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DOES TALENT EXIST?

A re-evaluation of the nature–nurture debate

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Introduction and chapter overview

Throughout history, knowledge and science have often progressed through dialectical debate. Logical arguments from one perspective are posed to counter those from another in the hopes of arriving at a holistic synthesis (e.g., see Sternberg, 1999). The nature–nurture debate has been one of the most enduring, frequently resurrected by the media and scientists alike in an attempt to provide explanation for the fantastic feats of those we call ‘talented’. While a central feature of debate is to discuss the pros and cons of opposing views and polarizing stances, relatively few research efforts have sought genuine reconciliation between the extreme positions of nature and nurture (cf. Davids & Baker, 2007). With some exceptions, the modus operandi has been to advocate for one side of the debate while giving little credit to the merits of opposing arguments beyond token gestures.

Debates on the science of talent are almost always theoretically and philosophically entrenched. We argue that perspectives are sometimes taken on one side of the debate to facilitate falsification in a systematic way but, more often, manufactured dichotomies lead to weak tests of a preferred theory, or are used as a guise to promote a preferred perspective incapable of providing unique explanations (see Feynman, 1974). In addition, despite best intentions to conduct ‘good science’, the tendency has been for research to be piecemeal rather than systematic, and disaggregated rather than systemic (Newell, 1973). Newell (1973) asserted that such practices result in ideological and theoretical differences becoming less clear and conflicting arguments being infrequently resolved. The end product is unlikely to be a mature and cumulative science. The risk here is that the goals of science are relegated in priority and, as a result, science gives way to the process of telling stories based on data ex post facto. Such a path is unlikely to lead to much needed advances in the development of a useful theory of talent and limited capability to improve talent development.

Thankfully, such practices are not unique to the science of talent. Newell’s original epiphany about the non-cumulative nature of science resulted from attempts to synthesize the latest research in cognitive science. Numerous researchers over the years have recognized the interplay between science and opinion. Disdain has routinely been expressed by a diverse range of scientists for those ‘in the other camp’, whose position, purpose, and methods have been described by those holding contrary views as having little scientific or societal value (e.g.,
Gigerenzer, 2004). If we ever want to rise above the ‘disaggregated scattering’ of research and achieve the kind of knowledge synthesis that Newell (1973) described, the science of talent needs to move beyond the mundane polemics portrayed in the typical caricature of nature vs. nurture, in favour of pursuing a much more integrated perspective (Simonton, 2000). Taking an either/or perspective is fundamentally silly (Ackerman, 2007). Both genes and environment (and the interaction between them) are necessary for talent to ensue.

One important question for advancing our understanding of talent is how best to conduct talent research. The research on mono/dizygotic twins provides some insight into Gene × Environment interaction. But, as Ericsson and Ward (2007) have argued, this research only partially informs the development of expertise and of talented individuals who become highly skilled (see Ericsson, 2007). In the meantime, we are left to wait for the necessary accumulation of genetic evidence, make tantalizing leaps of inference from related (e.g., twins) research, or examine the research on nature and nurture independently. The latter approach is likely to lead to a disaggregated body of knowledge! Rather depressingly, it is the approach taken in this chapter, mainly because it reflects the current state of the science – at least as we understand it. Is there any hope? The hope is that we can end this polarizing debate in favour of a more integrative stance – one that embraces and elevates the goals of science above personal perspectives and agendas. The nature vs. nature debate is dead. The issue needs to be reframed.

Let us assume (a) that the scientific evidence in genetics is not yet sufficiently mature to make recommendations about selection or training, and/or (b) that we cannot yet intervene at a genetic level to facilitate performance outcomes in those domains. The questions of primary concern, then, are whether there are any individual differences in domain-general abilities and/or domain-specific skills that affect talent development and whether these can be nurtured. In this chapter we attempt to address these issues (without escaping all polarizing dichotomies) by examining the empirical data on talent and expertise. We provide an overview of research on individual differences in domain-general ability and domain-specific skill,1 their relative contribution to talent and expertise, and then examine the measurement of talent. Last, we examine issues related to talent development, with a specific focus on practice and preconditions for performance improvement.

From general motor ability to domain-general abilities

Domain-general abilities, such as intelligence and eye–hand coordination, theoretically speaking, are thought to be innate and relatively non-malleable. Arguably, they are the basis on which talent is developed. In one of the first reported investigations of the heritable basis for superior performance, Sir Francis Galton noted that the highest performing individuals were often related to others who were also high performing. He concluded that inherited abilities must be the source of superior performance, and that training culminates in asymptotic levels of performance that are rigidly determined (Galton, 1869/1979). The notion that maximum performance is determined by genetic factors has persisted for over a century.

Much progress was made in our understanding of capability limits around the turn of the twentieth century. This period saw a range of domain-general ability tests being developed for the purposes of assessing physical and motor proficiency, as well as monitoring physical and mental ability, sometimes using verbal, non-verbal and performance-based tests of intelligence. In addition to understanding capability limits, these initiatives were often pragmatically driven, and geared towards improving ability to classify individual differences in all-around psychomotor ability, diagnose performance disabilities, and predict future accomplishment from current levels.
For instance, tests were developed to establish physical efficiency standards (McCurdy, 1923) and to aid in role selection and task assignment for military recruits (Yerkes, 1921).

The concept of a generalized motor ability (GMA) was popularized around the 1920s (see Brace 1927). However, little evidence followed that GMA was capable of predicting psychomotor performance on specialized tasks. For example, GMA did not predict typewriter skill (Walker & Adams, 1934). Only a more focused motor ability – steadiness – predicted rifle marksmanship (Humphreys, Buxton, & Taylor, 1936). Subsequent research confirmed that motor skill was highly task-specific (Henry, 1968); and GMA tests were superseded by those measuring both specific psychomotor (e.g., balance, coordination, etc.) and other non-motor abilities (e.g., intelligence, working memory capacity, etc.; see Fleishman, 1953). Researchers interested in better understanding talent development and training effectiveness adopted similar specific test batteries to address real-world problems of the day; for instance, when McFarland and Franzen (1944) were able to predict successful graduation of naval trainee pilots \((r = .41)\) using tests of individual differences in non-motor ability, such as general intelligence, morale, attitudes, and mechanical interests. When psychomotor abilities were included (e.g., Mashburn serial reaction, two hand coordination), prediction capability improved further \((r = .61)\).

Similarly, training outcomes in US Army Air Force pilots, navigators, and bombardiers were successfully predicted \((r = .50)\) using a battery of mental ability tests (e.g., mechanical comprehension, general intelligence), which improved when performance on specific psychomotor tasks (e.g., Mashburn task) were included \((r = .70; \text{Melton}, 1947)\). More recently, tests of general cognitive ability (e.g., general intelligence) were shown to be a good predictor of ‘trainability’ \((i.e., \text{potential to improve, } r = .56)\), and better than measures of initial performance on tasks that were representative of their future job \((r = .41)\) (e.g., Schmidt & Hunter, 1992).

At first glance, whether psychomotor or other abilities are used, these variables appear to do a good job of predicting initial development with training. Considering the (human and resource) costs of making an error in many applied domains \(e.g., \text{aviation})\) however, the predictive value should be considered relatively low (see Fleishman, 1953). Importantly, only training success was predicted in the above studies. The ability to predict advanced training criteria or operational performance was not determined. Fleishman (1953) prognosticated that as individuals become more skilled with training, ability measures are unlikely to predict ‘job’ performance as well. This prediction has since been borne out \(e.g., \text{see Ackerman, 1988})\). For instance, Wigdor and Green (1991) demonstrated that tests of a range of specific abilities \(e.g., \text{Armed Services Vocational Aptitude Battery})\) – although used to select military personnel for specific roles – did not predict individual differences in on-the-job performance after the first year of service.

In a recent meta-analysis of 20 studies, Voss, Kramer, Basak, Prakash, and Roberts (2010) demonstrated that, while the effects were too small to be detected in any single low-power study, an analysis across studies shows that expert athletes do differ from their lesser skilled counterparts in some aspects of domain-general ability. Rather than psychomotor ability, Voss et al. noted that cognitive processing speed (i.e., ability to quickly and accurately perceive and respond to non-specific environmental stimuli) and varied attentional tests (including measures of spatial and divided attention but not attentional cueing paradigms) yielded significant skill effects between elite and non-elite athletes \((ES = .67 \text{ and } ES = .53, \text{respectively})\). Whether skilled athletes possess these capabilities prior to engaging in sport and succeed because of them, or develop these abilities as a consequence of having invested their career in these sports is an empirical question. In the next section, we summarize research that has examined the relative contribution of domain-general abilities and acquired domain-specific skills to the attainment of expertise.
From domain-general ability to domain-specific skills

Multidisciplinary research examining the contribution of domain-general abilities and domain-specific skills has featured prominently in talent development research. Numerous physical, physiological, biological and maturational factors have been shown to predict athletic performance in children and young adolescents (e.g., Regnier & Salmela, 1987). However, as individuals mature, psychological factors such as susceptibility to anxiety, perceptual awareness, anticipatory skill and ego-orientation are required (when combined with physical factors) to discriminate across skill levels (e.g., Regnier & Salmela, 1987; Reilly, Williams, Nevill, & Franks, 2000).

Although some talent researchers have taken a multidisciplinary approach to talent, sports expertise researchers have mainly focused on perceptual-cognitive variables. Research by de Groot (1965) and Chase and Simon (1973) in chess drove early interest in the role of perceptual-cognitive abilities and skills in expert performance. Their research demonstrated that (domain-general, short-term) memory for random configurations of chess pieces did not differentiate expert from novice chess players. However, higher skilled chess players were better than less-skilled players at recalling meaningful patterns of chess pieces (i.e., actual game configurations). They concluded that, compared to novices, experts do not possess superior general memory ability. Instead, they have acquired domain-specific memory skills (i.e., can select, encode, index, and organize task-relevant information) that facilitate memory recall and support game play.

The finding that experts have a better memory for domain-specific information in chess and a more accessible knowledge repository – but not better general memory ability – has been extended to other talent domains, such as basketball (e.g., Allard, Graham, & Paarsalu, 1980), field hockey (e.g., Starkes & Deakin, 1984), soccer (e.g., Williams & Davids, 1995), and tennis (e.g., McPherson & French, 1991). Domain-specific memory and expert knowledge are a by-product of skill development that are more representative of on-the-job performance. In sport, those identified skills include anticipation and decision making (for a review, see Ward, Williams, & Hancock, 2006). In a comprehensive meta-analysis of perceptual-cognitive tasks, Mann, Williams, Ward, and Janelle (2007) reviewed 388 effect sizes from 42 studies. Their results indicated that experts were significantly more accurate than novices at anticipating their opponent's actions, made significantly faster decisions and employed a more efficient visual search strategy, suggesting that experts are able to do more with less information. Although the evidence suggests that these representative skills are learned and developed over time, one could argue that such skills have a genetic basis or, at the very least, are sub-served by some foundational abilities (see Voss et al., 2010).

Researchers have pitched the relative contribution of domain-general abilities against domain-specific skills. For instance, Helsen and Starkes (1999) examined expert and intermediate soccer players on domain-general visual, perceptual and cognitive factors (including simple and peripheral reaction time, visual correction time, static, dynamic and mesopic acuity, and horizontal and peripheral visual range) as well as performance on representative tasks requiring perceptual-cognitive skills (i.e., viewing either static images or dynamic first-person perspective video of a soccer game in which they are asked to make a game-related decision). Peripheral visual range was the only domain-general ability measure to discriminate between skill levels, which explained just 3 per cent of the between-group variance. Of the perceptual-cognitive skill measures, experts made faster and more accurate situation-specific decisions than less-skilled players, which explained far more variance than the ability measures (84 per cent vs. 3 per cent). Ward and Williams (2003) conducted a similar study but investigated the relative contribution of similar factors in players aged 9 and 18 years. General visual-perceptual abilities (i.e., dynamic acuity, stereoscopic depth sensitivity, and peripheral awareness) did not
discriminate between skill groups at any age, whereas specific perceptual-cognitive skills did (i.e., anticipation, situation assessment, and memory recall). The combination of anticipation and situation assessment skills (i.e., skill at assessing the current situation and predicting the future course of action) yielded the strongest effects across all age groups.

Belling, Suss, and Ward (2015) extended the Ward and Williams (2003) study conceptually by comparing domain-general cognitive abilities with domain-specific perceptual-cognitive skills. The focus on domain-general cognitive abilities (rather than visual-perceptual abilities by Ward & Williams, 2003) was in line with Voss et al. (2010) who showed these are a better predictor of expertise in sport. Cognitive ability was measured using the Berlin Numeracy Test (Cokely, Galesic, Shulz, Ghazal, & Garcia-Retamero, 2012) — a measure of statistical numeracy, highly correlated with intelligence — and a test of spatial ability (i.e., Mental Rotation Test; Vandenberg & Kuse, 1978). Their measure of perceptual-cognitive skill combined the tasks previously identified as most predictive of skilled performance (Ward & Williams, 2003): anticipation and situation assessment. The domain-specific skill measure was a significant predictor of level of expertise, whereas both cognitive ability measures did not contribute significantly to the model.

Across numerous studies, results suggest that only domain-specific perceptual-cognitive skills consistently differentiate between skill groups. When domain-general ability effects are found to contribute significantly to between-group variance, at best, they have minimal prediction capability (e.g., Voss et al., 2010). When direct comparisons are made between the two, perceptual-cognitive skills dwarf the contribution of abilities massively.

Test development as a basis for measuring talent and developing training

The focus of this section is on shifting our direction toward better ways of measuring talent and how we might improve procedures to better predict it. Although some modern-day sports institutions identify talent criteria intuitively, most early researchers adopted a multi-step approach to talent identification and development: delineating the target performance, identifying performance predictors, evaluating performance, and assessing the trainability of these factors (see Durand-Bush & Salmela, 2001). However, this approach has been criticized since criteria that are predictive of early performance success are not necessarily predictive in later years (Geron, 1978). The use of (multiple) one-shot predictors severely underestimates the instability of talent criteria and the non-linearity of the talent development process (Vaeyens, Lenoir, Williams, & Philippaerts, 2008). Bartmus, Neumann and de Marées (1987) suggested that one-shot tests were better used for performance diagnosis than for selection purposes. Their recommendations were consistent with early models of talent in sport that urged the inclusion of assessments of amenability to training, and with more recent progress-monitoring approaches to talent prediction that recommend selection for training based on the rate of performance improvement (Vaeyens et al., 2008; Williams & Reilly, 2000).

Few studies have employed a progress-monitoring approach or have based selection on measures of performance improvement or its rate. A handful of exceptions provide limited evidence of the superiority of this approach (e.g., Pienaar & Spamer, 1998). Hence, much more research is needed in this area before strong recommendations can be made for measuring talent and predicting its development. We argue that the strong recommendations from the extant research — to move away from prediction-based performance measures toward multidisciplinary measures of (the rate of) performance improvement — have, effectively, side-stepped the most important issue in talent science: reliable and valid measurement. Science rests on the adequacy of its measurement. Invalid and unreliable measures provide a weak foundation for research and intervention (Foster & Cone, 1995).
Various means to measure talent exist. Talent researchers have made the positive move towards favouring work-sample/job tests and representative tasks over coach/supervisor subjective evaluations of performance. Despite performance being notoriously difficult to measure and a ‘gold standard’ assessment task being elusive (Hoffman, Ward, Feltovich, DiBello, Fiore, & Andrews, 2014), talent scientists and expertise researchers have pushed the boundaries in developing representative tasks on which to assess performance (e.g., Ward, Williams, & Hancock, 2006, for a review). However, even those that have implemented systematic approaches to testing and measurement of talent and expert skill (e.g., expert-performance approach) have rarely assessed the psychometric properties of tests employing representative tasks or incorporated established procedures for developing valid and reliable tests (e.g., see Hambleton & Jones, 1993; Lord, 1980). This is the case, even though we have a 100+ year history of using psychometric techniques to measure abilities, as well as psychological traits and states. Formal test development and evaluation procedures can be used to ensure that representative tasks will also provide valid and reliable means to measure talent. This is important, not least when the goal is to objectively measure performance over time or to develop effective training interventions. We argue that integration of these procedures are necessary for the field to make progress in measurement, and hence the development of talent.

Two general theories or approaches have informed methods to analyse and select appropriate test items for inclusion within a test. The classical test theory (CTT) framework – a ‘test-based’ approach – assumes a linear relationship between test score and ability, whereas item-response theory (IRT) analysis – an ‘item-based’ approach – assumes a nonlinear relationship between item performance and ability. Item statistics such as difficulty and discriminability, in the case of CTT, are dependent on the specific sample and overall test score. In the case of IRT, the specific item characteristics remain sample independent. IRT also allows a “guessing” factor to be calculated and individual item modelling can be used to describe overall test ‘informativeness’, which allows for flexibility when selecting items based on the developers’ test objectives (e.g., see Hambleton & Jones, 1993; Lord, 1980, for reviews). In general, a test to identify high-performing ‘talented’ individuals should contain items that have higher discrimination and greater difficulty, but have a low guessing value. To increase efficiency of implementing the test and to minimize response burden, IRT analyses can be used to reduce the number of test items, without reducing its reliability. Once developed, validation is essential to interpret the score meaningfully and to better understand the underlying mechanisms responsible for successful test performance.

One recent example in which these procedures were used to develop a valid and reliable test of observational assessment skill is the Anterior Cruciate Ligament Injury-Risk-Estimation Quiz (ACL-IQ) (e.g., Petushek et al., 2015a, 2015b). The ACL-IQ test was developed to assess an observer’s talent at visually estimating an athlete’s risk for ACL injury. Put simply, it is a test that determines how good an individual is at diagnosing skilled movement execution – a key skill for any developer of psychomotor talent. In the first instance, we sampled 20 video clips of athletes performing drop vertical jumps – a routine screening test – where we also had concurrent biomechanical assessment of objective risk. Individuals from various athletic and sport medicine disciplines then responded to the clips by rating the athlete’s risk for ACL injury. From the responses, we calculated individual item characteristics such as reliability, discriminability, difficulty, and guessing error. The number of test items was reduced to create a short (5-item) test by optimizing these item characteristics and the final test was cross-validated in a larger representative sample. Summary characteristics were consistent across the larger sample, and test-retest reliability was high despite the low numbers of test items.
To provide an estimate of construct validity and to identify the underlying mechanisms supporting skilled performance on the ACL-IQ, we also measured participant performance on various domain-general and domain-specific measures of cognition. General measures included mental rotation and decision making (similar to those used by Belling et al., 2015) as well as a measure of personality. To measure domain-specific skill, we collected measures of ACL knowledge and cue utility ratings (e.g., participant ratings of the importance of particular information cues for risk estimation). Hierarchical and cognitive process modelling results revealed that cue utility and ACL knowledge, rather than domain-general ability measures, were significant predictors of risk estimation ability. Hence, the results suggest that performance on a validated and reliable measure of observational risk assessment skill was better explained by domain-specific measures of performance. Importantly, the measurement, and test development and validation procedures used in the development of the ACL-IQ provide confidence that what is being assessed is actual talent or skill at the task in question, rather than an artefact of the measurement procedure. Moreover, they provide confidence that the underlying factors identified as mediating performance (i.e., cue utility and ACL knowledge) are indicative of how successful performance on the task is and can be attained. Not least, training programs/systems to improve performance that are based on these underlying factors provide a more reliable basis for performance improvement (see Hoffman et al., 2014, for a detailed discussion of training principles and reliable methods to accelerate learning).

**Practice, mindset and ability**

Undoubtedly, there are certain domains in which genetic predispositions offer considerable advantage. Likewise, it is entirely possible that engagement in particular types of developmental activities, such as diligent and dedicated practice and training not only results in improvements in domain-specific skill and performance improvements, but in the development of domain-general ability. For instance, practice effects have been observed on IQ tests (see Howe, 1990 for a review), though these are not correlated with future performance (Lyons, Hoffman, & Michel, 2009). So what is changed during practice that impacts performance, what influences those changes, and how do they come about?

Numerous researchers have implicated the role of zeal and the capacity to engage in hard work in high levels of proficiency. One of the founders of educational psychology – Edwin Thorndike (1912) – coined the term ‘practice with zeal’ to capture diligent efforts to improve performance. Engagement in these types of activities was originally studied in domains such as music and sport (e.g., Ericsson, Krampe, & Tesch-Römer, 1993; Hodges & Starkes, 1996). More recently, this notion has been shown to be applicable to many skill and talent development domains, including weather forecasting, piloting, and military command (Hoffman, 2007).

One of the first systematic attempts to examine the developmental activities in which talented athletes engaged en route to expertise was conducted by Bloom (1985). His research highlighted that such individuals initially engaged in their domains through playful activities. Their talent was identified at an early age by parents or coaches and familial support was indicative of athletic success. In subsequent years, dedication increased, practice became serious, competition was more prevalent, their coach played a more demanding and respected role and, ultimately, talented individuals shifted towards greater autonomy and self-regulation.

Inspired by Bloom’s (1985) longitudinal research, Ericsson et al. (1993) coined the phrase *deliberate practice*. Consistent with Thorndike (1912), Ericsson et al. suggested that deliberate practice is a highly effortful form of practice in which an individual is focused on monitoring and improving performance. Moreover, they indicated that it is not inherently enjoyable and in
some cases involves mentoring or coaching in order to select activities to increase performance. Contrary to Galton, they hypothesized that expert performance is achieved through deliberate practice as opposed to being genetically determined. Their conclusions are based on their observation that the highest performing musicians started training around four or five years of age and logged over 10,000 hours in deliberate practice activities by the time they reached 20. A moderately skilled group spent approximately 8,000 hours and a less skilled group spent 5,000 hours. The authors noted that experts commonly engaged in deliberate practice for 10+ years.

The claims of deliberate practice theory have been assessed in numerous sports, originally in a study of wrestlers (Hodges & Starkes, 1996) and then many times since. The primary deviations from the original theory were that talented sports participants typically engaged in more team and individual practice, participation was both physically and mentally effortful, and often perceived as enjoyable (see also Helsen, Starkes, & Hodges, 1998). Despite these differences in definition, athletes typically had engaged in 10 years of deliberate practice before attaining an elite level of performance.

A study by Ward, Hodges, Starkes, and Williams (2007) also indicated that the number of hours spent in team practice more reliably discriminated between elite and recreational soccer players between 8 and 19 years of age. They showed that elite players spent more time focusing on decision-making activities during practice, were more motivated, and had more support from parents. Moreover, perceptions of enjoyment changed throughout development, with younger players focusing on enjoying participation, and older players focusing on the outcome, especially winning. In a subsequent study, Ford, Ward, Hodges, and Williams (2009) followed up with some of the original participants from the Ward et al. (2007) study. They compared the participation patterns of elite players (when they were aged between 6 to 12 years of age) who either became professionals later in life, or had been at the elite level but did not receive a professional contract. Since both sets of elite players had similar histories in the training academy, their practice profiles were almost identical and no longer discriminated between them. However, the professional elite players had also recorded more hours per year in soccer play activities during the early years. When data were compared to a recreational group, the recreational group had accrued even more play than the professionals, however, they had not received academy-based training or accrued anywhere close to the amount of deliberate practice as either elite group. Accordingly, they proposed the ‘early engagement hypothesis’, suggesting that both practice and play are important contributors to skill acquisition at a young age (cf. Côté, Baker, & Abernethy, 2007).

Until recently, the literature on deliberate practice has had limited training value. If a coach said to a student, ‘go and deliberately practice’, they would surely receive the obvious response: ‘Doing what?’ Although it is quite hard to extract tangible applied implications for training contexts from the research on deliberate practice (see Cobley & Baker, 2010), without additional description of specific practice activities and/or training principles, the mass of research counting hours is unlikely to move talent science forward. Some researchers have identified related practice activities (e.g., engagement in decision making and perceptual-cognitive skill development, see Ward et al., 2007; Côté et al., 2007), and others have identified specific activities in which participants do/should engage (e.g., see microstructure of practice, e.g., Deakin & Cobley, 2003). However, few have increased the training or scientific value of deliberate practice.

In a rare non-retrospective examination of ‘deliberate’ practice activities, Coughlan, Williams, McRobert, and Ford (2013) followed expert and intermediate Gaelic football players as they practised two types of kicks in a controlled experiment. Expert players spent more time on the challenging kick whereas the intermediate players focused their practice on the
less challenging kick. Although experts were better at both kicks, unsurprisingly, both groups improved the most on the kick where they spent the most time. During retention, however, only the expert group maintained their level of performance improvement on both kicks. The cognitive strategies employed during learning, and how players interpreted their engagement may provide some explanation. Experts engaged in more monitoring, evaluative, and planning-type thoughts during training and interpreted engagement as less enjoyable, and more physically and mentally effortful than the intermediate group. This suggests that their greater efforts to improve on more challenging tasks resulted in more marked improvements overall.

One promising strategy for encouraging people to be willing to engage in deliberate practice might be to encourage a growth mindset – a view that talent is a malleable quality that can be developed over time. A wealth of research suggests that growth-mindsets regarding domain-specific talents or abilities predict high levels of motivation and achievement, including in athletic (e.g., Wang & Biddle, 2003), professional (Tabernero & Wood, 1999), and health-relevant domains (e.g., Ehrlinger, Burnette, Park, Harrold, & Orvidas, 2016a). Growth theorists more often choose challenging, effortful tasks (Hong, Chiu, Dweck, Lin, & Wan, 1999), devote more time to practising those tasks (Curry, Da Fonseca, Zahn, & Elliot, 2008; Ehrlinger et al., 2016b), and attend more to negative feedback (Ehrlinger, Mitchum, & Dweck, 2016c) relative to those who hold more fixed views of talent (i.e., fixed theorists). Although researchers have not used the phrase ‘deliberate practice’ in reference to the benefits of a growth theory, these effects arguably could be defined as such. Unsurprisingly then, growth mindsets predict successful goal achievement. A recent meta-analysis of experimental and correlation studies conducted by Burnette, O’Boyle, VanEpps, Pollack, and Finkel (2013) revealed that growth mindsets lead people to adopt more mastery-oriented goals, to cope more effectively with setbacks and, consequently, to outperform fixed theorists in academics, sports, professional, and health domains. This research has led to successful intervention research that has led to increased adoption of mastery goals (e.g., Spray, Wang, Biddle, Chatzisarantis, & Warburton, 2006), positive views of effort, and higher grades (Blackwell, Trzesniewski, & Dweck, 2007), relative to control conditions.

Beyond individuals’ mindsets, past research suggests that managers and coaches who hold growth mindsets may be more effective with respect to both selection and training. Compared to those with more fixed theories, Ehrlinger and Ward (2009) found that growth theorists reported valuing motivation (e.g., willingness to work hard) over ‘raw talent’ in hiring selections for employees and athletes. After hiring selections have been made, theories of ability held by managers and coaches influence their approach to training and performance evaluation. Managers with stronger growth theories have shown more motivation to provide training (Heslin, Vandewalle & Latham, 2006), and they provide more and higher quality feedback (Heslin & VandeWalle, 2008) to employees than managers with stronger fixed theories. Therefore, managers who believe that their employees can improve are likely to pay closer attention to their performance and provide the feedback needed to help them excel.

To summarize, although attempts have been made to select individuals based on innate abilities and traits, and to count deliberate practice and play hours as a means to predict skilled performance and its development, belief in one’s ability to improve and willingness to invest effort in improvement activities may be a more important factor. The research suggests that the beliefs that managers, coaches, employees and athletes hold about their own and others’ abilities (and skills) impacts motivation and behaviour (such as deliberate efforts to improve during practice) in ways that have important consequences for talent development.

The theory of deliberate practice (and deliberate play – whichever one advocates) is not without its critics. For instance, Hambrick, Oswald, Altmann, Meinz, Gobet, and Campitelli
(2014) argued that deliberate practice is not nearly as important for determining expertise as Ericsson et al. (1993) claim it is. In particular, the former purported that the latter may have overestimated the role of deliberate practice relative to other individual differences in developing expertise. Persistence in accomplishing long-term goals – or grit – has been shown to predict musical performance – with deliberate practice mediating that relationship (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2012). Likewise, although not mediated through deliberate practice, several variables have been shown to explain some of the variance in performance, including starting age, (e.g., Howard, 2012), global intelligence (e.g., Grabner, Neubauer, & Stern, 2006), verbal and spatial ability (e.g., Hayward & Gromko, 2009), and working memory capacity (e.g., Meinz & Hambrick, 2010). In the latter study, working memory capacity accounted for 7.4 per cent of the variance in pianists’ performance, whereas deliberate practice accounted for 45.1 per cent. The correlation between working memory and deliberate practice was near zero. However, when combined with other domain-general factors (e.g., intelligence, music audition), this combination often explained more of the variance than does deliberate practice (e.g., Ruthsatz, Detterman, Griscom & Cirullo, 2008). Unfortunately, authors seemingly concerned with debunking the value of deliberate practice have not compared combinations of domain-general abilities (such as those above) with the domain-specific skills acquired through hours of deliberate practice – for example perceptual-cognitive skills. When these comparisons have been made, the contribution of individual differences in general abilities to the development of talent and expertise is typically dwarfed by domain-specific skills. From our perspective, the focus of future research in this area should not be on nature vs. nurture, domain-general abilities vs. domain-specific skills, or even promoting (or demoting) the value of deliberate practice. Instead, it should be on increasing the training value of the deliberate practice literature (and similar literature in related domains), better understanding for whom specific types of deliberate practice might work best, and gaining a better understanding of how experts learn, and of the types of training that might result in more resilient and adaptive performance in complex and dynamic domains more generally (e.g., Hoffman et al., 2014; Hoffman & Ward, 2015; Ward, Hutton, Hoffman, Gore, Anderson, & Leggatt, 2016).

Summary and commentary on the science of talent

In sum, over the last few decades one might argue that the nature–nurture debate has not always led to advances in talent science that one might have hoped. Rather, there appears to have been an overemphasis on counting practice hours and, compared to other dialectical debates, there has seldom been a push towards a synthesis of perspectives. In our opinion, talent should not and cannot be reduced to one side of the debate versus the other. We hope, no matter how mysterious the media presents it to be, that future talent scientists can embrace and elevate the goals of science above personal perspectives and agendas to pursue a more integrative science in a more systematic, systemic and cumulative manner.

The complete answer to the popular Galtonian question of whether innate traits drive eminence and talent still remains elusive and perhaps it always will. Although some physical traits, such as height and body size may predict expert performance in some sports, there are few domain-general abilities that could be used reliably as a sole predictor of performance in complex domains such as sport – at least to the extent that we could base selection entirely on such factors. Arguably, the antithetical argument is at least partially true too: there are few domain-specific skills that, alone, predict performance in such domains reliably and unequivocally – not without other domain-general skills contributing a small portion of the variance in
individual differences in performance. Whether domain-general abilities are improved through engagement in domain-specific deliberate practice remains an empirical question. Likewise, whether some individual differences predispose some people to be able to endure the, arguably, pathological levels of deliberate practice needed to achieve the lofty heights of expertise is open to debate.

What is crucial for advancing the science of talent, however, is reliable and valid measurement, and a better understanding of the context-sensitive nature of expert cognition and performance. Instead of continuing to debate nature versus nurture in talent domains, we call for researchers to focus on the development of methods and representative tasks that capture the complex nature of expertise in context (see Ericsson & Ward, 2007; Hoffman et al., 2014; Hoffman, 2007), and the development of reliable assessment tools that permit valid measurement of talent via the identification of diagnostic test items (Petushek et al., 2015a, 2015b). Following previous recommendations, measurement approaches should also focus on predictors of learning and performance improvement (e.g., see Durand-Bush & Salmela, 2001).

The large body of research evidence now amassed continues to confirm the value of practising with zeal for developing current and future talented performers. The research has also highlighted the value of starting practice at an early age – without overspecialization – and the importance of parenting and coaching to develop expertise (e.g., Côté et al., 2007; Hodges & Starkes, 1996; Helsen et al., 1998; Ward et al., 2007). In addition, recent research suggests that expert mentoring may be a useful vehicle to help scaffold learning, aiding to bridge the divide between current and next proficiency levels (see Hoffman & Ward, 2015; Hoffman et al., 2014).

However, current research also indicates that deliberate practice does not always account for all, or even most of, the variance between expert performers (Hambrick et al., 2014). On average, the data suggest that domain-general abilities (when combined with other abilities) and deliberate practice account for, roughly speaking, the same amount of variance in performance, whereas when one examines the relative contribution of domain-general abilities and domain-specific skills, the latter tend to result in greater discrimination. Although some researchers have identified the specific training activities needed to attain expertise within a domain or have begun to better define the parameters of deliberate practice within a given sport (e.g., Coughlan et al., 2013), the deliberate practice camp has often come up short when providing a meaningful prescriptive contribution to advance the science of training (see Hoffman et al., 2014). Considerable research investment is needed to more clearly articulate the deliberate practice activities, and more importantly, specify the training principles (and how they need to be modified) that drive the acquisition of adaptive and skilled performance in complex domains (see Ward, 2014; Ward et al., 2016). Extant research has tended to focus on one of two areas: (i) adapting traditional classroom-type (and/or laboratory-based) and more exploratory learning methods designed to improve the performance of naive individuals on artificial and/or non-representative tasks, or (ii) on developing simple cue-utilization and recognition methods that focus on a single aspect of perceptual and/or cognitive expertise (e.g., anticipation; see Ward, Farrow, Harris, Eccles, & Ericsson, 2008; Ward, Suss, & Basevitch, 2009). Neither of these methods accurately reflect how experts learn, nor are they likely to promote the type of understanding needed to develop intuitive skills associated with expert performance. Current evidence suggests that talent can be nurtured but currently, methods to accelerate expertise are being under exploited (see Hoffman et al., 2014).

Finally, a prerequisite for learning may be believing you can improve, and knowing the difference between what you know and what you don’t. Individuals that have a growth mindset and those at the higher end of the proficiency continuum typically have more accurate self-assessment (e.g., Ehrlinger et al., 2016c). A wealth of research has shown that viewing one’s
level of talent as an improvable quality carries benefits in terms of the adoption of mastery-oriented goals, more helpful attributions, and higher achievement compared to viewing talent as more fixed (see Burnette et al., 2013 for a review). A growth mindset seems, in particular, to promote behaviours that could be categorized as deliberate practice, including the increased persistence on (e.g., Ehrlinger et al., 2016b) and attention to (e.g., Ehrlinger et al., 2016c) effortful tasks. Individuals with growth mindsets in sport (Cury et al., 2008), academics (Blackwell et al., 2007), and management (Tabernero & Wood, 1999) outperform those with more fixed views of talent. Perhaps then, one particularly promising avenue for training is to teach growth mindsets in conjunction with clearly specified deliberate practice activities to maximize the opportunities for successful goal pursuit and mastery. Hence, the focus going forward should be on increasing the training value of the deliberate practice by gaining a better understanding of how experts learn, and identifying the training principles and methods that can accelerate the development of resilient and adaptive skill (e.g., Hoffman et al., 2014; Hoffman & Ward, 2015; Ward, 2014; Ward et al., 2016).

Notes
1 Domain-general (DG) abilities typically refer to those underlying, stable and innate characteristics that support performance in, and are generalizable to most, if not, all tasks. Examples of DG abilities include cognitive abilities such as intelligence, spatial ability, speed of reaction, and abstract reasoning ability, and psychomotor abilities, such as complex coordination and rotary pursuit. The term domain-general is also used to refer to related characteristics, such as personality traits. Domain-specific (DS) skills, on the other hand, typically refer to particular capabilities that are specific to a particular task or domain and acquired as a consequence of engaging in that specific activity (or engaging in similar activities that rely on a similar problem structure, solution principles, and/or require similar patterns of movement coordination and/or control).
2 Ericsson and Ward (2007) defined a representative task as one that captures the essential characteristics of an expert’s superior performance in naturally occurring situations (e.g., low-frequency, challenging tasks that require specific perceptual-cognitive skills and knowledge to complete successfully). This is not dissimilar to Brunswik’s (1956) conception of ‘representative design’ where the recommendation is to include perceptual variables, and their variants, from across the full spectrum of an individual’s natural environment to which they have adapted.

References
Does talent exist? Nature–nurture debate


