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

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Comparing the Contribution of Conscientiousness, Self-Control, and Grit to Key Criteria of Sport Expertise Development
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 et al., 2016; De Ridder et al., 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). Still, research outside sport shows they can have different effects, depending on
the context or task.
Emerging research suggests that grit (e.g., Author citation, 2017b; Larkin, O’Connor, &
Williams, 2015) and SC (e.g., Author citation, 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 any contrasted

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1 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.
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., Author citation, 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 Author citation (2017a; $N = 244$) and Author citation (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
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 (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, $\chi^2(2, N = 175) = 6.74, p < .05$. 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, $\chi^2(2) = 36.79, p < .001$, $b_{\text{Advanced}} = 1.02$, Wald $p < .001$, $b_{\text{Expert}} = 1.61$, Wald $p < .001$; however, conscientiousness facets were not predictors, with likelihood ratio tests ranging from $\chi^2_{\text{Orderliness}}(2) = 4.19, p = .12$ to $\chi^2_{\text{Cautiousness}}(2) = 0.002, p = .99$.

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, $\chi^2(2) = 14.72, p < .01$, $b_{\text{Advanced}} = 0.03$, Wald $p = .54$, $b_{\text{Expert}} = 0.13$, Wald $p < .01$, as was sex, $\chi^2(2) = 10.33, p < .01$, $b_{\text{Advanced}} = 1.16$, Wald $p < .05$, $b_{\text{Expert}} = 1.58$, Wald $p < .01$; however, no conscientiousness facets were predictors, with likelihood ratio tests ranging from $\chi^2_{\text{AS}}(2) = 3.38, p = .18$ to $\chi^2_{\text{Cautiousness}}(2) = 0.17, p = .92$. 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, $b = 0.10$, 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.
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. Author citation (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 (Author citation, 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 (Author citation, 2017a) and grit (Author citation, 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 Author citation, 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 Author citation, 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 ($\beta_{\text{Dut}} = -.20$ and $\beta_{\text{PE}} = .35$) compared to when they were assessed separately ($\beta_{\text{Dut}} = -.10$ and $\beta_{\text{PE}} = .28$). Similarly, the predictive contributions of dutifulness and AS were stronger ($\beta_{\text{Dut}} = -.25$ and $\beta_{\text{AS}} = .31$) compared to when they were assessed separately ($\beta_{\text{Dut}} = -.10$ and $\beta_{\text{AS}} = .20$). Finally, the predictive contributions of PE and AS were weaker ($\beta_{\text{PE}} = .25$ and $\beta_{\text{AS}} = .05$) compared to when they were assessed separately ($\beta_{\text{PE}} = .28$ and $\beta_{\text{AS}} = .20$). 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, $\chi^2(2) = 34.28, p < .001$, $b_{\text{Advanced}} = 1.02$, Wald $p < .001$, $b_{\text{Expert}} = 1.55$, 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, $\chi^2(2) = 11.81, \ p < .01$, $b_{\text{Advanced}} = .03, \ b_{\text{Expert}} = 0.12$, Wald $p < .05$; for sex, $\chi^2(2) = 7.11, \ p < .05$, $b_{\text{Advanced}} = .95, \ b_{\text{Expert}} = 1.30$, 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, $b_{\text{Expert}} = 1.15$, 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 group compared to the BI group, $b_{\text{Advanced}} = .89$, 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; Author citation, 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; Author citation,
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.
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**Table 2**  
Summary of Results of Multiple Regression Analyses for the Five Dependent Variables  

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Parsimonious combination</th>
<th>Unique contribution (partial $R^2$)</th>
<th>Adjusted $R^2$</th>
<th>$B$</th>
<th>$SE$</th>
<th>$β$</th>
<th>Best predictor ($β^*$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deliberate practice</td>
<td>(PE, Dut, AS, SD)</td>
<td>PE .04</td>
<td>.12***</td>
<td>3.32</td>
<td>.93</td>
<td>.27***</td>
<td>.28***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dut .05</td>
<td></td>
<td>-4.39</td>
<td>1.15</td>
<td>-26***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AS .01</td>
<td></td>
<td>2.45</td>
<td>1.18</td>
<td>.16*</td>
<td></td>
</tr>
<tr>
<td>Mandatory practice</td>
<td>(PE, SD, AS)</td>
<td>PE .06</td>
<td>.13***</td>
<td>0.30</td>
<td>0.07</td>
<td>.27***</td>
<td>.35***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD .03</td>
<td></td>
<td>0.18</td>
<td>0.06</td>
<td>.19**</td>
<td></td>
</tr>
<tr>
<td>Optional practice</td>
<td>(AS, SD, PE, IC, Ord)</td>
<td>AS .02</td>
<td>.09***</td>
<td>0.48</td>
<td>0.20</td>
<td>.18*</td>
<td>.29***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD .02</td>
<td></td>
<td>0.33</td>
<td>0.14</td>
<td>.18*</td>
<td></td>
</tr>
<tr>
<td>Think switching</td>
<td>(CI, SD, IC)</td>
<td>CI .11</td>
<td>.11***</td>
<td>-0.66</td>
<td>0.12</td>
<td>-33***</td>
<td>-33***</td>
</tr>
<tr>
<td>Think quitting</td>
<td>(CI, SD, IC)</td>
<td>CI .03</td>
<td>.12***</td>
<td>-0.31</td>
<td>0.11</td>
<td>-20**</td>
<td>-29***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD .02</td>
<td></td>
<td>-0.26</td>
<td>0.11</td>
<td>-16*</td>
<td></td>
</tr>
</tbody>
</table>

*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 $R^2 = .02$ *Standardized beta weights of best predictors when assessed alone in the model.*

*p < .05. **p < .01. ***p < .001.
Figure 1. Path model (a) depicting the links between broad conscientiousness and the criterion measures; model fit statistics were $\chi^2(9, N = 270) = 46.32, p < .001$, CFI = .85, SRMR = .06, RMSEA = .12 (90% CI = .090 -.161). Path model (b) depicting links between conscientiousness facets and criterion measures; model fit statistics were $\chi^2(8, N = 270) = 47.98, p < .001$, CFI = .96, SRMR = .04, RMSEA = .14 (90% CI = .101-.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 $p < .05$, .01, .001, respectively. a Standardized estimates for the structural paths. b Squared multiple correlations. c Added correlations between error terms as suggested by modification indices.
Highlights

Specific personality facets were associated to criteria for expert sport development.

Grit facets were better predictors than conscientiousness and self-control facets.

Of 10 initial facets, two grit facets and achievement-striving proved important.

Perseverance related to practice; consistency of interests related to commitment.

Athletes high in perseverance were much more likely to be in the expert group.