative studies have collected data through self-report surveys with athletes (e.g., Tedesqui & Young, 2018). Importantly, while these studies have elucidated the influence of athletes' personality on their *quantity* of practice, there have been calls for research investigating their impact on the *quality* of practice (e.g., McCardle, Young, & Baker, 2017;

Tedesqui & Young, 2018). Arguably, understanding quality of practice requires a first-hand, in-depth exploration of how athletes' conscientiousness-related traits impact their behaviours in training from the eyes of coaches, who are responsible for assessing the quality of athletes' practice in the daily training environment. Moreover, understanding the antecedent traits of relevant training behaviours as well as identifying the observed indicators of these traits is important for coaches who are tasked with identifying and developing talent. The current study will generate seminal data to this end by exploring coaches' perspectives through the lens of criteria for expertise development (Abernethy et al., 1993; Ericsson et al., 1991; Tedesqui & Young, 2018), specifically how conscientiousness-related traits (1) associate with practice quantity and quality, and (2) discriminate between elite and less elite athletes.

The purpose of this study was to explore, from coaches' perspectives, (a) how conscientiousness-related traits translate into behaviours in the daily training environment; and (b) the degree to which these traits are associated with engagement in quality deliberate practice and optimal efforts during difficult practice sessions, and their associations with higher skill status. We aimed to answer the following research questions: (1) How do coaches describe behavioural indicators of conscientiousness, grit, and self-control within the daily training environment? and (2) How do conscientiousness, grit, and self-control relate to athletes' quantity and quality of practice, commitment to their sport, and skill development?

Method

This study was exploratory and descriptive (Gratton & Jones, 2010) and informed by a constructionist approach (Rubin & Rubin, 2005) because we were interested in understanding *coaches'* views about the conscientiousness-related traits and the meaning *they* attribute to these traits in order to provide a rich and in-depth interpretation of coaches' perspectives. The results

should not be interpreted as objective descriptions of reality.

Recruitment and Procedures

Our criteria for recruiting coaches was based on Côté and Gilbert's (2009) considerations of coaching knowledge, athletes' outcomes, and coaching contexts. It was important to identify performance coaches both for young and older adolescents who have the added responsibility of selecting talented athletes and choosing members for competitive teams. We recruited performance coaches from both individual and team sports, who worked in elite programs and with at least 10 years of experience and relative success in high levels of their sport (e.g., at least national level). It was important to recruit coaches who had experience with developing athletes including adolescents and young adults (not only with adult athletes who have already reached their peak) and particularly experiences observing athletes in a developmental context (i.e., they remained heavily involved with athletes' daily training for most of the year, not just during a summer camp).

To recruit accessible high-level coaches, we combined sampling strategies. Convenience sampling was first used to reach coaches who fit our inclusion criteria and who would be available for interviews with the lead author. We used snowball sampling to recruit further interviewees and contacted major Canadian sport organizations to ask them to recommend coaches for interviews. Interviews happened in person (n = 7) and via Skype with video (n = 4). Informed written or oral consent was obtained from all coaches prior to the interview. Interviews were audio-recorded with coaches' permission, transcribed verbatim, and then analyzed. All procedures had received institutional ethics approval prior to the beginning of the study.

Participants

Participants were 11 high-performance coaches (9 male, 2 female) ranging in age from 28

to 63 (M_{age} = 46, *SD* = 11.3). They coached a variety of individual and team sports: Olympic weightlifting, athletics, Canadian football, baseball, basketball, biathlon, canoe/kayak (2), and rugby (3). Coaches reported that their highest level of competition was national (n = 3) and international (n = 8). All had at least 10 years of experience in competitive, high performance coaching, with some reporting over 30 years of experience (*M* = 22.6 years, *SD* = 8.1).

Data Collection

A semi-structured interview guide comprised sets of pre-established questions, though interviews happened in a flexible way with regards to the order of questions, the inclusion of probes, and follow up of unanticipated issues raised by participants (Smith, 1995). The interview guide was developed with two goals: (a) exploring coaches' views about how conscientiousness-related traits are expressed in daily training; and (b) understanding coaches' perspectives regarding athletes' personality characteristics that have been shown to be relevant for athletes' practice and expert development in prior research (Tedesqui & Young, 2017b; Toering & Jordet, 2015; Woodman et al., 2010). We included questions that assessed behavioural indicators of conscientiousness, self-control, grit, perseverance of effort, and consistency of interests, and asked which trait they considered to be the most relevant for athletes' development. Once the coach chose the most relevant trait, we focused the subsequent questions on the influence of such trait on (a) athletes' quality and quantity of training; (b) athletes' sport commitment and long-term engagement; and (c) the advancement to higher skill levels. To avoid influencing coaches' perceptions on the relevance of the traits, we randomized the order in which the traits were asked to each coach. Finally, we posed questions related to situations in practice where these traits may be undesirable or counterproductive. We piloted the interview guide with two coaches to help test its efficacy, clarity, and to refine probing questions.

Data Analyses

No hypotheses were formulated, given the exploratory nature of the research. NVivo 12 software assisted in the organization and management of data. We used thematic data analysis (Braun & Clarke, 2006), which is a method that helps researchers identify, analyse, and report patterns/themes in the data. The importance of a theme depends on its ability to capture a relevant aspect related to the research questions, regardless of its prevalence (Braun & Clarke, 2006). Data were coded inductively and deductively (Fereday & Muir-Cochrane, 2006). The deductive approach was driven by the researchers' conceptual interest (e.g., identification of behavioural indicators of five conscientiousness-related personality traits) and the research questions (Braun & Clarke, 2006). Deductive themes comprised: (a) behavioural indicators of *conscientiousness*, (b) of *grit*, (c) and of *self-control*, (d) relevance for *practice quantity and quality*, (e) relevance for *sport commitment and long-term engagement in practice*, (f) relevance for *advancing to higher skill levels*, (g) trait considered the most relevant for athletic development, and (h) situations in practice where traits may have a negative influence. The inductive approach was used to code and organize the data in subthemes related to the deductive themes.

We used several strategies to ensure quality and rigour. To provide consistency and familiarity with the data, all interviews were conducted by the lead author. Participants were allowed the opportunity to check the accuracy of the content of their interview transcripts (Whittemore, Chase, & Mandle, 2001); none indicated any issues or made major revisions. Further, the lead author read and read all transcripts to gain familiarity with the data (Braun & Clarke, 2006). Finally, discussions with the co-author, an expert in the expertise literature, about the themes, sub-themes, and coding procedures allowed verification of the analytical process.

Results

Coaches were assigned anonymous labels (C1 to C11) and any identifying information (e.g., club or athlete's name) has been omitted. We represented all coaches' voices, but prioritized quotes that best illustrated the results.

Coaches' Descriptions of How Conscientiousness-Related Traits Are Expressed in Training

Grit. When describing behavioural indicators of grit, coaches mentioned first and foremost athletes' ability to persevere despite adversity. Gritty athletes keep training despite difficult drills, minor bruises, and poor weather conditions. They also practice with the same intensity with which they compete. C10 said, "I would use that term for someone who trains very similar to how she plays. If there's any kind of little bumps and bruises, she'll stay in practice". A canoe/kayak coach mentioned, "We're an outdoor sport, so grit to me is when the environment is just bloody miserable, they still show up and they're not grumpy" (C8). C11 commented, "Despite failure, she will not give it up…. So, if she's not successful, she says, 'No, I'll try again'". Coaches acknowledged that failures/setbacks can upset gritty athletes, however, these athletes do not allow frustration to settle and manage to keep training in pursuit of their goals:

> You can tell with the body language and the way they carry themselves you may see some frustration, but that frustration doesn't manifest itself in a way that ends up in them shutting down or sort of going within themselves or losing that confidence. It manifests itself in, "Okay, I'm going to pick myself up, I'm gonna get in a place where I can do this again. Give me another chance. It didn't go the way that I wanted it to, but what do I need to do better? Perfect. Now let's go and do that." (C7)

An athlete's display of grit in training does not seem conditional on the athlete experiencing some sort of adversity. C6 explained, "It's not just after a failure, getting knocked

down seven [times], getting up eight. It's finding the energy, the focus, finding just whatever you need to get the job done in that moment". Further, they described gritty athletes as those who not only have a propensity to work hard but also who enjoy hard work:

> We do a lot of running, grappling, wrestling, driving bags, hitting bags, getting up, up-downs. So, the kids that appear to be enjoying the conditioning, those are the kids with a lot of grit…. They love contact. There's always a little bit of blood and hair's all undone, and they love that piece…. The gritty ones are waiting for it, can't wait to go all out. (C5)

Gritty athletes were also described as those who do not make excuses or avoid giving maximum effort:

> They don't take the easy way out when they shouldn't… A gritty athlete understands the intent of the workout and hits that…. He will not say, "It's windy", "It's rainy", "It's too hot". He'll say, "This is designed to make me better, so I'm going to get it done." People who are less gritty are more likely to say, "It's not a perfect day, so I'm gonna back off a little bit," "I'm tired", or "I'm emotionally down." (C9)

Some coaches described gritty athletes as those who seek extra work to improve and reach their goals, "When you tell her to stop because it [the session] is finished, she always wants more. She asks for extra work" (C4). C10 mentioned that gritty athletes have no difficulty going hard at their teammates in training, "When you're practicing physical work against your friends and teammates, a mental switch has to be turned on. A gritty athlete isn't deterred from working hard and hitting her teammates at the physical level that she has to."

Coaches mostly associated grit with *perseverance,* but also used other synonyms including "relentless" (C3), "toughness, resilience" (C9), "determination" (C1), and "tenacity" (C4). Notably, coaches did not equate grit with mindless perseverance. Instead, gritty athletes are

able to think critically and self-assess, make appropriate decisions, and follow through. C4 explained, “Those that don’t have grit will just sort of keep on with the errors without reflecting, without thinking critically about what they’re doing”. When considering how athletes respond to coaches’ feedback about errors, C7 mentioned, “Athletes that possess grit, there’s eye contact there. You can see the ‘wheels turning’. They try to process what’s happened and what needs to happen in order for them to go out and be successful.”

Perseverance of effort. Coaches generally described grit and perseverance synonymously. Likewise, they characterized perseverance of effort as an athlete’s ability to endure hardship and keep giving their best effort despite adversity. C3 commented:

> When they have a bad day at training, they will find a way to make it right. They’ll end on a positive note. They’ll find ways to perform well, even though they’re not at their best in that day…. It’s not only mental, it could be physical also. They’re tired, they’re sore, they’re stiff because of their training the previous day.

Persevering athletes seem to have a mental switch that allows them to concentrate on their training despite adverse circumstances within or outside sport:

> Athletes have different levels of perseverance to get through a bad day, a bad practice, a bad class. They got an argument with their girlfriend or something. Perseverance, I see it as overcoming an obstacle, whatever that obstacle is, and then locking in for 2 hours, 90 or 75 minutes, or however long the session is. Being able to leave your obstacles behind you and actually overcome them so that you can go into practice with the right state of mind to be able to benefit from it…. They have a switch that they can just shut off. (C6)

Higher perseverance levels were often observed in athletes who are not necessarily the most talented, who need more perseverance to remain competitive and progress through skill

ranks:

> Maturation happens at different speeds. Kids put on muscle mass at different speeds. So, this term [perseverance] would apply to the "hard gainer". The guy that doesn't gain a lot of strength easily. The slightly chubby kid that needs to work on aerobic power. They have a harder journey than other kids, in general. They have to overcome either a lack of athletic history or not the best genetics. So, that category of athletes tends to be very persistent, because you have to be to get to the next level. (C8)

Some coaches believed perseverance reflects an ability to see failure as a growth opportunity and a willingness to put themselves outside their comfort zone:

> If you're not putting yourself in situations where you can fail, you're not putting yourself in the right situations. So it's the willingness to put yourself in those situations over and over …. If you're the smartest person in the room, you're in the wrong room. There's no point in being the big dog that is always bashing around puppies. You have to punch outside your weight class. That's how you continue to grow and improve. (C7)

Coaches often described athletes who lack perseverance as giving excuses and deflecting responsibility to avoid working hard, "Complaining that they're tired, they're exhausted, it's hot outside. Transferring blame on all kinds of different things other than themselves" (C3). As a result, they miss growth opportunities, may drop out, or get dismissed from the program:

> When things get hard, they have to go for a drink, have an asthma attack, but it's not really an asthma attack, you know what I mean? They have some breathing issue which they never had before, have a headache, are sick, or "Oh, my tape job isn't good, I gotta get my ankle re-taped" right when we're doing long sprints or whatever…. They make a *lot* of excuses. I call it "below-the-line" behaviour. BCD: they *blame, complain,* or *defend*

> their own behaviours. That's a huge lack of perseverance. They don't like being uncomfortable, so, there's no growth and they don't tend to stay. They cut themselves or I'll let them go cause next group coming is gonna persevere and fight for that spot. (C5)

Some coaches believed perseverance is associated with self-confidence after a setback or under challenging circumstances:

> To me a lack of perseverance is just a lack of confidence, cause if you've got confidence and you've done work leading up to that moment, then it should be easier for you to say, "Yeah, I screwed that up. Ok, I've done it so many times that I know I'll get the next one." If you're shaky in your confidence, as soon as something goes wrong it's like someone chipped away at your core, "Man, I shouldn't even be out here"? If a coach yells at you or gets on you for something, they sink. They might not be able to kind of bounce back right away, so we have to understand how to coach it too. (C6)

Consistency of interests (passion). The most prevalent qualifier of an athlete's consistency of interests was their engagement, interest and even excitement about their own development. C9 noted, "They're the athletes who I am talking to at my office and you can see them getting excited. Their eyes get a little bigger, they lean forward in the chair, they're fired up". Athletes with a disposition for consistent interests do what is required to improve, are engaging and solicit feedback from coaches about their progress, "They're predictable in a positive way. So, they show up on time, they engage, they're inquisitive, ask questions, ask why. If you haven't stated the objective of the drill, they wanna know why they're doing it" (C4).

Some coaches explained that passionate athletes' interests are not restricted to their own development and transcend to their teammates and their program:

> You'll find her give to the other aspects of the program. Being a good teammate is not

> just about practicing your 2-hour time slot. It's about team bonding, understanding the team events outside of practice. Someone who has a true passion for the sport, the program, and her teammate is present in all of those things. (C10)

In contrast, athletes who lack passion or consistency in their interests tend to display a less than optimal engagement with their own development:

> Like, doing the bare minimum. If they gotta be in the locker room at 6:30, it is 6:29:50 and they're walking in. In a dynamic activation [warm-up exercise], they are doing the bare minimum to not get corrected as opposed to being fully engaged. (C6)

Conscientiousness. Several coaches described conscientious athletes as systematic and detail-oriented. C5 said, "They're meticulous, they're methodical, and they're getting the repetitions done properly. The thing I always say is perfect practice makes permanent. So, if they do it well, all the time, then they'll be permanent at that skill". C8 exemplified:

> Our boats are pretty simple. They got foot rest and seats. But I mean some kids [aged 14-18] don't even know how to change a foot rest. Other kids will know exactly where their seat and foot rest are supposed to be. They're [already] set up in the boat. They pay attention to what they're doing and how they're doing, in those details.

Athletes' conscientiousness is also displayed through an overall respect for the training regimen as well as through lifestyle adaptations needed to be a highly trainable athlete:

> They come early and are physically prepared. They will have their uniform and whatever prepared before the 2-hour slot. Preparation is also being rested. In weightlifting, they train 4x/week, Monday, Wednesday, Friday, and Saturday. Friday and Saturday, it's 2 in a row. There is less rest. So, the conscientious athlete, eventually they learn to be more respectful of what the sport requires on the Saturday. Which means they're not getting

drunk, they're going to bed early so that they can wake up well rested. (C2)

Some coaches described conscientious athletes as being considerate and respectful of others and others' contribution to their training:

> My first response is you're thoughtful about others. Conscientiousness is your ability to see the greater environment that you're in, to be aware of teammates or training partners and think of their interests and needs. The ability to see the responsibility and respect you should bring to the people working with you. A daily training environment, particularly at the high level, is a composite of a lot of people, not just the coach. It's your therapist, nutritionist, biomechanist, manager, everybody that is creating this idealized environment which is difficult to find…. It's not the athlete who gets massage therapy and is on their phone because they wanna play a videogame or put up a picture on Instagram. Somebody else is taking care of their body. That is not passive. We need them engaged. (C9)

Being conscientious is being a "good person". A conscientious athlete displays interest in others and goes out of their way to assist a teammate:

> Conscientious athletes are going to work the room a little bit. They're going to interact with their teammates and go out of their way to engage everybody. They will see an athlete that may be a little bit off, having a bad session, or whatever, and they'll go check in with them. Interactions with the coach can reflect conscientiousness. The side talks before or after training that aren't necessarily about rugby, [asking the coach] "Hey how's your dog? I know it was sick the other day." Something that's a little more personal. (C7)

In contrast, non-conscientious athletes were described as egocentric, narcissistic, and impulsive in that they focus on satisfying their own immediate needs. C9 elaborated:

> There is a degree or uber narcissism, or lack of conscientiousness, that is kind of mind-

> boggling. The bus is going to leave to practice at 9 am and they're just not there because they decided they needed an extra nap but they're not gonna tell anybody because they think the system should recalibrate to their momentary needs. If you're that person, you're not conscientious cause you're not aware of the impact of your choices and how they affect others. You just expect everything to calibrate to your needs.

Non-conscientious athletes were described as driven by pleasure, which is associated with a tendency to avoid working on difficult skills and activities that are outside their comfort zone:

> Those who were not so conscientious, they come in for their favourite drill or their favourite activity and as soon as you present things that are more peripheral, they don't seem to enjoy it, get frustrated. Usually this type of person does not last. (C2)

Several coaches believed conscientious athletes have a high degree of self-awareness and self-evaluation, which enables them to somewhat coach themselves. C4 said:

> They can always coach themselves to a certain extent within the framework of the information that you've given them. They understand when they succeeded in the drill or when they failed. That's where self-critique comes in and they're able to implement it.

Highly self-aware athletes are more deliberate in their efforts to practice and improve, and demonstrate great dedication even when preparing to practice:

> Someone who's not just self-aware but aware of the world around him. That could be in how they prepare…. We're not waiting for practice to start, we're preparing for practice. A conscientious athlete is someone who also displays appropriate dedication to his preparation, because he knows that for him to perform well in practice, get better, and help the team get better, he needs to be ready. And to be ready you need to get ready. So, he's conscious of that and going about that in a systematic way. (C6)

Self-control. Most coaches described self-controlled athletes in terms of an ability to control thoughts, emotions, and impulses in one's own best interests, "The first thing that comes to mind is emotionality. So, harnessing our emotions for good. Trying to use it for fuel and not fire, cause then it can burn you up. And that's a real challenge" (C6). C9 commented:

> Self-control is your ability to assess yourself and then decide in your best interests. So, you've got an instinct to do one thing, self-control would be your ability to stop that instinctive response that is not in your best interest, to do something else.

Coaches described scenarios where athletes were required to exercise the ability to control impulses to: (a) sacrifice form and lift too much weight, instead of respecting one's limitations; (b) disrespect the defined pace of a workout because of internal competition with teammates; or (c) disregard one's recovery needs because they want to be able to exit another day of workout with a "mission accomplished" feeling. For example, C9 commented:

> It's the ability to stay within the prescription for the workout. And that's difficult sometimes because we deal with a lot of analytical people. Sport is about measurement. A lot of times satisfaction, gratification is taken from pre-conceived notions of numbers, a certain rate of travel, a certain time for an interval, or whom you're around. A less experienced athlete might be in the same training group as a more experienced athlete and their ego might say, "Well, if I finish the workout with that athlete today, that means I was as good as they are." And that's not always the case. So, there's an element of self-control in somebody's ability to stay within the assigned guidelines…. Similarly, it might be not allowing your impulse, your ego to force you to continue a workout when you should stop. So, you're achy, injured, something is compromising the quality of your workout. We deal with highly disciplined people who have great work ethics and they're

> not afraid of physical discomfort. So, the best that I work with often have a desire to try to "crush something [a part of the workout]". If you say, "Today is the workout," they wanna go to completion because that allows them to go home and say, "I was disciplined and somewhere in England somebody is working just as hard, so I have to match them." So, self-control on a flip side is also your ability to say, "Today is not the day and I should stop. I should go home and I should not let that beat up my sense of self-esteem."

Self-controlled athletes are able to manage their emotions when they get stuck in a difficult exercise, or control their ego when being corrected by the coach:

> Some athletes demonstrate lack of self-control and discipline right away. They think that what they are doing is good. And the coach says, "It's not good. It has to be done this way." Then they start arguing with the coach…. If emotionally they're always frustrated at the end result of what's happening in their movement or drill, and they get stuck in that mindset, then it's very, very difficult for the coach to have any influence on them. (C2)

Chosen trait. The attribution of priority to one trait was far from unanimous. Three coaches prioritized *perseverance of effort*, three selected *passion (consistency of interests)*, two preferred *grit*, two selected *conscientiousness*, and one chose s*elf-control*. Most coaches' descriptions associated grit with perseverance, and less so with passion/consistency of interests. The investigated traits did not always appear to be neatly distinct from one another. For example, when asked about the characteristics of a persevering athlete, C9 said, "I would say it's associated with grit and self-control. I mean, all of these, to me, they're blended traits".

Role of Conscientiousness-Related Traits for Athletic Development

Coaches generally agreed that the investigated personality characteristics facilitate athletes' expertise development, though some acknowledged that the traits are not equally

important in all sports due to differing physical and technical requirements. For example, C9 mentioned:

> You could make a case that all of them [conscientiousness-related traits] are required. At least in the sport I work with [athletics], if you're deficient to a certain degree in any of them then you're pooched…. Every sport has its unique flavour. In golf, you're probably in physical discomfort less. But endurance runners, it lends to a certain type of personality [grit]. You feel physically poorly a lot. It doesn't stop. Once you start to feel off, you're there kind of for the rest of the workout.

Impact on training quality and quantity. Although the contribution of various traits could be a function of sport, there were commonalities in emergent themes in how coaches believed conscientiousness-related traits influenced athletes' quantity and quality of practice. C1 commented, "I think conscientiousness is gonna lead to a better quality of training. If you have grit, you'll probably train more than those who don't." Conscientiousness allows athletes to be purposeful and deliberate in their efforts, helping them make fewer mistakes:

> You are being purposeful with what you're doing and you're conscious of your own reactions emotionally. You're very deliberate in how you proceed mechanically from a motor learning perspective, so as to not make those mistakes. Cause when you end up not being present and conscious and deliberate, then you're making mistakes. (C4)

C2 explained how lack of self-control might cause weightlifters to be less careful in their efforts, "When somebody starts to lose control of their emotions, then everything becomes more guttural than cerebral. Then movement refinement, mental preparation, visualization before the movement are not done correctly. Things are done quickly, without thought."

Grit facilitates training quality by enabling athletes to maintain high levels of effort

throughout a session, “You see more effort at the back end of training sessions as opposed to people that don’t possess it [grit/perseverance]. Those without it let effort decline over the course of a session or as they accumulate failures” (C7). Grit enables athletes to withstand volumes of boring/tedious practice, “He [a gritty/persevering athlete] would often finish training and then put another half hour in, go home and spend more time on essentially what were really boring exercises. Not physically uncomfortable to do but tedious, psychologically uncomfortable” (C9).

Relevance for developing to higher skill levels. Coaches recognized the relevance of conscientiousness-related traits in helping athletes advance to higher skill levels, particularly grit/perseverance. Discussing an athlete’s main task in daily training, C10 commented:

> Her job is training hard and it’s a very tough environment. If you do not take that inner toughness, that grit to the edge, it’s hard to stay in that program, be happy, and ultimately perform. You gotta have that grittiness. I remember *athlete’s name* as a 16-year-old coming to camp. Talk about self-control and grit. She was young, full of piss and vinegar. All of us old girls were like, “Who’s this little tweet”? And she had what it took. She spent 13 years in the national program and that’s impressive. *Another athlete*, the same thing. She had an impressive national career and all because she was gritty at practice.

C7 said, “I think as you get closer and closer and closer to the pinnacle of your sport, to the top end, you see a higher percentage of athletes that possess that perseverance, grit, willingness and ability to recover from setbacks.” Less persevering athletes are more likely to quit over time:

> As you move up the ladder of the triangle to the very top, there are more persevering athletes, because people drop off. At the entry level of 12-year-olds, it’s randomly distributed just like the normal population. By the time you get to the very top, you’re gonna get a whole bunch that have persevered. (C8)

Grit/perseverance is critical for athletes' advancement through skill ranks because of the long-term commitment required by athletes. C8 explained:

> In canoe/kayak, we always have superstars. They were really good at 18 and just catapulted into the senior category. We call them outliers. But then you look at our national team squad, the guys who weren't outliers at 18 or 20, who may have been quite average at 18. It often took them 2 to 3 quadrennials to get to be a finalist at the Olympic Games or even a medalist…. In terms of not being an outlier and then making it, often takes that long, but they got there. And so, perseverance is probably the main factor.

Some coaches noted a lower prevalence of conscientious athletes in the highest levels:

> I think of all the traits that you've mentioned so far, [conscientiousness] is the one where in the best I don't see it as often…. There's a pretty strong prevalence of narcissists or egocentric people on those teams and I get why they're there. It is difficult to be good at what you [the athlete] do and you often are surrounded by people who tell you how awesome you are. They create this wonderful environment and then you normalize that. And when you normalize it, it's easy to go from there to think you're entitled to that. (C9)

Relevance for sport commitment and long-term engagement. Coaches generally believed the investigated traits impact athletes' commitment and long-term engagement. A conscientious athlete can make a commitment to work toward a long-term objective regardless of challenges and uncertainty about reaching the goal. C9 exemplified:

> He's conscientious. We sat down and I said, "This is gonna be pretty prosaic work. It's going to be boring. No one's gonna know about you doing it other than a small pool of us. You have to commit to it and we don't know if it's gonna be successful. If you don't do it, we believe you're gonna stay where you are." So, his conscientiousness allowed

> him to have this longitudinal approach to it. Months and months and months. He asked himself, "Is it worth pursuing the unknown and seeing what will happen"? And the answer is "Yes." So, then he did it. "Now, the good thing for you is, the rest of your life you'll never have to wonder 'what if'. You will know. Whether you go to the Olympics or not, you will know, buddy." That's conscientiousness.

The achievement and social recognition stemming from an athlete's expression of grit may be what facilitates their commitment:

> By being a gritty athlete, you will be successful and success breeds more commitment and the recognition from coaches. All athletes want to be recognized. The recognition of being a gritty athlete, doing the hard work, will help with commitment…. Because you're gritty, those other things provide an environment where commitment is maintained. (C10)

When traits can be counterproductive. Coaches mostly had difficulty describing situations where conscientiousness-related traits could be too much, "I've had much more success with athletes who, generally speaking, have lots of discipline and lots of self-control" (C2). In fact, having "too much" of these traits was actually desirable for C7. Still, coaches commented on a couple of situations where too much of them could be counterproductive. Highly conscientious and self-controlled athletes can be more susceptible to *overthinking*:

> These athletes are very cerebral. They think through things, assess problems. Sometimes as a [biathlon] coach you just want them to *do*. If it's not working, they continuously adapt and do things differently. And you go "No, no. Just stick with it and eventually you'll get there. This isn't a question of doing things differently. Do it more and it will come to you." Athletes that overthink. (C4)

Highly conscientious athletes may risk *lacking creativity and autonomy*. C11 noted:

> It's like at school. There are good students because they do well with what the teacher says, but do not venture into other things, don't display curiosity. So, I'm not sure the most conscientious athletes are always the best. Sometimes a little craziness is good, "I'm gonna try this cause I wanna see what will happen." You have to be determined but also explore things that are not written in the training plan…. It's a lack of autonomy. The conscientious one will do what's written but will not do more, or do differently.

Sometimes, these traits could be counterproductive when they pushed athletes to *overtrain, disregard warning signs of personal injury, or disregard their recovery needs*. C3 said, "Some athletes who are highly passionate could overtrain, which could be bad". And C1 noted, "It could be counterproductive if you tried to do too much and you're not able to turn off the switch. Some people, they want it so bad that they can't turn it off." A highly passionate athlete can become *too single-minded,* becoming so focused on the one goal of being the best athlete they can be that they may become less sensitive to their other needs, "…like relaxing, enjoying a social life and everything" (C3).

Conscientiousness can push an athlete to prioritize a teammate's needs at the expense of their own individual goals, which led C9 to state:

> Self-awareness and attention to people around you might distract you from the purpose at hand. We're in the middle of a workout and a teammate is having a rough day. Say they're just having gastrointestinal distress or they're just not feeling great. You stop your workout and go to check in on them. That's conscientious, but that's counterproductive to your individual needs that day. And in those situations, I might say, "You stay on point. Take care of yourself. They're gonna be okay."

Discussion

We explored coaches' perspectives on (a) the behavioural indicators of conscientiousness, grit, and self-control in daily training; and (b) the relevance of conscientiousness-related traits for athletes' practice and athletic development. Our findings complement prior quantitative inquiry on this topic and further help to identify dispositional antecedents that impact athletes' efforts in practice and the *quality* of their training.

How Gritty, Conscientious, and Self-Controlled Athletes Behave in Daily Training

Gritty athletes were often identified as being able to persevere despite adversity. They were also described as those who: (a) practice with the same intensity with which they compete; (b) enjoy working hard in training; (c) seek extra work in order to improve; and (d) perceive failure as a growth opportunity.

Although coaches mostly associated grit with perseverance, it was *not* mindless perseverance. Some coaches reported that one of the characteristics of gritty athletes was their ability to self-assess and make appropriate judgments about their effort allocation. Such strategic decision-making would presumably prevent the athletes from pursuing unrealistic goals. These findings are in contrast to Credé, Tynam, and Harms' (2017) opinion that having high grit may prevent people from disengaging the pursuit of unattainable goals. Our coaches did not support this view, believing that gritty athletes persevered but also critically self-assessed and made adaptive adjustments in their goal pursuits. Such *mindful perseverance* is adaptive and in line with research on goal disengagement (e.g., Wrosch, Scheier, Miller, Schulz, & Carver, 2003).

Coaches' characterizations of conscientious athletes embodied four of the six facets comprising conscientiousness (i.e., order, competence, deliberation, dutifulness, self-discipline, and achievement-striving; McCrae & Löckenhoff, 2010). These athletes were mainly described

as systematic and detail-oriented, which is conceptually aligned with *order* (i.e., preference for neatness, and organization). By considering conscientious athletes as those who efficaciously prepare to practice, coaches characterized these athletes in line with *competence* (i.e., the degree to which individuals are efficient, effective, and prepared). The characterization of conscientious athletes as those not driven by impulses or immediate gratification aligns with *deliberation* (i.e., the tendency to interpose thought between impulse and action) and also with a facet of impulse restraint that defines self-control (Tangney et al., 2004).

Coaches viewed conscientious athletes as those who not only are considerate and respectful of others but also benevolently assist those around them. This view is in accord with another conscientiousness facet: *dutifulness,* an other-centred construct representing concern for the welfare of others and social duties (Moon, 2001). Notably, coaches never related conscientiousness to *self-discipline*, the ability to begin and complete tasks despite boredom and distractions, or to *achievement-striving*, the tendency to set higher goals and work hard to reach those goals (McCrae & Löckenhoff, 2010). This contrasts with Tedesqui and Young's (2018) quantitative assessment of elite athletes wherein, of the six facets, achievement-striving showed the highest correlation with sport success. Our coaches' emphasis on athletes' tendencies to be considerate instead indicates they conceive conscientiousness as an other-oriented trait and not a self-centred construct. Indeed, athletes who *lacked* conscientiousness were described as self-centred and narcissistic. Moon (2001) described *two faces* of conscientiousness: an inclination towards others' *and* one's own needs. Our results suggest coaches have an incomplete view of conscientiousness and that coaches believe overly conscientious athletes focus so much on helping others they may neglect their own development.

Interestingly, coaches also described conscientious athletes as having high levels of *self-*

regulation (e.g., ability to self-assess, self-evaluate, and self-correct), which supports McCrae and Löckenhoff's (2010) position that conscientiousness predisposes one to self-regulation. Conscientious athletes were described as having a low need for immediate gratification, which is a corollary of effective self-regulation toward long-term goals (Mischel, Shoda, & Rodriguez, 1989). With respect to self-controlled athletes, coaches described them as *effectively delaying the need for immediate gratification* and appropriately *managing their self-presentation impulses* to respect their own limits in training (e.g., avoiding overtraining). Overall, self-controlled athletes were deemed able to control thoughts and impulses in their best interests, consistent with Tedesqui and Young's (2015) notion of impulse control as resisting temptations during effortful/tedious practice.

Relevance for the Development of Expertise

Coaches' descriptions further underscored the relevance of conscientiousness-related traits in terms of two major tenets of an expert development framework: associations with quality deliberate practice and discrimination of skill groups (e.g., Abernethy et al., 1993; Ericsson et al., 1993; Tedesqui & Young, 2018). To synthesize, tendencies to persevere despite adversity and mindfully use self-regulated processes seem to be powerful predispositions, at least in the eyes of coaches, for athletes' development toward expert performance levels. Our results suggest this may be especially true with "hard gainers" who may not be physically or technically advantaged and thus need to competitively compensate by persevering under suboptimal conditions.

Coaches generally described how high levels of conscientiousness-related traits help athletes accumulate more *quantities* of practice either by enduring through boring/tedious practice or enacting their passion to practice outside structured training. Notably, coaches more often emphasized the impact of these traits on athlete's *quality* of practice. Gritty/persevering

athletes maintain high effort throughout practice instead of fading, thus extending their period of possible skill acquisition. Conscientious and self-controlled athletes tend to be more deliberate in their efforts, minimizing mistakes and optimizing their learning. Conscientious athletes also have higher self-regulatory skills which allows them to practice with better quality. Though these proposed mechanisms still require testing, the latter parts of the *conscientiousness—self-regulation—practice quality* pathway and the *conscientiousness—self-regulation—skill level* pathway have support in broader literature on expertise development (Zimmerman, 2006) as well as within sport (Bartulovic, Young, & Baker, 2017; McCardle et al., 2017).

Our findings suggest that conscientiousness-related traits are synergistic and complementary. While gritty athletes have a predisposition to *work hard*, conscientious athletes are able to *work smartly*. The *grit—working hard* association and the *conscientiousness—working smart* association imply that while a gritty athlete may be able to endure hardship in training and persevere despite challenges, a conscientious athlete is able to strategically allocate their efforts to accomplish their goals. Both traits equip athletes to overcome numerous practice challenges and to optimize skill acquisition.

Athletes embodying conscientiousness-related traits were described as working hard with high quality, having great attendance, being self-evaluators, and more attentive to coaches' instructions; all are relevant indicators of practice quality (Oliver et al., 2010). Conscientious athletes tend to be considerate and go out of their way to help others. Although instances were noted where overly conscientious athletes compromise their own interests, almost all coaches deemed conscientious athletes as more coachable. Coaches clearly preferred other-oriented, as opposed to narcissistic, self-centred athletes. Despite only two out of our 11 coaches chose conscientiousness as the most relevant developmental trait, it is possible that coaches'

preferences result in conscientious athletes being afforded more skill acquisition opportunities over time. This said, there may be occasions where athletes need to be self-centred. For example, 'super-elite athletes' who developed to the highest performance levels demonstrated *selfishness* and *ruthlessness* (Hardy, Barlow, Evans, Rees, Woodman, & Warr, 2017).

Grit may impact an athlete's long-term commitment partly because gritty athletes tend to be successful and be recognized for their success. In turn, that achievement and social recognition would facilitate an athlete's willingness to remain committed to their sport. This is the first time that grit is positioned as an antecedent of higher commitment through the mediation of sport success/social recognition. Finally, results suggest that conscientious athletes tend to engage over the long-term because they are able to commit despite uncertainty that their efforts will produce desirable results. The finding that high conscientiousness is associated with greater tolerance to future uncertainty or with the preference for *probabilistic* vs. certain or *delayed* vs. immediate rewards has support in the personality literature (McCrae & Löckenhoff, 2010).

When predispositions might clash or be counterproductive. From coaches' perspectives, conscientiousness involves being detail-oriented and following instructions, whereas grit involves working hard and doing extra work. These conceptualizations might implicate certain tensions during training. For example, it is unclear what the predominant predisposition is for an athlete who has *both* high grit and high conscientiousness: would this athlete be more inclined to obey their coach's instruction to go home after training to get a well-deserved rest, or would they be tempted to push hard and keep practicing beyond the end of the training session? In addition, would a gritty and conscientious athlete be more inclined to go all out and hit their teammate hard, or would they be more predisposed to worry about hurting their teammate and reduce their effort? Such tensions, along with noted instances where

conscientiousness-related traits might not be productive (e.g., overthinking, overtraining), should be juxtaposed with many coaches' belief that athletes could never be "too gritty/persevering."

Implications

Coaches associated grit with athletes' perseverance, but to a much lesser extent with consistency of interests, which suggests coaches may have a partial view of the grit construct. Consequently, our findings may inform dialogue between researchers and coaches and knowledge translation efforts stemming from research on grit. Accurate knowledge transfer, free from misinterpretation, is critical especially considering that the predictive ability of the grit construct lies predominantly upon perseverance of effort (Credé et al., 2017) and that the two grit facets have distinct associations with outcomes of sport expertise (Tedesqui & Young, 2017b). Equipped with knowledge about how coaches conceive of grit, researchers may be in a better position to speak the lexicon of coaches when conveying empirical findings, and nuancing messages related to perseverance of effort and consistency of interests.

Conceptually, our results provide impetus for future research to test pathways through which conscientiousness-related traits help athletes maximize and optimize their practice. From an applied standpoint, talent developers may benefit from knowing that these conscientiousness-related traits impact both athletes' quantity and quality of training. Coaches involved in developing talent might consider implementing periodical assessments of these traits to forecast which athletes could benefit from preventive measures (e.g., extra coaching, psychological training) to accumulate more hours of practice and get the most out of their training. Our findings suggest that coaches might benefit from evaluating athletes' levels of conscientiousness-related traits to intervene with those at risk for showing poor commitment. Future research should longitudinally track athletes of varying conscientious-related profiles to explore how

these traits interact with athletes' personal efforts and choice of training activities, measures of quality deliberate practice, and the affordance of training opportunities by coaches, over time.

Limitations and Conclusion

This study was not without limitations. Due to the exploratory nature of the study, and in keeping with our constructionist view, our results should be regarded as one of multiple possible interpretations. Our finding that coaches chose grit/perseverance as the most relevant developmental trait may be an artifact of the interview design, since coaches were not asked about facets of conscientiousness or self-control. Our study results may reflect gender bias as most were male coaches. Further, we did not triangulate our findings on coaches' descriptions of athletes' personalities with measures of athletes' self-reported personality. Future studies that use such triangulation may validate the current findings and contribute to the development of other-report behavioural measures of athletes' personality. Finally, our results are limited to coaches' perspectives on the investigated conscientiousness-related traits, meaning we did not consider other characteristics shown to impact athletes' development (e.g., perfectionism, Stoeber, 2011). Future research might aim to explore coaches' views of how such traits are expressed in training.

In conclusion, coaches' perspectives on the behavioural indicators of conscientiousness-related traits in the daily training suggested some overlap between these constructs. Regarding the relevance of these traits for athletes' training and athletic development, coaches viewed grit, conscientiousness, and self-control as important. Grit/perseverance was deemed the most important developmental trait. We added richness on the potential mechanisms through which these traits impact athletes' development, and further described how these traits serve as dispositional antecedents of quality practice behaviours. Our findings on behavioural indicators of personality characteristics inform coach practitioners about how to identify athletes with high

levels of traits that predispose them to engage in relevant training behaviours for their athletic development.

Acknowledgments

This work was supported by the Social Sciences and Humanities Research Council of Canada (SSHRC).

References

Abernethy, B., Thomas, K. T., & Thomas, J. T. (1993). Strategies for improving understanding of motor expertise [or mistakes we have made and things we have learned!!]. *Advances in Psychology, 102,* 317-356.

Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies, 15,* 211-228. doi:10.1080/1359813042000314781

Baker, J., & Young, B. W. (2014). 20 years later: deliberate practice and the development of expertise in sport. *International Review of Sport & Exercise Psychology, 7,* 135-157. doi:10.1080/1750984X.2014.896024

Bartulovic, D., Young, B.W., & Baker, J. (2017). Self-regulated learning predicts skill group differences in developing athletes. *Psychology of Sport & Exercise, 31,* 61-69. doi:10.1016/j.psychsport.2017.04.006

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3,* 77-101.

Côté, J., & Gilbert, W. (2009). An integrated definition of coaching effectiveness and expertise. *International Journal of Sports Science & Coaching, 4,* 307-323.

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality & Social Psychology, 113,* 492–511. doi:10.1037/pspp0000102

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality & Social Psychology, 92,* 1087-1101. doi:10.1037/0022-3514.92.6.1087

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the

acquisition of expert performance. *Psychological Review, 100,* 363-406.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive coding and theme development. *International Journal of Qualitative Methods, 5*, 80-92.

Gratton, C., & Jones, I. (2010). What is research? In *Research methods for sports studies (2nd ed., pp. 1–14).* New York: Routledge.

Hardy, L., Barlow, M., Evans, L., Rees, T., Woodman, T., & Warr, C. (2017). Great British medalists: Psychosocial biographies of super-elite and elite athletes from Olympic sports. *Progress in Brain Research, 232,* 1-119. doi:10.1016/bs.pbr.2017.03.004

Maloney, P. W., Grawitch, M. J., Barber, L. K. (2012). The multi-factor structure of the Brief Self-Control Scale: Discriminant validity of restraint and impulsivity. *Journal of Research in Personality, 46*, 111-115. doi:10.1016/j.jrp.2011.10.001

McCardle, L., Young, B.W., & Baker, J. (2017). Self-regulated learning in sport training contexts: Current status, challenges, and future opportunities. *International Review of Sport & Exercise Psychology.* Online in advance. doi:10.1080/1750984X.2017.1381141

McCrae, R. R., & Löckenhoff, C. E. (2010). Self-regulation and the five-factor model of personality traits. In R. H. Hoyle (Ed.), *Handbook of personality and self-regulation* (pp. 145-168). Hoboken, NJ: Wiley InterScience.

Mischel, W., Shoda, Y., & Rodriguez, M. I. (1989). Delay of gratification in children. *Science, 244*, 933-938. doi:10.1126/science.2658056

Moon, H. (2001). The two faces of conscientiousness: Duty and achievement striving in escalation of commitment dilemmas. *Journal of Applied Psychology, 86,* 533–540. doi:10.1037//0021-9010.86.3.533.

Oliver, E. J., Hardy, J., & Markland, D. (2010). Identifying important practice behaviors for the development of high-level youth athletes: Exploring the perspectives of elite coaches. *Psychology of Sport & Exercise, 11*, 433-443. doi:10.1016/j.psychsport.2010.05.004

Rubin, H. J., & Rubin, I. S. (2005). *Qualitative interviewing: The art of hearing data (2nd ed.* Thousand Oaks, CA: Sage.

Smith, J. A. (1995). Semi-structured interviewing and qualitative analysis. In J. A. Smith, R. Harré, & L. van Langenhove (Eds.), *Rethinking methods in psychology* (pp. 9–26). Thousand Oaks, CA: SAGE.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K.A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts, sciences, sports and games* (pp. 81-106). Mahwah, NJ: LEA.

Stoeber, J. (2011). The dual nature of perfectionism in sports: Relationships with emotion, motivation, and performance. *International Review of Sport & Exercise Psychology, 4*, 128-145. doi:10.1080/1750984X.2011.604789

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271-324.

Tedesqui, R. A. B., & Young, B. W. (2015). Perspectives on active and inhibitive self-regulation relating to the deliberate practice activities of sport experts. *Talent Development & Excellence, 7*, 29–39.

Tedesqui, R. A. B., & Young, B. W. (2017a). Associations between self-control, practice, and skill level in sport expertise development. *Research Quarterly for Exercise & Sport, 88*,

108–113. http://dx.doi.org/10.1080/02701367.2016.1267836.

Tedesqui, R. A. B., & Young, B. W. (2017b). Investigating grit variables and their relations with practice and skill groups in developing sport experts. *High Ability Studies, 28,* 167-180. doi:10.1080/13598139.2017.1340262.

Tedesqui, R. A. B., & Young, B. W. (2018). Comparing the contribution of conscientiousness, self-control, and grit to key criteria of sport expertise development. *Psychology of Sport & Exercise, 34*, 110-118. doi:10.1016/j.psychsport.2017.10.002

Toering, T., & Jordet, G. (2015). Self-control in professional soccer players. *Journal of Applied Sport Psychology, 27*, 335–350. doi:10.1080/10413200.2015.1010047

Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative Health Research, 11*, 522-537.

Woodman, T., Zourbanos, N., Hardy, L., Beattie, S., & McQuillan, A. (2010). Do performance strategies moderate the relationship between personality and training behaviors? An exploratory study. *Journal of Applied Sport Psychology, 22*, 183-197. doi:10.1080/10413201003664673

Wrosch, C., Scheier, M. F., Miller, G., Schulz, R., & Carver, C. S. (2003). Adaptive self-regulation of unattainable goals: Goal disengagement, goal reengagement, and subjective well-being. *Personality & Social Psychology Bulletin, 29*, 14-94-1508. doi:10.1177/0146167203256921

Zimmerman, B.J. (2006). Development and adaptation of expertise: The role of self-regulatory processes and beliefs. In K. A. Ericsson, N. Charness, P. J. Feltovich, R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp.705-722). New York: Cambridge University Press.

Chapter VII: General Discussion

Overview of Purposes

This project examined the role of conscientiousness-related personality traits on athletes' quantity and quality of practice, skill level, and other criteria of sport expertise development. More specifically, the purposes of Phase 1 (Articles 1, 2, and 3) of this dissertation were to: (a) examine the structural validity of conscientiousness-related measures in sport; (b) understand whether athletes' deliberate practice (DP) amounts, sport commitment, practice engagement, and skill level could be predicted by conscientiousness-related traits; and (c) identify the best predictor as well as the parsimonious combination of predictors that maximized the explained variance in different criteria of expertise development. The aim of Phase 2 (Article 4) was to (d) examine whether grit variables predicted athletes' practice engagement across a demanding sport season. The purposes of Phase 3 (Article 5) were to: (e) explore coaches' perspectives about how athletes' levels of conscientiousness, grit, and self-control translated into behaviours in the daily training environment; and (f) explore coaches' views about how these personality traits may impact athletes' quantity and quality of practice and development toward higher skill levels. The research questions outlined in Chapter I with their corresponding answers derived from the three phases of the research are presented in executive summary form in Table 1 (see below). Next, is a summary of the research findings from each of the five articles that make up this dissertation.

Summary and Integration of Findings

Article 1 assessed the factor structure of the Brief Self-Control Scale (Tangney et al., 2004) in sport and the role of self-control on sport expertise. Results showed evidence for a two-factor structure of the scale (i.e., self-discipline and impulse control) and for how self-control

Table 1

Research Questions and Summary of Answers

Research Questions	Summary of Answers (supporting articles)
RQ1: *Are the conscientiousness-related personality scales psychometrically sound for use with a sample of athletes?*	IPIP Conscientiousness Subscales and Brief Self-Control Scale are sound. Grit Scale had to be adapted and now is also sound. (*Articles 1, 2, and 3*)
RQ2: *Can grit, conscientiousness, and self-control facets predict key criterion outcomes related to athletes' amount of DP, sport commitment, engagement in different practice contexts, and skill level?*	Each outcome investigated showed associations with some (not all) facets of grit, conscientiousness, and self-control. (*Articles 1, 2, and 3*)
RQ3a: *Which personality trait is the best predictor of variance in each of these outcomes?*	*Perseverance of effort* best predicted athletes' amount of DP, engagement in mandatory practice, and was the sole predictor of skill level. *Achievement-striving* best predicted engagement in optional practice. *Consistency of interests* best predicted sport commitment. (*Article 3*)
RQ3b: *What parsimonious combination of facets can explain the maximal amount of variance in DP, sport commitment, engagement in practice contexts, and skill level?*	*Amounts of DP*: perseverance of effort + dutifulness + achievement-striving. *Mandatory practice (engagement)*: perseverance of effort + self-discipline. *Optional practice (engagement)*: achievement-striving + self-discipline. *Thoughts of switching sports (commitment)*: consistency of interests. *Thoughts of quitting sports (commitment)*: consistency of interests + self-discipline. *Skill level*: perseverance of effort. (*Article 3*)
RQ4a: *Do athletes' self-reported grit scores predict their coach-reported practice engagement over the course of a season?*	Athletes' self-reported perseverance of effort score can predict their coach-reported practice engagement over the course of a season. (*Article 4*)
RQ4b: *Which grit variable (perseverance of effort, consistency of interests, or composite grit) shows greater predictive validity for indicators of quality practice?*	Compared to consistency of interests and overall grit, perseverance of effort showed the greatest predictive validity for indicators of quality practice. (*Article 4*)
RQ5: *How do coaches describe behavioural indicators of conscientiousness, grit, and self-control within the daily training environment?*	*Conscientious athletes*: systematic and detail-oriented, go out of their way in consideration of others, prepare to practice, delay gratification, display high engagement in self-regulation. *Gritty athletes*: show mindful perseverance despite adversity, practice with intensity, enjoy working hard, seek extra work to improve, see failure as growth opportunity. *Self-controlled athletes*: control impulses and resist temptations, delay gratification, respect their own limits. (*Article 5*)
RQ6: *From coaches' views, how do conscientiousness, grit, and self-control relate to athletes' quantity and quality of practice, commitment to their sport, and skill development?*	Coaches believe conscientiousness-related traits impact both quantity and quality of practice and help athletes remain committed to their sport and reach higher skill levels. The tendency to persevere despite adversity and mindfully use self-regulated processes seems to be a powerful predisposition, at least in the eyes of coaches, for their development toward expert levels of performance. (*Article 5*)

facets had different associations with criteria of expertise. In particular, self-disciplined athletes reported higher sport commitment as evidenced by fewer thoughts of switching or quitting one's sport. Self-discipline related to greater amounts of sport-specific practice among juniors (under 18 years of age). Athletes with higher impulse control reported a greater engagement in optional practice contexts. Athletes from higher and lower skill groups did not differ in levels of self-discipline or impulse control.

Article 2 reported tests of the factor structure of the Grit Scale (Duckworth et al., 2007) in sport and the role of grit on indicators of expertise. Through factor analyses and cross-validation procedures (e.g., using calibration and validation samples), we improved the two-factor structure of the Grit Scale (i.e., perseverance of effort and consistency of interests) for use in sport. Grit facets showed complementary associations with different criteria of expertise development. A full latent variable model showed that while athletes' levels of perseverance of effort significantly predicted their weekly hours of DP and engagement in different practice contexts, levels for consistency of interests predicted athletes' commitment to their sport. Compared to athletes from beginner/intermediate skill levels, athletes from expert and advanced levels showed higher perseverance of effort.

Article 3 reported two studies. Study 1 used path analyses to assess the role of conscientiousness (broad and facets; IPIP, n.d.) on criteria of expertise. At the broad level, conscientiousness was associated with sport commitment and engagement in different practice contexts, but not with athletes' weekly hours of DP. At the specific level, achievement-striving significantly predicted DP and practice engagement. A series of logistic regressions showed that neither broad conscientiousness nor any of its specific facets predicted the likelihood of athletes belonging to higher skill groups. Study 2 compared the associations that facets of self-control,

grit, and conscientiousness (that had shown to be significant predictors when assessed separately in Article 1, Article 2, and in Study 1 of Article 3) had with criterion measures for practice, sport commitment, practice engagement, and skill level. Perseverance of effort was the best predictor of athletes' weekly hours of DP and engagement in mandatory practice contexts, and the only predictor of higher skill group membership. Athletes with higher levels of perseverance of effort were at greater odds of belonging to the expert group compared to the beginner/intermediate group. Achievement-striving best predicted athletes' engagement in optional practice. Consistency of interests best predicted athletes' sport commitment (i.e., less inclination to have thoughts of switching and quitting one's sport).

Article 4 tested whether athletes' self-reported levels of grit (broad and facets) were longitudinally associated with their coach-reported practice engagement throughout one sport season. Perseverance of effort was the grit variable most related to coach ratings of athletes' quality practice engagement and the only variable related to overall practice engagement across three time points. Only the association of perseverance of effort (not consistency of interests, or overall grit) with athletes' stability of practice engagement approached significance, suggesting that athletes who report higher scores for perseverance of effort may be predisposed to sustain high quality practice over time.

Article 5 qualitatively explored coaches' views about the behavioural indicators of conscientious, gritty, and self-controlled athletes in the daily training environment and how these traits impacted athletes' practice and development. In general, coaches described (a) conscientious athletes as systematic and detail-oriented, highly considerate of others, and highly engaged in self-regulation; (b) gritty athletes as those who persevere despite adversity and work hard in practice; and (c) self-controlled athletes as those who control impulses, resist

temptations, and delay gratification. In coaches' views, grit, conscientiousness, and self-control play important roles on athletes' development toward higher skill levels. In general, the results highlight the preponderance of perseverance of effort for athletes' quality practice and optimal development and highlight potential mechanisms (e.g., *conscientiousness—self-regulation—practice quality* and *conscientiousness—self-regulation—skill level*) that would help explain the personality-expertise link found in Phases 1 and 2.

Research Designs and Inferences Made. Overall, the results of Phase 1 (Articles 1, 2, and 3) showed there is an association between athletes' conscientiousness-related personality traits and different criteria of expertise development including DP amounts, commitment to one's sport, engagement in different practice contexts, and higher skill levels. The cross-sectional nature of Phase 1 did not allow one to make an inference that there is a causal relationship between the investigated traits and expertise-related outcomes in sport nor to infer the directionality of a potential causal relationship. The possibility that athletes' high involvement with DP and different practice contexts contributed to make them more conscientious, gritty, and self-controlled could not be ruled out. Phase 2 (Article 4) provided evidence that an athlete's self-reported level of perseverance of effort at time 1 could predict their practice engagement at later points throughout the season, and potentially predict the stability (or fluctuation) of their practice engagement over time. Phase 2 contributed to improve the confidence in the hypothesis of directionality of the findings of Phase 1, but a definitive conclusion could not be reached since grit variables were not reassessed at times 2 and 3.

Several studies provide support for the hypothesis of directionality in this dissertation. Personality is an important predictor for a number of important life outcomes including well-being and relationships (Ozer & Benet-Martínez, 2006), occupational attainment (Roberts,

Kuncel, Shiner, Caspi, & Goldberg, 2007), academic performance (Poropat, 2009), and sport success (Allen et al., 2013). Further, personality researchers have provided evidence for the relative stability and continuity of personality (Roberts et al., 2008). For example, Duckworth and Quinn (2009, Study 4) examined the test-retest reliability of the Grit Scale after 1 year and found evidence for the relative stability of the measure even among a sample of students aged 11 to 17. This result is consistent with the accepted definition of personality traits as "*relatively enduring* [emphasis added] patterns of thoughts, feelings, and behaviours that distinguish individuals from one another" (Roberts et al., 2008, p. 375) and with the finding that although personality does change, the magnitude of that change is only around one standard deviation across an individual's life span (Roberts et al., 2008). Therefore, although some level of bidirectionality arguably exists in the personality-practice relationship, there are conceptual and empirical reasons to believe that conscientiousness-related traits occupy more often the *antecedent* than the outcome role. Thus, taken together, the results of this dissertation suggest that conscientiousness-related personality traits are relevant antecedents within the broader field of expertise (e.g., DP and expert performance frameworks; Abernethy et al., 1993; Ericsson et al., 1993; Ericsson & Smith, 1991) and the specific field of sport expertise development (e.g., Baker & Young, 2014; Baker, Young, McCardle, & Tedesqui, in press).

The overarching purpose of the qualitative Phase 3 (Article 5) was to add richness to the interpretation of findings from Phases 1 and 2. Importantly, Article 5 revealed potential mechanisms that could help explain why athletes with high levels of conscientiousness-related traits tend to practice more, get more out of their practice, remain committed to their sport, and develop to higher skill levels. For example, athletes high in perseverance of effort tend to maintain high effort throughout the entire duration of a practice session, thus improving their

practice quality. Also, conscientious athletes would display higher self-regulation skills (e.g., self-awareness, self-evaluation, self-correction) and be more deliberate in their training efforts.

The mechanisms proposed in Phase 3 to explain the *personality—expertise* relationship may add to current knowledge (pending confirmation via mediation studies) about optimizing athletes' practice quality and skill development. For example, the *conscientiousness—self-regulation—practice quality* and the *conscientiousness—self-regulation—skill level* pathways identify conscientiousness as an antecedent in the proposed link between athletes' self-regulation and optimal practice habits (McCardle, Young, & Baker, 2017) and in the observed relationship between athletes' self-regulation and higher skill levels (Bartulovic, Young, & Baker, 2017). These pathways also have partial support in the personality literature (e.g., conscientiousness impacts self-regulation processes; McCrae & Löckenhoff, 2010) and in the broader literature on expertise (e.g., self-regulation impacts expertise; Zimmerman, 2006). Collectively, these findings contribute to further position personality traits from the family of conscientiousness as important predispositions for the development of expertise in sport. In a review paper, Hampson (2012) noted that although personality research has advanced knowledge about the prediction of relevant life outcomes, currently missing from the literature is research trying to understand the processes that produce the effects of personality traits or, in other words, how personality traits "get outside the skin" (p. 1). Thus, this dissertation also contributed by highlighting processes/mechanisms through which conscientiousness-related traits might impact consequential outcomes for aspiring expert athletes.

Grit Facets and the Predominance of Perseverance. Notably, throughout the three phases of the dissertation, the grit facet of perseverance of effort was predominant in explaining criteria associated with expertise development. In Phase 1, perseverance of effort was the best

predictor of athletes' quantity of practice and the only predictor of athletes' likelihood of belonging to the expert skill group compared to the beginner/intermediate group. In Phase 2, among the three grit variables (perseverance of effort, consistency of interests, and overall grit), only perseverance of effort prospectively related to athletes' overall quality engagement in practice over the course of a season. Finally, in Phase 3, coaches mostly aligned grit to the perseverance of effort facet, considered grit/perseverance to be related to athletes' quality of practice, and most often (five out of 11 coaches) chose grit/perseverance as the most critical trait (among those investigated) with respect to athletes' training and development to expert levels of performance. Collectively, these studies corroborate Credé et al.'s (2017) conclusion based on their meta-analysis of the grit effect: perseverance of effort shows important associations with many criteria of performance. Elsewhere, perseverance has been considered critical to the development of sport experts (Durand-Bush & Salmela, 2002) and an important attribute of Olympic champions (Gould, Dieffenbach, & Moffett, 2002). Holt and Dunn (2004) found resilience—a construct conceptually related to grit and defined as the ability to bounce back after adversity—was among the central psychosocial competencies associated with success in soccer.

Relatedly, findings from Article 5 suggested perseverance would be more prevalent among athletes who had certain physical or technical disadvantages. These "hard gainers" would tend to be more persevering relative to their more skilled peers in order to compensate for physical/technical disadvantages. In a seminal study of world-class adolescent tennis players, Monsaas (1985) found that less endowed athletes "compensated for physical drawbacks or for lack of any extraordinary physical qualities by working 'twice as hard' as their peers" (p. 239). Similarly, a weak inverse association between personality and ability has been found in other fields. Personality was inversely related with measures of ability in the educational (e.g., grit and

SAT scores: *r* = -.20; Duckworth et al., 2007, Study3) and occupational fields (e.g., conscientiousness and IQ scores: *r* = -.24; Moutafi, Furnham, & Paltiel, 2005). Supposedly, among relatively talented individuals, those who are less bright compensate by working harder and persevering with more determination (Duckworth et al., 2007, Study 3). Alternatively, the additional challenges encountered by less-talented athletes might have helped them become more resistant to adversities along the way.

A recent body of literature has highlighted the role of adversity-related experiences both within sport (e.g., repeated non-selection, performance slumps, serious injury) and outside sport (e.g., death in the family) on the development of elite athletes (e.g., Collins & MacNamara, 2012; Hardy et al., 2017; Sarkar & Fletcher, 2017; Sarkar, Fletcher, & Brown, 2015; Tamminen, Holt, & Neely, 2013). Based on evidence that challenging experiences throughout development are more common among athletes who reach the highest skill levels, one of the central arguments surrounding these works is that early experiences of adversity decrease vulnerability and strengthen resistance to future instances of adversity (Gucciardi, 2017). Adversity-related experiences can trigger an intense motivation, fuel ambition, and stimulate a single-minded and self-serving indifference which, combined, allow athletes to remain primarily focused on their own goal of developing toward the most elite levels (Sarkar & Fletcher, 2017). Adversity-related experiences may also stimulate a perfectionistic, ruthless, and selfish attitude to one's sport development (Hardy et al., 2017). Regardless of the pathway that led to an athlete's high level of perseverance of effort, the tendency to persevere despite adversity appears to be a powerful predisposition for athletes' development toward expert levels of performance. Moreover, coaches in Article 5 attributed a notion of compensation associated with perseverance to the developmental efforts of initially less-advantaged athletes.

Despite the predominance of perseverance in extant literature and in the current dissertation, it is also important to note that consistency of interests demonstrated its value within this dissertation for understanding athletes' path to expertise. In particular, athletes' self-report for consistency of interests was associated with fewer thoughts of switching or quitting one's sport (Article 2) and outperformed other conscientiousness-related traits as a predictor of these proxies for sport commitment (Article 3). The qualitative results from Article 5 further corroborated these quantitative findings—athletes who have consistent interests were characterized by coaches as those who are highly committed to their own development. Baker and Côté (2003) argued that commitment "may be the most important attribute for the acquisition of expertise in sport" (p. 139) and that "the key to amassing the quantity of training required for developing expert-level skills is sustaining commitment across years of involvement in a domain" (p. 140). In this dissertation, consistency of interests was the best predictor of athletes' commitment, which highlights its role for one's development toward expertise. In sum, while consistent athletes remain committed to their development (Articles 2, 3, and 5), persevering athletes work harder, practice more, and reach higher skill levels in their sport (Articles 2, 3, 4, and 5). Taken together, the results of this dissertation pertaining to the two grit facets suggest that although grit may be a relevant construct for understanding behaviours associated with expert levels of performance, perseverance of effort seems especially critical.

Insights on the Use of Complementary Methodological Approaches. This dissertation pursued a sequential explanatory mixed-methods design (Creswell, 2011) whereby the research project started with the collection and analyses of quantitative data, which were assigned priority for addressing the research questions, followed by the collection and analyses of qualitative data, which helped to interpret the quantitative results. In particular, an interactive mixed-methods

approach was adopted (Creswell, 2011) where results from Phases 1 and 2 informed the design and data collection of Phase 3. Prior quantitative comparative analyses of the role of the investigated traits on athletes' development had highlighted the critical contribution of grit facets (Article 3). Therefore, in addition to coaches' views on the three broad traits (conscientiousness, grit, and self-control), their views were explored about the two grit facets (perseverance of effort and consistency of interests).

Another advantage of this mixed-methods design was that the qualitative findings from Phase 3 helped explain instances of Phase 1 where the quantitative results were intriguing. For example, some findings from Phase 1 were unexpected, including a lack of association between conceptually meaningful traits and practice outcomes. Notably, *broad* conscientiousness was not a significant predictor of athletes' amounts of DP (Article 3, Study 1). The qualitative results of Phase 3 offered potential explanations by shedding light into instances where coaches believed high levels of conscientiousness could be counterproductive for athletes' training and development. Excessively conscientious athletes might "think too much" and get stuck scrutinizing their mistake in a drill, constantly trying to self-correct (instead of simply moving on and trying again), wasting valuable time in DP. Furthermore, highly conscientious athletes' tendency to go out of their way to help others could put them at risk for poorer dedication to their own development and limit the amount of practice they accumulate. The possibility of explaining the quantitative findings through a follow up qualitative study highlights a major strength of the sequential explanatory mixed methods design used in the current dissertation.

This dissertation used a mixed-methods approach that entailed different methods of assessment (quantitative and qualitative) and reports from the perspective of the athletes themselves as well as their coaches (i.e., *self*- vs. *other*-ratings). Some observations can be made

about the use of such complementary methods. The assessment of athletes' practice engagement via coach ratings in Phase 2 (Article 4) improved the confidence in the outcome measures relative to Phase 1 (Articles 1 to 3) when the results only relied on athletes' self-assessment of practice-related outcomes. Coach ratings of athletes' practice engagement (Article 4) eliminated self-report bias and social desirability, presumably constituting a more objective measure of athletes' practice behaviours. Phase 3 (Article 5) added richness to the prior quantitative results by (a) describing the behaviours that conscientious, gritty, and self-controlled athletes display in day-to-day training; and (b) shedding light into the processes or mechanisms that link traits to important outcomes.

The richness of the coaches' qualitative descriptions of athletes' manifestations of conscientiousness-related personality traits (Article 5) brings to light whether their descriptions are incongruent/incomplete with respect to conceptual definitions, or whether they are important extensions of operational constructs. On one hand, coaches' descriptions were only in partial agreement with conceptual understandings of the investigated traits from the extant academic literature. Coaches seemed to have an incomplete view of the traits. They most often described gritty athletes as persevering, but not necessarily as being consistent in their interests. They most often described conscientious athletes as orderly and dutiful, but never as achievement-strivers. Finally, coaches typically described self-controlled athletes as those able to exert control over their impulses, but rarely as self-disciplined. On the other hand, the richness in coaches' descriptions might alternatively suggest that the conceptual understandings of the investigated traits are incomplete without considering the interpretation of practitioners. Coaches' descriptions extended beyond the quantitative measurement of the traits, possibly because coaches' in-depth descriptions reflected not only indicators of the investigated traits but also

encompassed correlates (e.g., confidence), conditions/contexts (e.g., physical disadvantage), or outcomes (e.g., self-regulation) associated with the traits. For example, conscientious athletes were described as having a high ability to self-regulate their practice efforts. Some personality researchers have positioned self-regulation as an outcome instead of an indicator of conscientiousness (e.g., McCrae & Löckenhoff, 2010). Thus, the value in having high-level coaches (practitioners who observe athletes' behaviours in the training environment) describe the daily, in situ manifestation of athletes' conscientiousness-related traits is providing a richer, more comprehensive understanding of how predispositions translate to expertise-related outcomes.

It is important to note that coaches' descriptions were possibly limited in that they emphasized athletes' patterns of *behaviours* in training but not their patterns of thoughts or feelings. Because one's personality also encompasses patterns of thoughts and feelings in addition to patterns of behaviours (Roberts et al., 2008), another issue in the assessment of personality via a qualitative exploration of coaches' views (as opposed to athletes' own self-assessments as in Articles 1, 2, and 3) is that coaches' descriptions of behavioural indicators may have neglected relevant aspects of athletes' personality (i.e., patterns of thoughts and feelings). Regarding athletes' habitual thoughts and feelings in training, coaches could at best make inferences and educated guesses based on indirect observations. For example, they described lack of perseverance as an athlete's tendency to *think* about immediate gratification and an inability to ponder long-term outcomes of their behaviours. Such a description could only be based on inference about the thinking processes underpinning the observed behaviour of quitting a long-term goal. Nevertheless, it is important to note that research supports the validity of other-rated personality measures in different domains including education (e.g., Poropat, 2014) and occupational domain (e.g., Mount, Barrick, & Strauss, 1994). For example, prior research in the

occupational domain found that other-ratings (i.e., supervisor, coworker, and customer) of the personality of sales representatives were not only valid predictors of performance criteria, but also accounted for significance variance in the criteria beyond self-ratings. Thus, coaches' descriptions of athletes' behavioural indicators of conscientiousness-related traits can be deemed valid and meaningful for understanding expertise outcomes.

Finally, coaches' descriptions were restricted to athletes' behaviours that they could observe within the daily training environment. Presumably, several conscientious, gritty, and self-controlled behaviours that might also impact athletes' development occur outside the daily training environment, thus away from the auspices of a coach. For example, in the field of education, learners' conscientiousness-related behaviours such as homework and study generally occur outside classroom, beyond the observation of teachers/instructors, potentially limiting the accuracy of teacher-rated personality (e.g., Poropat, 2014). Similarly, coaches cannot observe the time athletes habitually go to bed on the eve of an early training session, or how much extra time outside mandatory, coach-supervised practices an athlete commonly spends working to improve their performance. Practicing in such voluntary contexts requires the enactment of self-regulatory competencies (e.g., Tedesqui & Young, 2015; Young, Medic, & Starkes, 2009) which coaches might not be able to witness. Despite these issues, Phase 3 offered critical insights on behavioural indicators of athletes' conscientiousness-related traits in training from the perspective of high-level coaches who were involved with them in the daily training environment. These coaches were, thus, in a privileged position to provide rich descriptions and insights about how key personality traits are manifested in different conditions of practice and throughout athletes' development. Further, these insights may extend traditional understanding of the investigated traits by including correlates, conditions/contexts, and outcomes affiliated

with these traits. These insights were not possible to obtain from the assessment methods used in Phases 1 and 2. In sum, by considering multiple and complementary methods of assessment of practice behaviours and athletes' personality through mixed methods and both self- and other-ratings, the studies in this dissertation collectively compensated for the shortcomings inherent to any one method.

Implications

This dissertation has several conceptual, methodological, and applied implications.

Conceptual implications. Overall, the results of this dissertation might have implications for the DMSP as well as for the DP and expertise development frameworks. In light of the DMSP (Côté et al., 2003), as athletes progress from sampling to specializing and later to investment years, they increase frequency of DP in a single sport and the role of an enduring commitment to that sport becomes increasingly critical. Therefore, the results of this study shed light into conscientiousness-related personality traits that may serve athletes well in their transitions across developmental stages since these traits predispose athletes to amass more DP (e.g., perseverance and achievement-striving) and to display higher commitment to their chosen sport (e.g., consistency of interests). Consequently, the results of this dissertation point to personality traits that may constitute psychological assets in athletes' development across the stages of the DMSP.

In regards to the main tenets of any expertise development framework, associations with quality practice and discrimination of skill groups (e.g., Abernethy et al., 1993; Ericsson et al., 1993), perseverance of effort was the best predictor of athletes' weekly amounts of DP and the only investigated trait that associated with higher skill level; perseverance of effort was also the only grit variable related to quality practice engagement over time. Consistency of interests best

predicted athletes' commitment to their sport. These findings are in line with some of the speculative hypotheses outlined earlier in this dissertation, notably, those relating perseverance of effort to DP and consistency of interest to sport commitment. Therefore, these findings suggest that persevering athletes have a better predisposition to sustain hard work in effortful DP activities, whereas those high on consistency of interests are able to remain committed to the same expertise pursuit over time. The implication for expertise development frameworks is that grit variables might be positioned as important dispositional assets allowing athletes to maximize DP while successfully circumventing effort and motivational constraints in the pursuit of expert levels of performance.

Results of this project also shed light on potential mechanisms by which personality might influence expertise development. Results from Article 5 suggested potential causal pathways that have yet to be fully tested. For example, coaches described conscientious athletes as enacting more self-regulatory skills, which in turn would help them optimize and maximize their training and reach higher skill levels. Pending future confirmation via mediation analyses, these results might inform adaptations to expert development frameworks (e.g., Ericsson et al., 1993) by positioning conscientiousness (achievement-striving in particular) as an important antecedent of greater DP and higher skill levels through its impact on self-regulation. These proposed mediational pathways have thus far not been proposed or tested in the literature, though there is partial support for them. For example, McCardle et al. (2017) and Bartulovic et al. (2017) showed that self-regulatory skills might be important predictors of optimal practice and skill development, respectively; however, neither works identified conscientiousness as a presumed antecedent of higher self-regulation skills among those athletes who display optimal practice or higher skill levels. Further, McCrae and Löckenhoff (2010) connected

conscientiousness to self-regulation and Zimmerman (2006) related self-regulation to expertise development; however, neither identified a potential mediation pathway linking conscientiousness to expertise outcomes through the mediation of self-regulation. These pathways were proposed in full in Article 5 and provide important conceptual implications for advancing the understanding of the way athletes develop into experts.

In addition, in Phase 1, perseverance of effort predicted athletes' DP amounts and skill level (Articles 2 and 3). These two tenets of expertise development (e.g., associations with practice and skill level; Abernethy et al., 1993; Ericsson et al., 1993) were analyzed in parallel, that is, their interactions were not analyzed in the same design. However, the *perseverance—DP* and *perseverance—skill level* links found in the current dissertation provide partial support for a potential mediation pathway. For example, perhaps the impact of perseverance of effort on athletes' skill level could be mediated by their amounts of DP. This *perseverance—DP—skill level* pathway remains to be fully tested. Elsewhere, Baker et al. (in press; also see Baker, Young, & Mann, 2017) suggested that personality variables such as grit may be positioned as antecedents of expertise development, mediated by athletes' engagement in DP. A similar mediational pathway has already received support outside sport (e.g., Duckworth et al., 2011). Investigating Spelling Bee competitors, Duckworth et al. (2011) showed that DP mediated the prediction of spellers' final performance by a composite measure of grit. Confirmation of a similar mediation model within sport could inform adaptations to current frameworks of expertise development by including personality as an antecedent in the *DP—skill level* link (e.g., DP framework; Ericsson et al., 1993).

In sum, this dissertation made contributions and offered insights that have relevant conceptual implications. First, this dissertation followed a systematic approach for consistently

testing how each conscientiousness-related trait associated with relevant criteria of expertise development, including two major tenets of expertise frameworks (i.e., associations with practice and skill level). Second, the studies within this dissertation used complementary methods of assessment including quantitative and qualitative approaches and the collection of self-report and other-rated data, circumventing the limitations to each approach and method. Finally, this dissertation offered rich insights on how conscientiousness-related predispositions translate to behaviours in training and proposed mediational pathways that, upon future testing, may constitute relevant conceptual implications for the field of sport expertise development. Therefore, this dissertation paved the way for the development of a line of inquiry aimed to uncover *how* (through which mechanisms) personality variables related to conscientiousness might influence athletes' development toward expert levels of performance.

Methodological implications. From a methodological standpoint, this project filled a void in sport expertise research by initially inspecting and confirming the validity of tools used to assess conscientiousness-related predictors of expertise in sport. By evaluating, refining, and cross-validating the Grit Scale (Articles 2 and 4), we provided a psychometrically improved tool for future researchers aiming to assess grit within sport pending further replication of the factor structure obtained in Article 2. The Grit Scale (Duckworth et al., 2007) is a widely-used domain-general measure, however, prior factor analyses had revealed troublesome indices of model fit (i.e., comparative fit index = .83, root mean-square error of approximation = .11; Duckworth et al., 2007; see Hu & Bentler, 1999, for suggested cutoff criteria for fit indices). The resultant factor structure of the Grit Scale from Article 2 might inform similar adaptations to the original Grit Scale traditionally used outside sport (e.g., education, occupation, and military domains).

Methodologically, this dissertation set a precedent for future research on personality in sport to also assess traits at the *facet* level instead of only at the broad factor level. In personality research, as in any science, there is a trade-off between simplicity and parsimony on one end (e.g., broad-factor assessment) and precision and comprehensiveness on the other end (e.g., facet-level assessment; Mõttus, Kandler, Bleidorn, Riemann, & McCrae, 2017). Facet-level assessment also tends to improve the predictive ability of the broad traits (Paunonen & Ashton, 2001). In the current dissertation, this was perhaps best exemplified by the finding that, even though broad conscientiousness was not related to athletes' DP, both achievement-striving and dutifulness showed significant associations at the facet level. Further, facet-level assessment allows an understanding of the unique contributions of different facets within specific contexts (Roberts et al., 2014). In this dissertation, this precise and comprehensive type of assessment provided a more nuanced and richer understanding of the relationships between conscientiousness-related traits and practice outcomes. For example, facet-level assessment allowed the identification of complementary associations that grit variables had with athletes' amounts of DP, engagement in different contexts of practice (perseverance of effort), and commitment to one's sport (consistency of interests). While persevering athletes practiced more and reported higher engagement in different practice contexts, passionate[5] athletes (i.e., those high on consistency of interests) remained more committed to their sport. Finally, facet-level assessment allowed speculation of a potential explanation for the lack of association between broad conscientiousness and DP. While dutifulness was *negatively* associated with DP,

[5] In her book, Angela Duckworth (2016) acknowledged that the word *passion* was perhaps not the best representative of the *consistency of interests* facet and explained that it was not meant to capture the *intensity* of one's commitment to their goals; instead it was meant to capture the idea of "sustained, enduring devotion" (p. 58).

achievement-striving showed a *positive* association. Possibly, facet-level associations with DP in opposite directions may have cancelled out the association at the broader level.

Applied implications. The results of this dissertation have several applied implications. The rich qualitative results from Phase 3 on the behavioural indicators of conscientiousness-related traits may inform the development of an other-rated *sport-specific behavioural assessment tool* designed to help coaches and practitioners (who are involved with athletes in the daily training environment) assess their athletes' conscientiousness-related traits. Such other-rated tool should be cross-validated through self-report scales in future studies and could potentially serve a diagnostic purpose for coaches and practitioners to identify athletes low on conscientiousness-related traits who might benefit from interventions aimed at improving patterns of behaviours that have been shown to predict expertise development. Although Jackson, Wood, Bogg, Walton, Harms, and Roberts's (2010) work provided a precedent for the development of such assessment tools, their goal was to comprehensively catalog the broad range of behaviours associated with conscientiousness. Their domain-general approach resulted in a long tool comprising 185 items—most irrelevant for athletes' daily training (e.g., "Get a haircut on a regular schedule" and "Wash my car"). Thus, Jackson et al.'s (2010) tool is inconvenient for practitioners' use with athletes. Finally, Jackson et al. used a top-down approach for generating the items that comprise their tool, that is, *researchers* generated a list of behavioural indicators based on the literature and then validated the list with participants. In contrast, Phase 3 of the current dissertation used a sport-specific, bottom-up approach whereby coaches' views were given priority and were explored first. Then coaches' views served as a basis for identifying behavioural indicators of the investigated traits in training. The advantage of a bottom-up approach was allowing practitioners' views, who are involved with athletes in the

day-to-day training, to inform current conceptual understandings of the investigated traits as well as providing applied-relevant information for the development of an other-rated sport-specific behavioural assessment tool.

Despite the utility of an other-rated sport-specific behavioural assessment tool, a caveat is that such tool should be used only by individuals who know athletes very well (e.g., family members, friends, and coaches involved with athletes in a daily training environment; McCrae & Costa, 1987). Because personality is best understood as a relatively stable *pattern* of thoughts, feelings, and behaviours that distinguish individuals (Roberts et al., 2008), other-rated assessments of athletes' personality should be based on a number of observations of athletes' behaviours and not based on a one-off assessment by talent scouts. Thus, talent selectors who are tasked with assessing athletes with whom they have not previously worked should refrain from using the behavioural indicators identified in Article 5 to make assessments or inferences about athletes' personality. Instead, results from Article 5 should assist the decision-making process of coaches/practitioners who are involved with athletes in the daily training environment.

From an applied perspective, the findings on behavioural indicators of conscientiousness-related traits (Article 5) have practical implications for coaching and sport psychology practitioners. Coaching interventions and psychological skills training programs aimed at helping athletes develop higher levels of the desired personality traits should have better success targeting more specific, lower-level indicators of personality such as thoughts, feelings, and behaviours rather than broader, higher-level latent predispositions. Therefore, by describing how conscientiousness-related traits translate into behaviours and context-specific strategies in the daily training environment, Article 5 provides coaches and practitioners with behavioural indicators that may be used equally as (a) reference points or standards for comparison when

assessing their athletes' current behaviours; and (b) behavioural targets for interventions aimed at facilitating athletes' conscientiousness-related behaviours.

Additionally, coaches may benefit from knowing which conscientiousness-related traits predict several criteria of expertise development. Equipped with such knowledge and armed with a tool to assess behavioural indicators, coaches would be in a better position to know where to intervene in order to help an athlete who needs to maximize their training hours (e.g., providing counsel and/or resources to heighten perseverance of effort), improve their attendance at optional practice sessions (e.g., working to improve their achievement-striving), or who has admitted considering quitting their sport (e.g., fostering higher consistency in their interests).

Considering that coaches most often associated grit with perseverance of effort, it is important that practitioners are attuned to and clearly understand the nuanced distinction between the broad grit construct and its specific facet of perseverance. Grit is widely popular in the media—as of September 2018, Angela Duckworth's TED Talk on grit (Duckworth, 2013, April) has had nearly 15 million views. However, with virtually no attention dedicated to the distinction of its facets among sport researchers (e.g., Larkin et al., 2015; Martin et al., 2015; for an exception, see Meyer et al., 2016), practitioners might inadvertently (and inappropriately) make decisions based on results from a measure that is founded on a conceptualization of the broad construct of grit (composite of perseverance of effort and consistency of interests). The practice of combining the two grit facets into one grit score has been criticized both outside (Credé et al., 2017) and within sport in this dissertation (Article 2). Thus, another implication of this dissertation is better informing practitioners about grit facets and helping them tease out the differential conditions associated with each facet.

Strengths, Limitations, and Future Directions

Although facet-level assessment was a strength of the current dissertation, a recent body literature (e.g., Mõttus et al., 2017; Mõttus et al., 2018) suggests there is utility in assessing personality at an even lower level in the trait hierarchy, *nuances*. Nuances consist of the personality level below facets that are represented by specific behavioural, cognitive, motivational, and affective patterns and that are measured by individual items of personality questionnaires (McCrae, 2015; Mõttus et al., 2017). Mõttus et al. (2017) found that nuances help explain additional variance than that already explained by broad factors and facets, which implies there is a ripe avenue for secondary analyses of personality data. As an illustration, secondary analyses of the data from the current dissertation could be used to assess the predictive ability of conscientiousness-related traits at the nuance-level. For example, having identified perseverance of effort as the best predictor of DP, the next step would be to examine which of the indicators of perseverance of effort from the items comprising the subscale (i.e., "I am a hard worker"; "I am diligent"; "I have overcome setbacks to conquer an important challenge"; "I have achieved a goal that took years of work") show the greatest predictive ability. An inspection of the estimates of regression weights from the final parsimonious full latent variable model predicting practice outcomes from grit indicators (Article 2, Figure 2) shows the item "I am a hard worker" had the strongest standardized regression weight. Pending more rigorous testing, this preliminary observation could suggest that an athlete's tendency to work hard could be the "grit nuance" that best predicted their weekly amounts of DP and engagement in different practice contexts.

One important strength of Phase 1 was the assessment of conscientiousness-related personality measures separately in each study (Articles 1 to 3). First, this systematic, step-by-step

approach allowed the proper assessment of whether each of the trait measures, which are widely used outside sport, could be validly used within a sport cohort. In addition, jumping straight to a simultaneous assessment of the personality traits without first assessing their merits and relevance for different criteria of expertise could have led to a mistaken interpretation that some traits did not matter for athletes' development. For example, achievement-striving was not included in our parsimonious model predicting athletes' engagement in mandatory practice (Article 3, Study 2). In contrast, when achievement-striving was assessed against other conscientiousness facets (Article 3, Study 1), it was the only significant predictor of mandatory practice. Relying on the results of the comparative study alone could have led to a misguided dismissal of the effect of achievement-striving on athletes' engagement in mandatory practice.

Relatedly, another strength of Phase 1 was the culminating comparative analyses in Article 3 (Study 2) where all facets (that had been proved significant when assessed previously separately) were brought together to determine the single best predictor of each investigated outcome as well as the parsimonious combination of traits that maximized the predictions of each outcome. Benefits of these culminating comparative analyses include (a) identifying which traits practitioners should prioritize when working with their athletes; and (b) understanding which parsimonious combination of variables maximized the explanation of variance in criteria of expertise development.

This dissertation also addressed the shortage of research on individual differences that influence sport expertise development (Baker & Young, 2014; Baker et al., 2017). Ericsson et al. (1993) had noted that individual differences related to one's personality might "affect the inevitable differences in the capacity to engage in hard work (deliberate practice)" (p. 399). Baker and Horton (2004) had also recognized that "predispositions facilitate the completion of

the required amounts of training" (p. 218). Despite these works, very little research had investigated the role of conscientiousness-related traits on athletes' training and development (for exceptions, see Larkin et al., 2015; Toering & Jordet, 2015). Therefore, this dissertation contributed by further positioning the investigated personality traits as antecedents of expertise development. In particular, of the 10 conceptually-relevant conscientious-related traits studied, only five were pertinent to the explanation of key criterion variables for expertise development (perseverance of effort, consistency of interests, achievement-striving, dutifulness, and self-discipline; Article 3, Study 2) and three were identified as best predictors: (a) perseverance of effort was the best predictor of athletes' DP amounts, engagement in mandatory practice, and skill group membership; (b) achievement-striving best predicted optional practice; and (c) consistency of interests best predicted thoughts of switching and quitting one's sport.

Another strength of Phase 1 was the inclusion of outcome measures outside those traditionally used as criteria of expertise development (e.g., DP and skill level; Abernethy et al., 1993; Ericsson et al., 1993) but that were conceptually related to expertise. The search for variables that maximize explained variance and our fullest understanding of sport expertise development is challenging and ongoing. Indeed, a recent meta-analysis found that DP explained around 18% of variance in sport performance, leaving a large amount of variance to be explained (Macnamara, Moreau et al., 2016). Therefore, in addition to the traditional tenets of expertise development such as DP and athletes' skill level, Phase 1 also assessed athletes' *frequency of engagement in mandatory and optional practice contexts* as well as their *frequency of thoughts about quitting or switching out of their sport* as proxies for athletes' engagement and commitment to their sport, respectively (Articles 1 to 3). Researchers have argued that the field of expertise might benefit from the identification of variables that could represent the remaining

"pieces of the puzzle" (Starkes et al., 1996) or the other "parts of the picture" (Sternberg, 1996) of sport expertise development. Therefore, this dissertation also contributed to this continued dialogue by assessing engagement and commitment variables that are conceptually associated with expert development (Baker & Côté, 2003).

Important contributions of Phase 2 include the prospective design over three time points, the assessment of athletes' practice engagement via coach ratings, and informing how coaches may identify and intervene with athletes at risk for poorer quality training and for unstable practice engagement over time. Coaches' interviews in Phase 3 (Article 5) added richness, qualified the numbers obtained in the results of the prior two phases, offered clues about potential mechanisms involved in the prediction of expertise by the investigated personality constructs, and corroborated prior findings further positioning the investigated traits as relevant predispositions for athletes' training and development outcomes. In addition, another strength of Phase 3 was the unique exploration of whether conscientiousness, grit, and self-control could be counterproductive for athletes' development. Coaches mostly considered the benefits of athletes displaying very high levels of these traits. However, it was noted that highly conscientious or self-controlled athletes could, for example, (a) be more susceptible to *overthinking* and spend too much time over analyzing a mistake, (b) lack creativity and miss opportunities to improvise, or (c) prioritize others' needs at the expense of one's own goals. In addition, results of Phase 3 suggest that highly gritty athletes display *mindful perseverance.* Yet, future studies should further examine whether extremely gritty athletes might have difficulty disengaging from unattainable goals (Wrosch et al., 2003) and continue exploring the risks associated with extreme levels of conscientiousness-related personality characteristics.

Despite the contributions of this dissertation, it was not without limitations. First, the quantitative measure of DP adopted in this dissertation was relatively crude and consisted in a single self-report item. The current measure built on prior work that developed best available proxies for assessing DP (e.g., Hopwood 2013; Ward et al. 2007). Still, researchers have not yet reached consensus on which measures meet the criteria for evaluating DP (e.g., Baker et al., in press; Macnamara, Hambrick, & Moreau, 2016; Ericsson, 2016) and recent recommendations have been provided to improve the validity and reliability of current measures of DP in sport (e.g., Tedesqui, McCardle, Bartulovic, & Young, under review).

This dissertation improved the factor structure of the Grit Scale for use in sport. Although the resultant factor structure of the grit measures were refined in Article 2 (i.e., two poor-performing items were removed), the measurement models for self-control or the conscientiousness measures were not similarly refined. Thus, the refined Grit Scale used in the analyses of this dissertation may have benefitted from the elimination of unwarranted variance and boosted the performance of grit variables in the culminating, comparative analyses of Article 3 (Study 2). Grit was the only construct that underwent rigorous factor analyses in order to arrive at a clean and valid measure for use within sport samples (Article 2). No attempt was made to improve the internal structure of self-control (Article 1) or conscientiousness (Article 3, Study 1) measures. The rationale behind the attempt to improve the factor structure of the Grit Scale in sport, but not that of the Brief Self-Control Scale or the IPIP Conscientiousness subscales was: (1) the original Grit Scale had shown weak internal validity from its conception (Duckworth et al., 2007); (2) factor analyses of the Brief Self-Control Scale (Tangney et al., 2004) showed relatively acceptable model fit with the two-factor structure (Article 1); (3) even if an attempt was made to improve the internal validity of the Brief Self-Control Scale for use with athletes,

there were not enough participants to split the sample into calibration and validation samples, so it would not be possible to confirm any eventual changes made to the factor structure of the scale; and (4) experts in the personality literature recommend that researchers avoid assessing and modifying the structure of scales designed to assess well-established constructs, which is the case for conscientiousness (Hopwood & Donnellan, 2010). Given the relative novelty of the grit construct and prior weak results from factor analyses of Duckworth et al.'s (2007) original Grit Scale, its factor evaluation and subsequent minor refinement using rigorous cross-validation procedures were warranted. This dissertation submits that the refined grit scale is a structurally-valid instrument to be used hereafter with samples of competitive athletes.

Results from Phase 3 highlighted that little is known about how the investigated traits interact in the prediction of practice-related outcomes. For example, would an athlete equally high on grit and conscientiousness have a higher tendency to *work hard* or *work smart*? Would they train for longer or be conscientious about their recovery needs? Would they tackle their teammate with vigour in training or go out of their way and reduce effort to avoid causing discomfort to their teammate? Future research would do well to further investigate the interactions between these desirable traits and how they are expressed concomitantly within the daily training environment. Future studies might, for example, screen athletes for different profiles of grit and conscientiousness (i.e., high-high, high-low, low-high, and low-low) and explore their thoughts, emotional reactions, and behavioural inclinations under different hypothetical scenarios similar to those described above and in the various contexts of practice presented in Article 5.

Future work might also explore how coaches conceive of, and deal with the *relative stability* of personality. For example, coaches may attempt to directly influence personality

change by stimulating an increase in grit levels. Alternatively, coaches may employ strategies to change psychological processes that moderate grit effects. For example, coaches may teach less gritty athletes how to avoid quitting when facing challenges. Future research should also aim to improve our understanding of strategies that coaches use to help athletes overcome personality-related barriers to DP and try to elucidate how athletes' practice might impact personality change throughout their athletic development.

Finally, an intriguing avenue for future research is the integration of research on personality with recent technological advances in the field of data science, machine learning, and big data (e.g., Bleidorn, Hopwood, & Wright, 2017). Machine learning algorithms have successfully identified people's personality based on digital footprints such as Facebook likes (Youyou, Kosinski, & Stillwell, 2015) and Twitter profiles (Quercia, Kosinski, Stillwell, & Crowcroft, 2011). Research suggests that computer-based personality judgements are more accurate than those made by humans (Youyou et al., 2015). They showed that computers' judgments of people's personalities based on their digital footprints are more accurate and valid than judgments made by their close others or acquaintances (e.g., friends, family, spouse). Computer personality judgments have higher external validity when predicting life outcomes such as substance use, political attitudes, and physical health; for some outcomes, they even outperform the self-rated personality scores (Youyou et al., 2015). Findings of the current dissertation could inform the development of reliable markers of personality traits that are predictive of expert development. From a talent identification perspective, the Facebook likes and Twitter profiles of athletes who are about to be drafted could be explored in order to identify the most persevering athletes, thus who have higher predisposition for working hard, amassing

more DP, and reaching higher skill levels. Despite the obvious ethical concerns that might arise, this is certainly a ripe avenue for personality research in sport.

Conclusion

Outside sport, personality research has been fruitful and there have been robust findings supporting the predictive ability of personality for educational, occupational, health, and military outcomes (e.g., Credé et al., 2017; De Ridder et al., 2012; Poropat, 2014). Within sport, a comprehensive review study (Allen et al., 2013) concluded that personality is an important predictor of long-term success. However, little research had assessed the role of individual differences such as personality on athletes' engagement in DP activities, the enhancement of practice, and development of expert levels of performance. Using a sequential explanatory mixed-methods design, this dissertation contributed to the literature on sport expertise by identifying personality traits related to conscientiousness that were associated with measures of athletes' practice quantity, quality, and stability, commitment to one's sport, and higher skill level. Although in the comparative analyses perseverance of effort, consistency of interests, achievement-striving, dutifulness, and self-discipline showed associations with the investigated practice and performance-related outcomes, this dissertation generally highlighted the role of grit facets. In particular, perseverance was the best predictor of athletes' amounts of DP, the only grit variable associated with overall practice engagement, and the only predictor of higher skill level. Consistency of interests was the best predictor of commitment variables. Furthermore, the qualitative results (a) provided behavioural indicators of conscientiousness-related traits that serve as reference points for practitioners aiming to help athletes develop desirable traits, (b) suggested that gritty athletes work hard and conscientious athletes work smart, and (c) proposed mechanisms to explain the personality-expertise link found in the quantitative studies. Taken

together, the results of this dissertation suggest that the tendency to persevere despite adversity and mindfully use self-regulated processes seems to be a powerful predisposition for athletes' development toward expert levels of performance. Collectively, these results contribute to a new chapter in personality research in sport and open up promising avenues of research on personality predictors of sport expertise development.

Statement of Contribution

I, Rafael Tedesqui, was responsible for gathering and analyzing data in the three phases of this research. I was entirely responsible for writing the five articles that made up this doctoral dissertation. Dr. Bradley Young, my thesis supervisor, reviewed all five articles and reviewed all parts of the dissertation, providing invaluable feedback, and editing at a conceptual and organizational level. Specifically, Dr. Young contributed by verifying all steps of this research project, from the early stages of the design to the final stages of publication of research results through journal articles and conference presentations. Thus, Dr. Young was critical in ensuring the quality of all quantitative studies (Articles 1 to 4) as well as the qualitative study (Article 5) by establishing the trustworthiness of the data and serving as a critical friend who challenged my coding and interpretations. Therefore, Dr. Young is a co-author on all five articles emerging from this research. Dr. Natalie Durand-Bush and Dr. Diane Ste-Marie provided conceptual feedback during the thesis proposal, as well as during our annual meetings where I updated them on the progress of my dissertation. Ethics approval was obtained from the Research Ethics Board of the Office of Research Ethics and Integrity at the University of Ottawa prior to data collection for each of the five studies found within the current dissertation.

References

Abernethy, B., Thomas, K. T., & Thomas, J. T. (1993). Strategies for improving understanding of motor expertise [or mistakes we have made and things we have learned!!]. *Advances in Psychology, 102,* 317-356.

Aidman, E. V. (2007). Attribute-based selection for success: The role of personality attributes in long-term predictions of achievement in sport. *The Journal of the American Board of Sport Psychology, 3,* 1-18.

Allen, M. S., Greenlees, I., & Jones, M. (2011). An investigation of the five-factor model of personality and coping behaviour in sport. *Journal of Sports Sciences, 29*(8), 841-850. doi:10.1080/02640414.2011.565064

Allen, M. S., Greenlees, I., & Jones, M. (2013). Personality in sport: A comprehensive review. *International Review of Sport and Exercise Psychology, 6*(1), 184-208. doi:10.1080/1750984X.2013.769614

Allen, M. S., & Laborde, S. (2014). The role of personality in sport and physical activity. *Current Directions in Psychological Science, 23*(6), 460-465. doi:10.1177/0963721414550705

Baker, J., & Côté, J. (2003). Resources and commitment as critical factors in the development of 'Gifted' athletes. *High Ability Studies, 14,* 139-140, doi:10.1080/1359813032000163816

Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies, 15*(2), 211-228. doi:10.1080/1359813042000314781

Baker, J., Wattie, N., & Schorer, J. (2015). Defining expertise: a taxonomy for researchers in skill acquisition and expertise. In J. Baker and D. Farrow (Eds.). *The Routledge Handbook of Sport Expertise*. London: Routledge.

Baker, J., Wattie, N., & Schorer, J. (2018). A proposed conceptualization of talent in sport: The first step in a long and winding road. *Psychology of Sport and Exercise.* Advance online publication. doi:10.1016/j.psychsport.2018.12.016

Baker, J., & Young, B. (2014). 20 years later: deliberate practice and the development of expertise in sport. *International Review of Sport and Exercise Psychology, 7*(1), 135-157. doi:10.1080/1750984X.2014.896024

Baker, J., Young, B. W., & Mann, D. (2017). Advances in athlete development: Understanding conditions of and constraints on optimal practice. *Current Opinion in Psychology, 16*, 24-27. doi:10.1016/j.copsyc.2017.03.005

Baker, J., Young, B. W., McCardle, L., & Tedesqui, R. A. B. (in press). New perspectives on deliberate practice and the development of sport expertise. In R. Ecklund & G. Tenenbaum (Eds.), *Handbook of sport psychology* (4th ed.). London: Wiley.

Barrick, M. R., Mount, M. K., & Judge, T. A. (2001). Personality and performance at the beginning of the new millennium: What do we know and where do we go next? *International Journal of Selection and Assessment, 9*(1/2), 9-30.

Bartulovic, D., Young, B.W., & Baker, J. (2017). Self-regulated learning predicts skill group differences in developing athletes. *Psychology of Sport and Exercise, 31*, 61-69. doi:10.1016/j.psychsport.2017.04.006

Bleidorn, W., Hopwood, C. J., & Wright, A. G. C. (2017). Using big data to advance personality theory. *Current Opinion in Behavioural Sciences, 18*, 79-82. doi:10.1016/j.cobeha.2017.08.004

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77-101.

Burnette, J. L., O'Boyle, E. H., VanEpps, E. M., Pollack, J. M., & Finkel, E. J. (2013). Mind-sets matter: A meta-analytic review of implicit theories and self-regulation. *Psychological Bulletin, 139*(3), 655-701. doi:10.1037/a0029531

Butcher, J., Lindner, K.J., & Johns, D.P. (2002). Withdrawal from competitive youth sport: A retrospective ten-year study. *Journal of Sport Behavior, 25*(2), 145-163.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge/Taylor & Francis.

Campitelli, G., & Gobet, F. (2011). Deliberate practice: Necessary but not sufficient. *Current Directions in Psychological Science, 20*(5), 280-285. doi:10.1177/0963721411421922

Chiviacowsky, S., & Drews, R. (2014). Effects of generic versus non-generic feedback on motor learning in children. *Plos One, 9*(2), 1-6. doi:10.1371/journal.pone.0088989

Collins, D., & MacNamara, A. (2012). The rocky road to the top: why talent needs trauma. *Sports Medicine, 42*, 907–914. doi:10.1007/BF03262302.

Costa, P. T., Jr., & McCrae, R. R. (1998). Six approaches to the explication of facet-level traits: Examples from conscientiousness. *European Journal of Personality, 12*, 117-134.

Côté, J. (1999). The influence of the family in the development of talent in sport, *The Sport Psychologist, 13*, 395-417.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89–110). Champaign, IL: Human Kinetics.

Côté, J., Baker, J., & Abernethy, B. (2007). Practice and play in the development of sport expertise. In R. C. Eklund & G. Tenenbaum (Eds.), *Handbook of sport psychology* (3rd ed., pp. 184–202). Hoboken, NJ: Wiley.

Côté, J., & Gilbert, W. (2009). An integrated definition of coaching effectiveness and expertise. *International Journal of Sports Science & Coaching, 4*(3), 307-323.

Côté, J., Young, B., North, J., & Duffy, P. (2007). Towards a definition of excellence in sport coaching. *International Journal of Coaching Science, 1*(1), 3-17.

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality & Social Psychology, 113,* 492-511. doi:10.1037/pspp0000102

Creswell, J. W. (2003). Mixed methods procedures. In *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed., pp. 208-227). Thousand Oaks: SAGE.

Creswell, J. W., & Plano Clark, V. L. (2011). Choosing a mixed methods design. In *Designing and conducting mixed methods research* (pp. 53-106). Los Angeles: Sage.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). London: Sage.

De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality & Social Psychology Review, 16,* 76-99.

Duckworth, A. (2016). *Grit: The power of passion and perseverance.* Toronto, Canada: Collins.

Duckworth, A., & Gross, J. J. (2014). Self-control and grit: Related but separable determinants of success. *Current Directions in Psychological Science, 23*(5), 319-325. doi: 10.1177/0963721414541462

Duckworth, A. L. (2013, April). *Grit: The power of passion and perseverance.* [Video file] Retrieved from https://www.ted.com/talks/angela_lee_duckworth_grit_the_power_of_passion_and_perseverance?language=en

Duckworth, A. L., Kirby, T. A., Tsukayama, E., Berstein, H., & Ericsson, K. A. (2011). Deliberate practice spells success: Why grittier competitors triumph at the National Spelling Bee. *Social Psychological and Personality Science, 2*(2), 174-181. doi:10.1177/1948550610385872

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087-1101. doi:10.1037/0022-3514.92.6.1087

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (Grit-S). *Journal of Personality Assessment, 91*, 166-174. doi:10.1080/00223890802634290

Duckworth, A. L., & Steinberg, L. (2015). Unpacking self-control. *Child Development Perspectives, 0*(0), 1-6. doi: 10.1111/cdep.12107

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of Applied Sport Psychology, 14*(3), 154-171. doi:10.1080/10413200290103473

Dvorak, R. D., & Simons, J. S. (2009). Moderation of resource depletion in the self-control

strength model: Differing effects of two modes of self-control. *Personality and Social Psychology Bulletin, 35*(5), 572-583. doi:10.1177/0146167208330855

Dweck, C. S. (2008). Can personality be changed? The role of beliefs in personality and change. *Current Directions in Psychological Science, 17*(6), 391-394.

Englert, C. (2016). The strength model of self-control in sport and exercise psychology. *Frontiers in Psychology, 7*, 1-9. doi:10.3389/fpsyg.2016.00314

Ericsson, K. A. (1996). The acquisition of expert performance: An introduction to some of the issues. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 1-50). Hillsdale, NJ: Erlbaum.

Ericsson, K. A. (2003). How the expert performance approach differs from traditional approaches to expertise in sport: In search for a shared theoretical framework for studying expert performance. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 371–402). Champaign, IL: Human Kinetics.

Ericsson, K. A. (2007). Deliberate practice and the modifiability of body and mind: Toward a science of the structure and acquisition of expert and elite performance. *International Journal of Sport Psychology, 38*, 4-34.

Ericsson, K. A. (2014). Why expert performance is special and cannot be extrapolated from studies of performance in the general population: A response to criticisms. *Intelligence, 45*, 81-103. doi:10.1016/j.intell.2013.12.001

Ericsson, K. A. (2016). Summing up hours of any type of practice versus identifying optimal practice activities: Comments on Macnamara, Moreau, and Hambrick (2015).

Perspectives on Psychological Science, 11, 351–354. doi:10.1177/1745691616635600

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363-406.

Ericsson, K. A., & Smith, J. (1991). Prospects and limits of the empirical study of expertise: An introduction. In K. A. Ericsson, & J. Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 1-38). New York: Cambridge University Press.

Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., & Duckworth, A. L. (2014). The grit effect: Predicting retention in the military, the workplace, school and marriage. *Frontiers in Psychology, 5*(36), 1-12. doi: 10.3389/fpsyg.2014.00036

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive coding and theme development. *International Journal of Qualitative Methods, 5*(1), 80-92.

Gee, C. J., Marshall, J. C., & King, J. F. (2010). Should coaches use personality assessments in the talent identification process? A 15 year predictive study on professional hockey players. *International Journal of Coaching Science, 4*(1), 25-34.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. *Journal of Research in Personality, 40*, 84-96.

Gould, D., Dieffenbach, K., & Moffett, A. (2002). Psychological characteristics and their development in Olympic champions. *Journal of Applied Sport Psychology, 14*, 172-204. doi:10.1080/10413200290103482

Hambrick, D. Z., Oswald, F. L., Altmann, E. M., Meinz, E. J., Gobet, F., & Campitelli, G. (2014). Deliberate practice: Is that all it takes to become an expert? *Intelligence, 45,* 34-45. doi:10.1016/j.intell.2013.04.001

Hampson, S. E. (2012). Personality processes: Mechanisms by which personality traits "get outside the skin". *Annual Review of Psychology, 63,* 315-339. doi:10.1146/annurev-psych-120710-100419

Hardy, L., Barlow, M., Evans, L., Rees, T., Woodman, T., & Warr, C. (2017). Great British medalists: Psychosocial biographies of Super-Elite and Elite athletes from Olympic sports. *Progress in Brain Research, 232,* 1-119. doi:10.1016/bs.pbr.2017.03.004

Haugaasen, M., & Jordet, G. (2012). Developing football expertise: A football-specific research review. *International Review of Sport and Exercise Psychology, 5*(2), 177-201.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport and Exercise Psychology, 20,* 12-34.

Hodges, N. J., & Starkes, J. L. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe, and Tesch-Römer's (1993) Theory of "Deliberate Practice". *International Journal of Sport Psychology, 27,* 400-424.

Holt, N., & Dunn, J. G. H. (2004). Toward a grounded theory of the psychosocial competencies and environmental conditions associated with soccer success. *Journal of Applied Sport Psychology, 16*(3), 199-219. doi: 10.1080/10413200490437949

Hopwood, M. (2013). The developmental history of athletes questionnaire: Towards a comprehensive understanding of the development of sport expertise. (Doctoral dissertation). Retrieved from http://vuir.vu.edu.au/22353/

Hopwood, C. J., & Donnellan, M. B. (2010). How should the internal structure of personality inventories be evaluated? *Personality and Social Psychology Review, 14*, 332-346. doi:10.1177/1088868310361240

Hough, L. M. (1992). The "Big Five" personality variables-construct confusion: Description versus prediction. *Human Performance, 5*(1-2), 139-155. doi:10.1080/08959285.1992.9667929

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55. doi:10.1080/10705519909540118

International Personality Item Pool. (n.d.). The Items in Each of the Preliminary IPIP Scales Measuring Constructs Similar to Those in the 30 NEO-PI-R Facet Scales. Retrieved from http://ipip.ori.org/newNEOFacetsKey.htm

Jackson, J. J., Wood, D., Bogg, T., Walton, K. E., Harms, P. D., & Roberts, B. W. (2010). What do conscientious people do? Development and validation of the Behavioral Indicators of Conscientiousness (BIC). *Journal of Research in Personality, 44*, 501-511. doi:10.1016/j.jrp.2010.06.005

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative Big-Five trait taxonomy: History, measurement, and conceptual issues. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (pp. 114-158). New York, NY: Guilford Press.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher, 33*(7), 14-26.

Joseph, A. I. (2009). *The role of grit in predicting performance in collegiate athletes*. (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (Publication No. 305164224).

Kaufman, S. B. (2014). A proposed integration of the expert performance and the individual differences approaches to the study of elite performance. *Frontiers in Psychology, 5*, 1-3. doi:10.3389/fpsyg.2014.00707

MacCann, C., Duckworth, A. L., & Roberts, R. D. (2009). Empirical identification of the major facets of conscientiousness. *Learning and Individual Differences, 19*, 451-458. doi:10.1016/j.lindif.2009.03.007

Macnamara, B. N., Hambrick, D. Z., & Moreau, D. (2016). How important is deliberate practice? Reply to Ericsson (2016). *Perspectives on Psychological Science, 11*, 355–358. doi:10.1177/1745691616635614

Macnamara, B. N., Moreau, D., & Hambrick, D. Z. (2016). The relationship between deliberate practice and performance in sports: A meta-analysis. *Perspectives on Psychological Science, 11*, 333–350. doi:10.1177/1745691616635591

Malinauskas, R., Dumciene, A., Mamkus, G., Venckunas, T. (2014). Personality traits and exercise capacity in male athletes and non-athletes. *Perceptual & Motor Skills: Motor Skills & Ergonomics, 118*(1), 145-161. doi: 10.2466/29.25.PMS.118k13w1

Maloney, P. W., Grawitch, M. J., Barber, L. K. (2012). The multi-factor structure of the Brief Self-Control Scale: Discriminant validity of restraint and impulsivity. *Journal of Research in Personality, 46*, 111-115. doi:10.1016/j.jrp.2011.10.001

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice, 13*, 522-525.

McCardle, L., Young, B.W., & Baker, J. (2017). Self-regulated learning in sport training

contexts: Current status, challenges, and future opportunities. *International Review of Sport & Exercise Psychology.* Advance online publication. doi:10.1080/1750984X.2017.1381141

McCrae, R. R. (2015). A more nuanced view of reliability: Specificity in the trait hierarchy. *Personality & Social Psychology Review, 19*, 97-112. doi:10.1177/1088868314541857

McCrae, R. R., & Costa, P. T., Jr. (2008). The five-factor theory of personality. In O. P. John, R. W. Robins & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 159–181). New York: Guilford Press.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality, 60*, 175–215.

McCrae, R. R., & Löckenhoff, C. E. (2010). Self-regulation and the five-factor model of personality traits. In R. H. Hoyle (Ed.), *Handbook of personality and self-regulation* (pp. 145-168). Hoboken, NJ: Wiley InterScience.

Meriac, J. P., Thomas, A. L. E., & Milunski, M. (2014). Work ethic as a predictor of task persistence and intensity. *Learning and Individual Differences, 37*, 249-254. doi:10.1016/j.lindif.2014.11.006

Monsaas, J. A. (1985). Learning to be a world-class tennis player. In B. S. Bloom (Ed.), *Developing talent in young people* (pp. 211-269). New York: Ballantine.

Morean, M. E., DeMartini, K. S., Leeman, R. F., Pearlson, G. D., Anticevic, A., Krishnan-Sarin, S., … O'Malley, S. S. (2014). Psychometrically-improved, abbreviated versions of three classic measures of impulsivity and self-control. *Psychological Assessment, 26*(3), 1003-1020. doi:10.1037/pas0000003

Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Applications to health research. *Qualitative Health Research, 8*(3), 362-376.

Mõttus, R., Kandler, C., Bleidorn, W., Riemann, R., & McCrae, R. R. (2017). Personality traits below facets: The consensual validity, longitudinal stability, heritability, and utility of personality nuances. *Journal of Personality & Social Psychology, 112*, 474-490. doi:10.1037/pspp0000100.supp

Mõttus, R., Sinick, J., Terracciano, A., Hřebíčková, M., Kandler, C., Ando, J., ... & Jang, K. L. (2018). Personality characteristics below facets: A replication and meta-analysis of cross-rater agreement, rank-order stability, heritability, and utility of personality nuances. *Journal of Personality & Social Psychology*. Advance online publication. doi:10.1037/pspp0000202

Moutafi, J., Furnham, A., & Paltiel, L. (2005). Can personality factors predict intelligence? *Personality & Individual Differences, 38*, 1021-1033. doi:10.1016/j.paid.2004.06.023

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*(2), 247-259.

Oliver, E. J., Hardy, J., & Markland, D. (2010). Identifying important practice behaviors for the development of high-level youth athletes: Exploring the perspective of elite coaches. *Psychology of Sport and Exercise, 11*, 433-443. doi:10.1016/j.psychsport.2010.05.004

Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology, 57*, 401–421. doi:10.1146/annurev.psych.57.102904.190127

Paunonen, S. V., & Ashton, M. C. (2001). Big Five factors and facets and the predictor of behavior. *Journal of Personality and Social Psychology, 81*, 524-539. doi:10.1037/0022-3514.81.3.524

Piedmont, R. L., Hill, D. C., & Blanco, S. (1999). Predicting athletic performance using the five-factor model of personality. *Personality and Individual Differences, 27*, 769-777. doi:10.1016/S0191-8869(98)00280-3

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin, 135*, 322-338. doi:10.1037/a0014996

Poropat, A. E. (2014). Other-rated personality and academic performance: Evidence and implications. *Learning and Individual Differences, 34*, 24-32. doi:10.1016/j.lindif.2014.05.013

Quercia, D., Kosinski, M., Stillwell, D., & Crowcroft, J. (2011, October). Our twitter profiles, our selves: Predicting personality with twitter. In *Privacy, Security, Risk and Trust (PASSAT) and 2011 IEEE Third International Conference on Social Computing*.

Roberts, B. W., Kuncel, N., Shiner, R. N., Caspi, A., & Goldberg, L. R. (2007). The power of personality: The comparative validity of personality traits, socio-economic status, and cognitive ability for predicting important life outcomes. *Perspectives in Psychological Science, 2*, 313–345. doi:10.1111/j.1745-6916.2007.00047.x

Roberts, B. W., Lejuez, C., Krueger, R. F., Richards, J. M., & Hill, P. L. (2014). What is conscientiousness and how can it be assessed? *Developmental Psychology, 50*(5), 1315-1330. doi: 10.1037/a0031109

Roberts, B.W., Wood, D, & Caspi, A. (2008). The development of personality traits in adulthood. In O.P. John, R.W. Robins, & L. A. Pervin (Eds.), *Handbook of personality:*

theory and research (3rd ed., pp. 375-398). New York, NY: Guilford.

Rottensteiner, C., Laakso, L., Pihlaja, T., & Konttinen, N. (2013). Personal reasons for withdrawal from team sports and the influence of significant others among youth athletes. *International Journal of Sports Science & Coaching, 8*(1), 19-32.

Sarkar, M., & Fletcher, D. (2017). Adversity-related experiences are essential for Olympic success: Additional evidence and considerations. *Progress in Brain Research, 232*, 159-165. doi:10.1016/bs.pbr.2016.11.009

Sarkar, M., Fletcher, D., & Brown, D. J. (2015). What doesn't kill me…: Adversity-related experiences are vital in the development of superior Olympic performance. *Journal of Science and Medicine in Sport, 18*, 475–479. doi:10.1016/j.jsams.2014.06.010

Simon, H. A., & Chase, W. G. (1973). Skill in chess: Experiments with chess-playing tasks and computer simulation of skilled performance throw light on some human perceptual and memory processes. *American Scientist, 61,* 394-403.

Stake, R. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 443-466). Thousand Oaks, CA: SAGE.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 81-106). Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1996). Costs of expertise. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 347-354). Hillsdale, NJ: Erlbaum.

Tamminen, K. A., Holt, N. L., & Neely, K. C. (2013). Exploring adversity and the potential for

growth among elite female athletes. *Psychology of Sport & Exercise, 14*, 28–36. doi:10.1016/j.psychsport.2012.07.002

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2), 271-324.

Tedesqui, R. A. B., McCardle, L., Bartulovic, D., & Young, B. W. (under review). Toward a more critical dialogue for enhancing self-report surveys in sport expertise and deliberate practice research.

Tedesqui, R. A. B., & Young, B. W. (2015). Perspectives on active and inhibitive self-regulation relating to the deliberate practice activities of sport experts. *Talent Development & Excellence, 7*, 29–39.

Tedesqui, R. A. B., & Young, B. W. (2017). Associations between self-control, practice, and skill level in sport expertise development. *Research Quarterly for Exercise and Sport, 88*, 108–113. http://dx.doi.org/10.1080/02701367.2016.1267836.

Tedesqui, R. A. B., & Young, B. W. (2017). Investigating grit variables and their relations with practice and skill groups in developing sport experts. *High Ability Studies, 28*, 167-180. doi:10.1080/13598139.2017.1340262.

Tedesqui, R. A. B., & Young, B. W. (2018). Comparing the contribution of conscientiousness, self-control, and grit to key criteria of sport expertise development. *Psychology of Sport & Exercise, 34*, 110-118. doi:10.1016/j.psychsport.2017.10.002

Tedesqui, R. A. B., & Young, B. W. (under review). Relationships between athletes' self-reported grit levels and coach-reported practice engagement over one sport season.

Tedesqui, R. A. B., & Young, B. W. (under review). How coaches see conscientiousness-related

traits and their impact on athletes' training and expertise development.

Toering, T., & Jordet, G. (2015). Self-control in professional soccer players. *Journal of Applied Sport Psychology, 27*, 335-35. doi:10.1080/10413200.2015.1010047

Von Culin, K. R., Tsukayama, E., & Duckworth, A. L. (2014). Unpacking grit: Motivational correlates of perseverance and passion for long-term goals. *The Journal of Positive Psychology, 9*(4), 306-312. doi:10.1080/17439760.2014.898320

Vukasovic, T., & Bratko, D. (2015). Heritability of personality: A meta-analysis of behavior genetic studies. *Psychological Bulletin, 141,* 769-785. doi:10.1037/bul0000017

Ward, P., Hodges, N. J., Starkes, J. L., & Williams. M. A. (2007). The road to excellence: Deliberate practice and the development of expertise. *High Ability Studies, 18*(2), 119-153. doi:10.1080/13598130701709715

Weiss, M. R., & Amorose, A. J. (2008). Motivational orientations and sport behavior. In T.S. Horn (Ed.), *Advances in sport psychology* (3rd ed., pp. 115-155). Champaign, IL: Human Kinetics.

Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative Health Research, 11*(4), 522-537.

Woodman, T., Zourbanos, N., Hardy, L., Beattie, S., & McQuillan, A. (2010). Do performance strategies moderate the relationship between personality and training behaviors? An exploratory study. *Journal of Applied Sport Psychology, 22*, 183-197. doi:10.1080/10413201003664673

Youyou, W., Kosinski, M., & Stillwell, D. (2015). Computer-based personality judgments are more accurate than those made by humans. *Proceedings of the National Academy of Sciences, 112*(4), 1036-1040.

Young, B. W., & Medic, N. (2008). The motivation to become an expert athlete: How coaches can promote long-term commitment. In D. Farrow, J. Baker, & C. MacMahon (Eds.), *Developing elite sports performers: Lessons from theory and practice* (pp. 43-59). New York: Routledge.

Young, B. W., Medic, N., & Starkes, J. L. (2009). Effects of self-monitoring training logs on behaviors and beliefs of swimmers. *Journal of Applied Sport Psychology, 21,* 413-428. doi:10.1080/10413200903222889

Young, B. W., & Salmela, J. H. (2010). Examination of practice activities related to the acquisition of elite performance in Canadian middle distance running. *International Journal of Sport Psychology,* 41, 73-90.

Zimmerman, B.J. (2006). Development and adaptation of expertise: The role of self-regulatory processes and beliefs. In K. A. Ericsson, N. Charness, P. J. Feltovich, R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 705-722). New York: Cambridge University Press.

Ziv, G., & Lidor, R. (2014). Anthropometrics, physical characteristics, physiological attributes, and sport-specific skills in under-14 athletes involved in early phases of talent development - A review. *Journal of Athletic Enhancement, 3*(6), 1-8. doi:10.4172/2324-9080.1000175

Appendix A: Model of Conceptual Parallels Between Conscientiousness-Related Traits

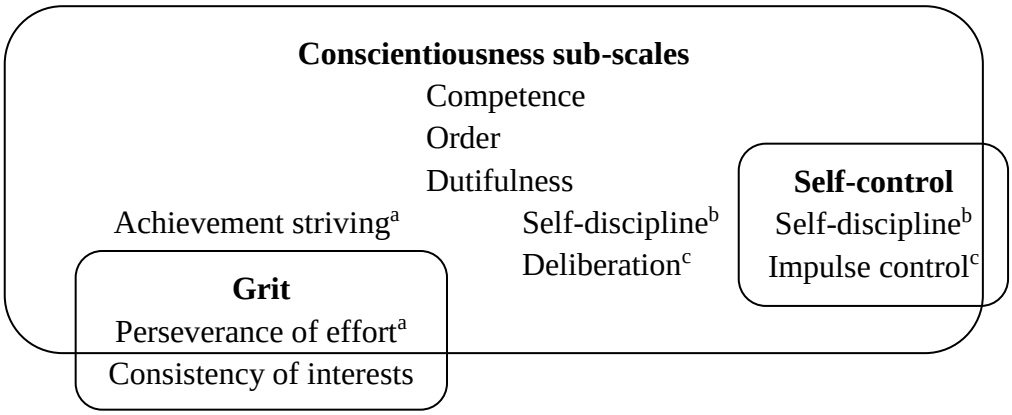

Figure 1. Conceptual parallels between the traits considered in this dissertation. Although they do not seem to fully overlap, the traits within each letter group (marked by superscripts *a*, *b*, and *c*) appear to have conceptual parallels. *Consistency of interests* appears to be a unique factor in grit that does not overlap with any other trait. Similarly, *competence*, *order*, and *dutifulness* do not appear to overlap with any other trait. *Self-control* is not fully inside *conscientiousness* because it also assesses one's ability to break bad habits.

[a]Both *achievement striving* and *perseverance of effort* represent the tendency to work hard toward goals. However, each seems to provide unique understandings. *Achievement striving* seems to uniquely assess one's tendency to set higher goals, whereas *perseverance of effort* uniquely assesses one's tendency to overcome setbacks and persist working hard over time.

[b]Both *deliberation* and *impulse control* tap into one's tendency to control impulses and resist temptations in order to pursue valued goals.

[c]Both *conscientiousness* and *SC* have a self-discipline facet. However, the latter uniquely taps into one's tendency to avoid procrastination.

Appendix B: Ethics Approval

File Number: H06-15-19 **Date (mm/dd/yyyy):** 07/30/2015

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Bradley	Young	Health Sciences / Human Kinetics	Supervisor
Rafael Alves Ballon	Tedesqui	Health Sciences / Human Kinetics	Student Researcher

File Number: H06-15-19

Type of Project: PhD Thesis

Title: Personality, Deliberate Practice, and Expertise Development in Sport

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
07/30/2015	07/29/2016	Ia (Partial)

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:

Partial Approval: As they are received, please submit all copies of approvals/permissions from universities, school boards, as well as any institution that requires external approval. Recruitment and data collection may not begin at these sites until uOttawa approval has been updated to reflect these permissions. (Note that we do not need copies of permission from sport clubs, whereby their role is simply to forward on information on the researchers' behalf.)

550, rue Cumberland, pièce 154 550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

Appendix C: Ethics Renewal 2016

File Number: H06-15-19 Date (mm/dd/yyyy): 08/12/2016

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Bradley	Young	Health Sciences / Human Kinetics	Supervisor
Rafael Alves Ballon	Tedesqui	Health Sciences / Human Kinetics	Student Researcher

File Number: H06-15-19

Type of Project: PhD Thesis

Title: Personality, Deliberate Practice, and Expertise Development in Sport

Renewal Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
07/30/2016	07/29/2017	Approved

Special Conditions / Comments:
N/A

550, rue Cumberland, pièce 154 550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Télec./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

Appendix D: Ethics Approval of Modifications

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Health Sciences and Science Research Ethics Board

APPROVAL OF MODIFICATIONS

October 17, 2016

Rafael A.B Tedesqui [redacted]

Bradley Young [redacted]

RE: Personality, Deliberate Practice, and Expertise Development in Sport (# H 06-15-19)

Dear Mr. Tedesqui and Professor Young,

The Health Sciences and Science Research Ethics Board has examined your request for ethics approval of the following modifications to your research project:

- A qualitative component is added: Face to face or via Skype semi-structured interviews will be conducted with new participants.

Your request has been accepted. The certification of ethical approval renewed on July 30, 2016 and valid until July 29, 2017 covers these modifications.

During the course of the study, any further modifications to the protocol or forms may not be initiated without prior written approval from the REB. You must also promptly notify the REB of any adverse events that may occur.

If you have any questions, please do not hesitate to contact me at extension 5387.

Sincerely yours,

[redacted]

Germain Zongo
Protocol Officer for Research Ethics
For Daniel Lagarec, Chair of the Health Sciences and Sciences REB

550, rue Cumberland 550 Cumberland Street
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada

(613) 562-5387 • Téléc./Fax (613) 562-5338
http://www.research.uottawa.ca/ethics/index.html

Appendix E: Ethics Renewal 2017

File Number: H06-15-19 **Date (mm/dd/yyyy):** 07/06/2017

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Bradley	Young	Health Sciences / Human Kinetics	Supervisor
Rafael Alves Ballon	Tedesqui	Health Sciences / Human Kinetics	Student Researcher

File Number: H06-15-19

Type of Project: PhD Thesis

Title: Personality, Deliberate Practice, and Expertise Development in Sport

Renewal Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
07/30/2017	07/29/2018	Renewal

Special Conditions / Comments:
N/A

550, rue Cumberland, pièce 154 550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

uOttawa

Appendix F: Template of Consent Form for Parents

Université d'Ottawa
Faculté des sciences de la santé

École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences

School of Human Kinetics

Title of Project: Personality, Deliberate Practice, and Expertise Development in Sport.

Principal Investigator: Rafael A. B. Tedesqui, PhD candidate, School of Human Kinetics, University of Ottawa. This study is funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) through the Joseph-Armand Bombardier Canada Graduate Scholarship (767-2013-2136).

Co-Investigator: Bradley W. Young, PhD, associate professor, School of Human Kinetics, University of Ottawa.

Purpose of the Study: This project is part of Rafael Tedesqui's PhD thesis under the supervision of Dr. Bradley Young. It aims to understand whether and how certain personality characteristics may be associated with how athletes train for sport. Overall, we wish to better understand whether certain personality characteristics allow athletes to persist in relevant forms of practice to develop into experts.

Participation: After obtaining parental consent (see below), athletes will be invited by e-mail (through athletes' and/or parents' e-mail address, depending on parents' preference) to complete an on-line survey. The survey is written in English, because it relies on questionnaire items that have only been previously validated and proven reliable in English by prior research. Therefore, it is important that all participants are able to read and understand English. The survey will take approximately 20 minutes to complete.

Benefits: Athletes' participation in this project will help contribute to scientific knowledge. In addition, this study has the potential to identify athletes' characteristics that relate to improved quality and increased quantity of sport training. This knowledge may allow sport coaches to adapt training strategies to help athletes maximize their performance and their overall experience in sport.

Confidentiality and Anonymity: The anonymity of participants will be protected and no one other than the researchers mentioned above will have access to athletes' survey data. Similarly, the information collected will not be associated with the club where athletes are registered. The consent and assent forms will be stored electronically on a password protected computer in a locked office. Physical copies will be kept under lock as well. All identifiable information in the consent form will be filed separately from survey data to protect participants' anonymity. All original data will be electronic in nature and will be stored using the certified-secure online survey provider "FluidSurveys" and protected by a password required to log into the account. Data will be kept secure and conserved for 10 years after which all of the data will be destroyed.

Compensation: For athletes' contribution to the research project, they will be given the option to enter their name to win one of five gift cards from a sporting goods retail store worth CAD$50 each. All athletes who begin the first component of the on-line ir name automatically entered in the draw, regardless of whether they decide to her participating in the research project.

☎ 613 562-5852
613 562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

After the study has ended, five names will be randomly selected amongst those who have entered and the people whose names have been drawn will be informed by e-mail. To win the prize, the person must correctly answer a skill testing question. If each winner cannot be reached within 14 days from the date of the draw, the prizes will be awarded to the subsequent names that are randomly selected and until the prizes have been awarded. The odds of winning a prize will depend on the number of eligible entries received. The prize must be accepted as awarded or forfeited. The information that athletes provide when they enter the draw (i.e., name and e-mail) is collected for the purpose of contacting them if their name is selected in the draw. Their name and the contact information they provide will be kept confidential and then destroyed once the prizes have been awarded. We reserve the right to cancel the draw or cancel the awarding of the prizes if the integrity of the draw or the research or the confidentiality of the participants is compromised. This draw is governed by the applicable laws of Canada.

Voluntary Participation and Withdrawal: Athletes' participation is completely voluntary. Participants may withdraw from the project at any time without penalty. If participants choose to withdraw, their data will be destroyed, unless permission to use it is granted. Also, the decision to participate will not in any way impact athletes' access to the club or sport event where athletes are registered.

Risks: Although very unlikely, there is a remote possibility of athletes feeling some discomfort when asked questions about their performance level and their personal characteristics. In this case, participants may contact the Kids Help Phone is Canada's free, anonymous and confidential phone (1-800-668-6868) and on-line (http://www.kidshelpphone.ca/Teens/Home.aspx) professional counselling service for youth.

If you have any questions regarding this research project you can contact the principal investigator, or the project supervisor, Dr. Bradley Young.

For any questions regarding the ethical conduct of this project, you can contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, Ottawa, ON, K1N 6N5, (613) 562-5387 or ethics@uottawa.ca.

Consent:

I have read this consent form and I understand the procedures of this research project. Also, I understand that my child's participation is completely voluntary and he/she may withdraw from the study at any time without penalty. By clicking "Next" on the web page below, I provide consent for my child to participate.

☐ My child is younger than 18 years of age, and I permit them to participate in this project.

☐ I would like to receive a report with the summary of the overall results of this study, when they are ready.

CHILD'S E-MAIL (optional): _____
PARENT'S E-MAIL: _____
PARENT'S NAME: _____

Please print and keep a copy of this form for your records.

[Next]

uOttawa

Université d'Ottawa
Faculté des sciences de la santé

École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences

School of Human Kinetics

Appendix G: Template of Assent Form

Title of Project: Personality, Deliberate Practice, and Expertise Development in Sport.

Principal Investigator: Rafael A. B. Tedesqui, PhD candidate, School of Human Kinetics, University of Ottawa.

Co-Investigator: Bradley W. Young, PhD, associate professor, School of Human Kinetics, University of Ottawa.

What is this study about?
The purpose of this research is to understand how athletes' personality influences sport training and success.

What happens if I choose to be in this study?
If you choose to participate, you will be asked to answer an online survey that may take around 20 minutes. The survey is written in English because the questions come from prior research that has been only in English. Thus, it is important that you are able to read, write, and understand English. You will be asked to answer questions about your sport experience and achievements, your sport aspirations, and about your personality. It is important that you answer all questions honestly. You do not have to answer any question you do not want to answer and can decide to stop participating at any time. For athletes' contribution to the research project, they will be given the option to enter their name to win one of five gift cards from a sporting goods retail store worth CAD$50 each. All athletes who begin the first component of the on-line study will have their name automatically entered in the draw, regardless of whether they decide to withdraw from further participating in the research project.
After the study has ended, five names will be randomly selected amongst those who have entered and the people whose names have been drawn will be informed by e-mail. To win the prize, the person must correctly answer a skill testing question. If each winner cannot be reached within 14 days from the date of the draw, the prizes will be awarded to the subsequent names that are randomly selected and until the prizes have been awarded. The odds of winning a prize will depend on the number of eligible entries received. The prize must be accepted as awarded or forfeited. The information that athletes provide when they enter the draw (i.e., name and e-mail) is collected for the purpose of contacting them if their name is selected in the draw. Their name and the contact information they provide will be kept confidential and then destroyed once the prizes have been awarded. We reserve the right to cancel the draw or cancel the awarding of the prizes if the integrity of the draw or the research or the confidentiality of the participants is compromised. This draw is governed by the applicable laws of Canada.

Will you tell anyone what I write in the survey?
We will not share your answers with your parents, coaches, friends, or anyone else. Also, when writing about this research, we will never use your name. We will take every step to protect your identity. We will not associate the information you give with the club or sport event to which you are registered.

What will you do with my answers?

☎ 613 562-5852
613 562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

We will find out about personality characteristics that can help you improve your training so you can achieve higher levels of performance. After you complete the survey, all original data will be stored on a password-protected computer at the University of Ottawa (paper form) or through the certified-secure online survey provider "FluidSurveys" (online form) and protected by a password required to log into the account. Your anonymous answers will be kept for 10 years.

What else do I need to know?
You may decide to stop participating in the study at any time without any penalty. In this case, all your answers will be deleted from our records. Your decision to participate or stop participating will not in any way impact your access to the club or sport event where you are registered. Also, although very unlikely, there is a remote possibility of you feeling some discomfort when asked questions about your performance level and your personal characteristics. In this case, you may contact the researchers to request information for appropriate resources to help you or you may directly contact the Kids Help Phone which is Canada's free, anonymous and confidential phone (1-800-668-6868) and on-line (http://www.kidshelpphone.ca/Teens/Home.aspx) professional counselling service for youth.

Questions?
If you have any questions about being in this study, you or your parent can contact me (Rafael Tedesqui) or my supervisor (Dr. Bradley Young).

For any questions about this project, you can contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 rue Cumberland, Room 154, Ottawa, ON, K1N 6N5, (613) 562-5387 or ethics@uottawa.ca.

Consent:

I have read this assent form and I understand the procedures of this research project. Also, I understand that my participation is completely voluntary and I may withdraw from the study at any time without penalty. By clicking “Next” on the web page below, I indicate my interest to participate.

☐ I want to have my name entered in the draw to have the chance to win one of five sporting goods retail store gift card prizes worth CAD$50 each.

☐ I would like to receive a report with the summary of the overall results of this study, when they are ready.

If you checked any of the boxes above, please provide your email and your name. We will only use this information for the purpose(s) you indicated above and for no other purpose.

Name: _____ E-mail: _____

Please print and keep a copy of this form for your records.

[Next]

uOttawa

Université d'Ottawa
Faculté des sciences de la santé

École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences

School of Human Kinetics

Appendix H: Template of Consent Form for Athletes

Title of Project: Personality, Deliberate Practice, and Expertise Development in Sport.

Principal Investigator: Rafael A. B. Tedesqui, PhD candidate, School of Human Kinetics, University of Ottawa. This study is funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) through the Joseph-Armand Bombardier Canada Graduate Scholarship (767-2013-2136).

Co-Investigator: Bradley W. Young, PhD, associate professor, School of Human Kinetics, University of Ottawa.

Purpose of the Study: This project is part of Rafael Tedesqui's PhD thesis under the supervision of Dr. Bradley Young. It aims to understand whether and how certain personality characteristics may be associated with how athletes train for sport. Overall, we wish to better understand whether certain personality characteristics allow athletes to persist in relevant forms of practice to develop into experts.

Participation: Athletes will be asked to complete an on-line survey after providing their consent below. The survey is written in English, because it relies on questionnaire items that have only been previously validated and proven reliable in English by prior research. Therefore, it is important that all participants are able to read and understand English. The survey will take approximately 20 minutes to complete.

Benefits: Athletes' participation in this project will help contribute to scientific knowledge. In addition, this study has the potential to identify athletes' characteristics that relate to improved quality and increased quantity of sport training. This knowledge may allow sport coaches to adapt training strategies to help athletes maximize their performance and their overall experience in sport.

Confidentiality and Anonymity: The anonymity of participants will be protected and no one other than the researchers mentioned above will have access to athletes' survey data. Similarly, the information collected will not be associated with the club where athletes are registered. The consent and assent forms will be stored electronically on a password protected computer in a locked office. Physical copies will be kept under lock as well. All identifiable information in the consent form will be filed separately from survey data to protect participants' anonymity. All original data will be electronic in nature and will be stored using the certified-secure online survey provider "FluidSurveys" and protected by a password required to log into the account. Data will be kept secure and conserved for 10 years after which all of the data will be destroyed.

Compensation: For athletes' contribution to the research project, they will be given the option to enter their name to win one of five gift cards from a sporting goods retail store worth CAD$50 each. All athletes who begin the first component of the on-line study will have their name automatically entered in the draw, regardless of whether they decide to withdraw from further participating in the research project.
ended, five names will be randomly selected amongst those who have entered and the es have been drawn will be informed by e-mail. To win the prize, the person must skill testing question. If each winner cannot be reached within 14 days from the date of

☎ 613 562-5852
613 562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

the draw, the prizes will be awarded to the subsequent names that are randomly selected and until the prizes have been awarded. The odds of winning a prize will depend on the number of eligible entries received. The prize must be accepted as awarded or forfeited. The information that athletes provide when they enter the draw (i.e., name and e-mail) is collected for the purpose of contacting them if their name is selected in the draw. Their name and the contact information they provide will be kept confidential and then destroyed once the prizes have been awarded. We reserve the right to cancel the draw or cancel the awarding of the prizes if the integrity of the draw or the research or the confidentiality of the participants is compromised. This draw is governed by the applicable laws of Canada.

Voluntary Participation and Withdrawal: Athletes' participation is completely voluntary. Participants may withdraw from the project at any time without penalty. If participants choose to withdraw, their data will be destroyed, unless permission to use it is granted. Also, the decision to participate will not in any way impact athletes' access to the club or sport event where athletes are registered.

Risks: Although very unlikely, there is a remote possibility of athletes feeling some discomfort when asked questions about their performance level and their personal characteristics. In this case, participants may contact the Mental Health Helpline at 1-866-531-2600 and on-line at http://www.mentalhealthhelpline.ca/.

If you have any questions regarding this research project you can contact the principal investigator or the project supervisor.

For any questions regarding the ethical conduct of this project, you can contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, Ottawa, ON, K1N 6N5, (613) 562-5387 or ethics@uottawa.ca.

Consent:

I have read this consent form and I understand the procedures of this research project. Also, I understand that my participation is completely voluntary and I may withdraw from the study at any time without penalty. By clicking "Next" on the web page below, I indicate my interest to participate.

☐ I want to have my name entered in the draw to have the chance to win one of five sporting goods retail store gift card prizes worth CAD$50 each.

☐ I would like to receive a report with the summary of the overall results of this study, when they are ready.

If you checked any of the boxes above, please provide your email and your name. We will only use this information for the purpose(s) you indicated above and for no other purpose.

Name: _____ E-mail: _____

Please print and keep a copy of this form for your records.
[Next]

uOttawa

Université d'Ottawa
Faculté des sciences de la santé

École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences

School of Human Kinetics

Appendix I: Template of Consent Form for Coaches

Title of Project: Personality, Deliberate Practice, and Expertise Development in Sports.

Principal Investigator: Rafael A. B. Tedesqui, PhD candidate, School of Human Kinetics, University of Ottawa. This study is funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) through the Joseph-Armand Bombardier Canada Graduate Scholarship (767-2013-2136).

Co-Investigator: Bradley W. Young, PhD, associate professor, School of Human Kinetics, University of Ottawa.

Purpose of the Study: This project is part of Rafael Tedesqui's PhD thesis under the supervision of Dr. Bradley Young. It aims to understand whether and how certain personality characteristics may be associated with how athletes train for sport. Overall, we wish to better understand whether certain personality characteristics allow athletes to persist in relevant forms of practice to develop into experts.

Participation: If you consent to participate in this research project, at the end of the season, you will be asked to complete an on-line form about athletes in your roster who will have completed an on-line survey. You will be asked about your athletes' records of attendance and level of engagement in practice, as well as their performance records in competitions throughout the season. The form will take approximately 10 minutes to complete.

Benefits: Your participation in this project will help contribute to scientific knowledge. In addition, this study has the potential to identify athletes' characteristics that relate to improved quality and increased quantity of sport training. This knowledge may allow sport coaches to adapt training strategies to help athletes maximize their performance and their overall experience in sport. For your contribution to the research project, you will be given the option to request a summary of the results of the study.

Confidentiality and Anonymity: Your anonymity will be protected. Athletes will not have access to coaches' responses to the on-line form. Similarly, the information collected will not be associated with the club to which you are affiliated. This consent form will be stored electronically on a password protected computer in the project supervisor's locked office. Physical copies will be kept under lock in the supervisor's office as well. All identifiable information in the consent form will be filed separately from the form data to protect your anonymity. All original data will be electronic in nature and will be stored using the certified-secure online survey provider "FluidSurveys" and protected by a password required to log into the account. Data will be kept secure and conserved for 10 years after which all of the data will be destroyed.

Voluntary Participation and Withdrawal: Your participation is completely voluntary. Participants may withdraw from the project at any time without penalty. If participants choose to withdraw, their data will be destroyed, unless permission to use

the decision to participate will not in any way impact coaches' affiliation to their club.

☎ 613 562-5852
613 562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

Risks: There are no known risks associated with your participation in this study.

If you have any questions regarding this research project you can contact the principal investigator or the project supervisor.

For any questions regarding the ethical conduct of this project, you can contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, Ottawa, ON, K1N 6N5, (613) 562-5387 or ethics@uottawa.ca.

Consent:

I have read this consent form and I understand the procedures of this research project. Also, I understand that my participation is completely voluntary and I may withdraw from the study at any time without penalty. By clicking "Next" on the web page below, I indicate my interest to participate.

☐ I would like to receive a report with the summary of the overall results of this study, when they are ready. Please provide your e-mail: _____

Please print and keep a copy of this form for your records.

[Next]

uOttawa

Appendix J: Template of Informational Letter to Organizational Representatives

Université d'Ottawa
Faculté des sciences de la santé

École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences

School of Human Kinetics

Dear organizational representative,

I am contacting you in the hope that you will consider endorsing a research project and grant us permission to recruit athletes aged 18 to 29 who attend your club as well as their coaches.

This study is part of Rafael Tedesqui's PhD thesis which is being conducted within the School of Human Kinetics at the University of Ottawa. The purpose of this research is (a) to understand how certain personality characteristics may be associated with how athletes train for sport and with performance differences between elite and less-skilled athletes, and (b) to determine whether certain personality characteristics may impact athletes' persistence and level of engagement in practice over the course of a sport season.

To assess athletes' personality characteristics, practice amounts, and performance level, athletes will be asked to complete an on-line survey that will take approximately 20 minutes. The survey is available in English only, because the questionnaire items have been validated and proven reliable in English by previous research. Therefore, it is important that all participants are able to read and understand English.

To determine athletes' persistence and their quality of engagement in the program, at the end of the season, coaches of athletes who completed the survey will be asked to provide athletes' records of attendance in practice and participation in competitions, and will be asked to rate athletes' overall level of engagement in practice, by completing a brief on-line form.

In accordance with the ethical procedures at the University of Ottawa, all information that participants provide will remain confidential and steps will be taken to ensure the anonymity of participants during all stages of the study. This study is occurring at multiple clubs simultaneously, thus, the data will not be presented or discussed in relation to any one specific club. Instead, data will be analyzed and reported at a group level to protect the identity of athletes and clubs. All collected information will remain safe and secure at all times. All original data will be electronic in nature and will be safely stored using the certified-secure online survey provider called "FluidSurveys" and protected by a password required to log into the account. Only the investigators listed below will have access to the data collected.

Participation in the study is entirely voluntary. If at any time a participant wishes to withdraw from the study, he or she may do so freely without penalty of any kind. Although very unlikely, there is a remote possibility of athletes feeling some discomfort if reporting lack of success in relation to their current competition level and achievements. However, the likelihood and the intensity of such discomfort are relatively negligible compared to what may already be experienced by athletes in their

☎ 613 562-5852
613 562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

daily routine of sport practice and competitions. In any case, participants may contact the appropriate resources (provided within the survey) to help with such discomfort.

This study has the potential to identify athletes' characteristics that relate to improved quality and increased quantity of practice. This knowledge may allow sport coaches to adapt training strategies to help youth athletes maximize their performance and their overall experience in sport.

In light of this, we would like to ask your permission to be on-site at your club or event. After obtaining permission to be on-site, the principal investigator will collect athletes' e-mail through a ballot to later invite them to access the consent form and the survey. If they prefer, potential participants who express an interest in this study will be able to take a recruitment letter. The principal investigator will not approach or solicit potential study participants on-site. Rather, potential participants will have to approach the recruitment booth to receive a recruitment letter. The recruitment letter will provide information about the study and what participants are asked to do, will contain the contact information of the principal investigator, and will invite interested participants to access the electronic version of the consent form in our online survey-based website.

Alternatively, if you prefer, we would like to ask you to consider forwarding the following link [Link] to 18-29 year-old athletes who attend your club/event. Once you forward this link, athletes will be able to access a website URL that contains a consent form, where they can indicate whether they wish to participate. Should consent be obtained, athletes will proceed to complete the survey on-line.

To recruit coaches, later in the season, we will contact you again. With your permission, coaches will be invited to complete the on-line form only if they have at least one athlete who completed the survey. If you agree to collaborate with us, we look forward to discussing how you can assist us with recruitment based on your preferences.

If you would like more information, please contact Rafael Tedesqui to discuss any questions that you may have regarding this research project.

Sincerely,

Rafael A. B. Tedesqui
PhD candidate
School of Human Kinetics
University of Ottawa

Bradley W. Young, PhD
Associate Professor
School of Human Kinetics
University of Ottawa

Appendix K: Demographic Questionnaire

1. Sex:

   ☐ Male ☐ Female

2. Date of birth:

   ____/____/_____

   DD/MM/YYYY

3. What town/city do you live? _____

4. What is the highest level of education that you completed?

   ☐ Elementary school

   ☐ Middle school

   ☐ High school

   ☐ Undergraduate degree

   ☐ Graduate degree

Appendix L: Skill Level Questionnaire

(Baker, Wattie, & Schorer, 2015; Hopwood, 2013)

1. What is your main sport? _____

   **** *Please answer all remaining questions as they relate to your main sport* ****

2. Highest level of competition ever achieved as a junior-aged (under 18) athlete:

   ☐ Local/House League ☐ City ☐ Regional ☐Provincial ☐ National ☐ International

3. Highest level of competition ever achieved as a senior-aged (18 and older) athlete:

   ☐ Local/House League ☐ City ☐ Regional ☐Provincial ☐ National ☐ International

4. How long have you competed at the level indicated above? _____ In years.

5. How successful have you been at your current competition level?

   ☐ 1 = not very successful ☐ 2 ☐ 3 ☐ 4 ☐ 5 = very successful

6. If your main sport has measured race distances or measured performances, please indicate your best competitive performance, the event type, and the date when you achieved it.

   Best performance (ex.: minutes and seconds, distance in metres and centimetres, or number of points): _____

   Event type (ex.: 100 m sprint, long jump, 50 metre freestyle swim): _____

   Please estimate the date achieved (month and year): _____

7. What do you consider your skill level to be?

   ☐ Naiveté: I am completely unfamiliar with the sport.

   ☐ Novice: I have minimal amount of experience.

   ☐ Basic: I understand the rules and can perform specific movements of the sport.

   ☐ Intermediate: I have played at state or provincial levels of competition.

   ☐ Advanced: I have played at national levels of competition and/or high levels of intercollegiate competition such as the NCAA.

☐ Expert: My performance is within the top 5% in my age group. Other experts in the field (e.g., coach) have recognized me as an expert.

☐ Eminence: I have entered the "Hall of Fame".

8. Do you want to become an elite athlete?

a. How important is it for you to become an elite athlete in your sport?

9. Compared to other activities, how important to you is playing/training/competing in your main sport?

1 = not very important 2 3 = somewhat important 4 5 = very important

10. Do you feel that you have reached the peak of your sporting career?

☐ Yes. At what age did you achieve this peak? _____

☐ No. How much longer are you willing to be involved to reach your peak? (please estimate the number of years): _____

Appendix M: Deliberate Practice History Questionnaire

(Baker et al., 2015; Hopwood, 2013; Ward et al., 2007)

1. We will now ask you to report the number of hours per week that you spend in 3 different activity categories relating to your main sport. Please consider these 3 categories separately and not overlapping. During a typical MID-SEASON week, how many HOURS per WEEK do you spend in...

a. ... playful activities related to your sport (fun games or unstructured activities that are undertaken primarily for enjoyment)? Examples for basketball may include playing pick-up basketball or shooting hoops with friends. Examples for swimming may include going for a swim at the beach or playing at the backyard pool. Hours per week: _____

b. ... competition (formal competitive activities or scheduled games in which you compete against other athletes or teams)? This category includes preparatory activities at the venue and post-competition time. Hours per week: _____

c. ... individual or team practice (activities deliberately designed to improve performance such as technical and tactical training)? Hours per week: _____

2. How many HOURS per WEEK do you spend playing, competing or practicing OTHER sports (NOT your main sport)? Hours per week: _____

3. How often do you train? _____ Hours/week. _____ Days/week. _____ Months/year.

4. How long have you regularly practice for your main sport (in YEARS)? _____

Appendix N: Conscientiousness Subscales

(IPIP)

Please use the rating scale below to describe how accurately each statement describes *you*.

1-*not at all like me* to 5-*very much like me*.

1. I complete tasks successfully.
2. I excel in what I do.
3. I handle tasks smoothly.
4. I am sure of my ground.
5. I come up with good solutions.
6. I know how to get things done.
7. I misjudge situations.*
8. I don't understand things.*
9. I have little to contribute.*
10. I don't see the consequences of things.*

11. I like order.
12. I like to tidy up.
13. I want everything to be "just right."
14. I love order and regularity.
15. I do things according to a plan.
16. I often forget to put things back in their proper place. *
17. I leave a mess in my room. *
18. I leave my belongings around. *
19. I am not bothered by messy people. *
20. I am not bothered by disorder. *

21. I try to follow the rules.
22. I keep my promises.
23. I pay my bills on time.
24. I tell the truth.
25. I listen to my conscience.
26. I break rules. *
27. I break my promises. *
28. I get others to do my duties. *
29. I do the opposite of what is asked. *
30. I misrepresent the facts. *

31. I go straight for the goal.

32. I work hard.
33. I turn plans into actions.
34. I plunge into tasks with all my heart.
35. I do more than what's expected of me.
36. I set high standards for myself and others.
37. I demand quality.
38. I am not highly motivated to succeed. *
39. I do just enough work to get by. *
40. I put little time and effort into my work. *

41. I get chores done right away.
42. I am always prepared.
43. I start tasks right away.
44. I get to work at once.
45. I carry out my plans.
46. I find it difficult to get down to work. *
47. I waste my time. *
48. I need a push to get started. *
49. I have difficulty starting tasks. *
50. I postpone decisions. *

51. I avoid mistakes.
52. I choose my words with care.
53. I stick to my chosen path.
54. I jump into things without thinking. *
55. I make rash decisions. *
56. I like to act on a whim. *
57. I rush into things. *
58. I do crazy things. *
59. I act without thinking. *
60. I often make last-minute plans. *

IPIP scale name (items). Equivalence with Costa and McCrae's (1989) scales.
Self-efficacy (items 1-10). Equivalent to C1: Competence
Orderliness (items 11-20). Equivalent to C2: Order
Dutifulness (items 21-30). Equivalent to C3: Dutifulness
Achievement striving (items 31-40). Equivalent to C4: Achievement striving
Self-discipline (items 41-50). Equivalent to C5: Self-discipline
Cautiousness (items 51-60). Equivalent to C6: Deliberation
* = Reversed items.

Appendix O: Grit Scale

(Duckworth et al., 2007)

Here are a number of statements that may or may not apply to you. When responding, think of how you compare to most people–not just the people you know well, but most people in the world. There are no right or wrong answers, so just answer honestly!

How much do you agree with each sentence?
1 = Not like me at all
2 = Not much like me
3 = Somewhat like me
4 = Mostly like me
5 = Very much like me

1. I have overcome setbacks to conquer an important challenge. (P)
2. New ideas and projects sometimes distract me from previous ones.* (C)
3. My interests change from year to year.* (C)
4. Setbacks don't discourage me. (P)
5. I have been obsessed with a certain idea or project for a short time but later lost interest.* (C)
6. I am a hard worker. (P)
7. I often set a goal but later choose to pursue a different one.* (C)
8. I have difficulty maintaining my focus on projects that take more than a few months to complete.* (C)
9. I finish whatever I begin. (P)
10. I have achieved a goal that took years of work. (P)
11. I become interested in new pursuits every few months.* (C)
12. I am diligent. (P)

Scoring:

For questions 1, 4, 6, 9, 10 and 12 assign the following points:
5 = Very much like me
4 = Mostly like me
3 = Somewhat like me
2 = Not much like me
1 = Not like me at all

For questions with "*" reverse the score.
(P) = *Perseverance of effort* factor. (C) = *Consistency of interests* factor
Add up all the points and divide by 12. The maximum score on this scale is 5 (extremely gritty), and the lowest scale on this scale is 1 (not at all gritty).

Appendix P: Brief Self-Control Scale

(Tangney et al., 2004)

Using the scale provided, please indicate how much each of the following statements reflects how you typically are.

1 = Not at all
5 = Very much

1. I am good at resisting temptation.
2. I have a hard time breaking bad habits. (R)
3. I am lazy. (R)
4. I say inappropriate things. (R)
5. I do certain things that are bad for me, if they are fun. (R)
6. I refuse things that are bad for me.
7. I wish I had more self-discipline. (R)
8. People would say that I have iron self- discipline.
9. Pleasure and fun sometimes keep me from getting work done. (R)
10. I have trouble concentrating. (R)
11. I am able to work effectively toward long-term goals.
12. Sometimes I can't stop myself from doing something, even if I know it is wrong. (R)
13. I often act without thinking through all the alternatives. (R)

(R) = Reversed Items
Self-discipline subscale: items 2, 3, 7, 8, 9, 10, 11.
Impulse control subscale: items 1, 4, 5, 6, 12, 13.

Appendix Q: Coach Ratings of Athletes' Level of Engagement in Practice

Based on your observations of your athletes (only those who are participating in this study) at this point in this season, please use the scale below to rate them on the following items by circling the corresponding number.

Note: We will take every step to protect yours and your athletes' anonymity. You will not be identified in any publication of the results of this study.

1 = not at all true 5 = very true

Athlete's name →								
This athlete **perseveres through setbacks and difficulties.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **is diligent with respect to training responsibilities.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **invests extra time in training.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **has a positive attitude toward training.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **takes on new challenges.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **consistently works hard.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
This athlete **misses practice.**	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Do you know of any reason for this athlete's absence (injury, work, other)?								

Appendix R: Interview Guide

Pre-interview

Thanks, purpose of the interview, confidentiality, anonymity, recording, signing consent form.

Opening questions

For this interview, I will ask you to consider your work with competitive and not recreational athletes. When we talk about competitive sport we think a lot about how athletes perform, how they compete. But today I want to focus on their day-to-day training. So, my first question is:

1. What does training mean to you? How important is it for your athletes?

Main section

(a) Coaches' views about the traits

Ok, so thinking about the day-to-day training, I would like to know how you would describe the following kinds of athletes. Think about what they do before training, as they prepare and get ready for training or even as they get to training, also think about what they do during the actual training session, and also think about what they do after training is over:

2. Have you ever heard about *grit*? What does it mean to you? In terms of the day-to-day training, how would you describe an athlete who has *grit* (gritty athlete)? What else does a gritty athlete do/look like in training? How does a gritty athlete differ from a less gritty one?
3. How would you describe an athlete who has *perseverance/persistence* (persevering athlete)?
4. How would you describe an athlete whose passions/interests are consistent/stable and do not change over time? An athlete who maintains interest in their goals no matter how long they may take? How would you call an athlete like this?
5. How would you describe an athlete who has *conscientiousness* (conscientious athlete)?
6. How would you describe an athlete who has *self-control* (self-controlled athlete)?

(b) Importance of traits for expertise

7. So, now when you think about these characteristics, which of these characteristics is the most important? Why is it important?
8. Do you think it matters for their skill development? Will this characteristic help an athlete get to the next level? Can you explain?
9. Is this characteristic more prevalent at certain levels (e.g., elite vs. novice)? Any examples?
10. Do you think this characteristic has an influence on or is this something that impacts:
    (a) the number of hours that athletes put into their weekly training? Explain/example?
    (b) the quality of their training?
    (c) their hard work and intensity in training?
    (d) their commitment to their sport (e.g., whether they get to practice or not)?
    (e) their long-term engagement, so their engagement over time and not just in certain circumstances?

(c) Situations where traits may be undesirable

11. Now, are there any situations or conditions where you think this characteristic may be undesirable or counterproductive? Which ones?

(d) Strategies to develop traits

12. How do you train an athlete who already has a high level of this characteristic? Is that athlete more “trainable” or more “coachable”?
13. Now, how do you train an athlete who does not have a high level of this characteristic?

14. If you had to choose between two athletes, would you rather have an athlete with a moderate level of this characteristic and a high level of technical ability or one with a high level of such characteristic and a moderate level of technical ability? Why?
15. Have you tried to help athletes develop this characteristic? If yes, how do you improve this in an athlete? Which strategies have you used? Were you successful?

(e) Stability/malleability

16. From your experience, how do you think this characteristic is developed?
17. Do you think it is more stable and fixed or more changeable and malleable? Why do you think so? Can you give an example to illustrate?

(f) Implications for TID

18. Now, let's talk about TID. What does it mean to you? Probe on training.
19. When you reach a point in the season when have to decide which athletes to bring back next year, or who to select to representative teams, or who to advance to higher levels, do you consider how much an athlete has displayed this characteristic over the season? Does this influence your decision at all? Example?
20. All things considered, if you have two athletes that are tested the same in their performance and physiological measures, would you rely on these characteristics to choose one of them?
21. You also mentioned these other characteristics. Are any of these also important?

Concluding questions

22. Do you want to comment on how the other characteristics may help athletes in a different way or help them do something different than the first characteristic?
23. Would you like to add anything you think that is important and that we may have missed?
24. Any final comments or questions?