Beyond 10,000 Hours: Addressing Misconceptions of the Expert Performance Approach

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Journal of Expertise
2021. Vol. 4(2)

ISSN 2573-2773

Abstract

It has been three decades since K. Anders Ericsson (Ericsson & Smith, 1991) proposed the expert performance approach as a general theoretical and methodological framework for studying the development of expert-level performance. Drawing on Ericsson's most recent writing, this review corrects four misconceptions about the expert performance approach that have persisted in both the popular and scientific literatures on expertise: (1) anyone can become an expert by putting in 10,000 hours of any kind of practice, (2) the expert performance approach is exclusively concerned with deliberate practice, (3) expert performers can be identified based on reputation or experience, and (4) Ericsson's claims require that a majority of the variance in performance is explained by deliberate practice. We conclude by making the case for integrating aspects of the expert performance approach into broader learning contexts, including educational and occupational environments. Such *in situ* experiments will mark the transition of expertise research from the basic science of describing exceptional performance to the applied science of maximizing human potential.

Keywords

Expert performance, expertise, practice, deliberate practice, training

Introduction

> The classic conception of human nature is captured in the name we gave ourselves as a species, *Homo sapiens*...We call ourselves "knowing man" because we see ourselves as distinguished from our ancestors by our vast amount of knowledge. But perhaps a better way to see ourselves would be as *Homo exercens*, or "practicing man," the species that takes control of its life through practice and makes of itself what it will. (Ericsson & Pool, 2016, p. 258)

K. Anders Ericsson left an unparalleled legacy on the field of expertise research (see other reviews, this issue). His *expert performance approach* is both a methodological and theoretical framework that emphasizes the development of domain-specific mental representations through thousands of hours of intense practice (Ericsson, 2006, 2018d; Ericsson and Smith, 1991). Until his death in 2020, Ericsson continued to develop and improve his body of work—much like the world-class experts who were the focus of his interest. Improbably, his work not only seeded scientific inquiry but also captivated public imagination. However, misunderstandings about the expert performance approach stubbornly resisted Ericsson's efforts to clarify his position.

In this review, we identify and attempt to address some of these misconceptions. The authors have personal ties to this topic: One of us (Harwell) was a fifth-year graduate student working under Ericsson at the time of his death, and the other (Southwick) was collaborating with Ericsson on two empirical papers prior to his passing. Here, we present our best efforts at clarifying Ericsson's positions. The arguments presented should be regarded as the authors' interpretation of Ericsson's research and writing rather than as the views of Ericsson himself.

Ericsson's research has been popularized in best-selling books, including *Outliers* (Gladwell, 2011), *The Talent Code* (Coyle, 2009), and *Deep Work* (Newport, 2016), as well as in popular media such as Justin Bieber and Dan + Shay's hit song *10,000 Hours* (Smyers et al., 2019) and Macklemore's song by the same title (Haggerty et al., 2012). Further evidence of Ericsson's impact can be traced in the usage of language that was prominent in his research: Since 1993, when Ericsson's most influential paper on expertise was published (Ericsson et al., 1993), usage of the phrase "expert performance" has increased by about 6 times in printed material, and "deliberate practice" has increased by more than 25 times (see Figure 1).

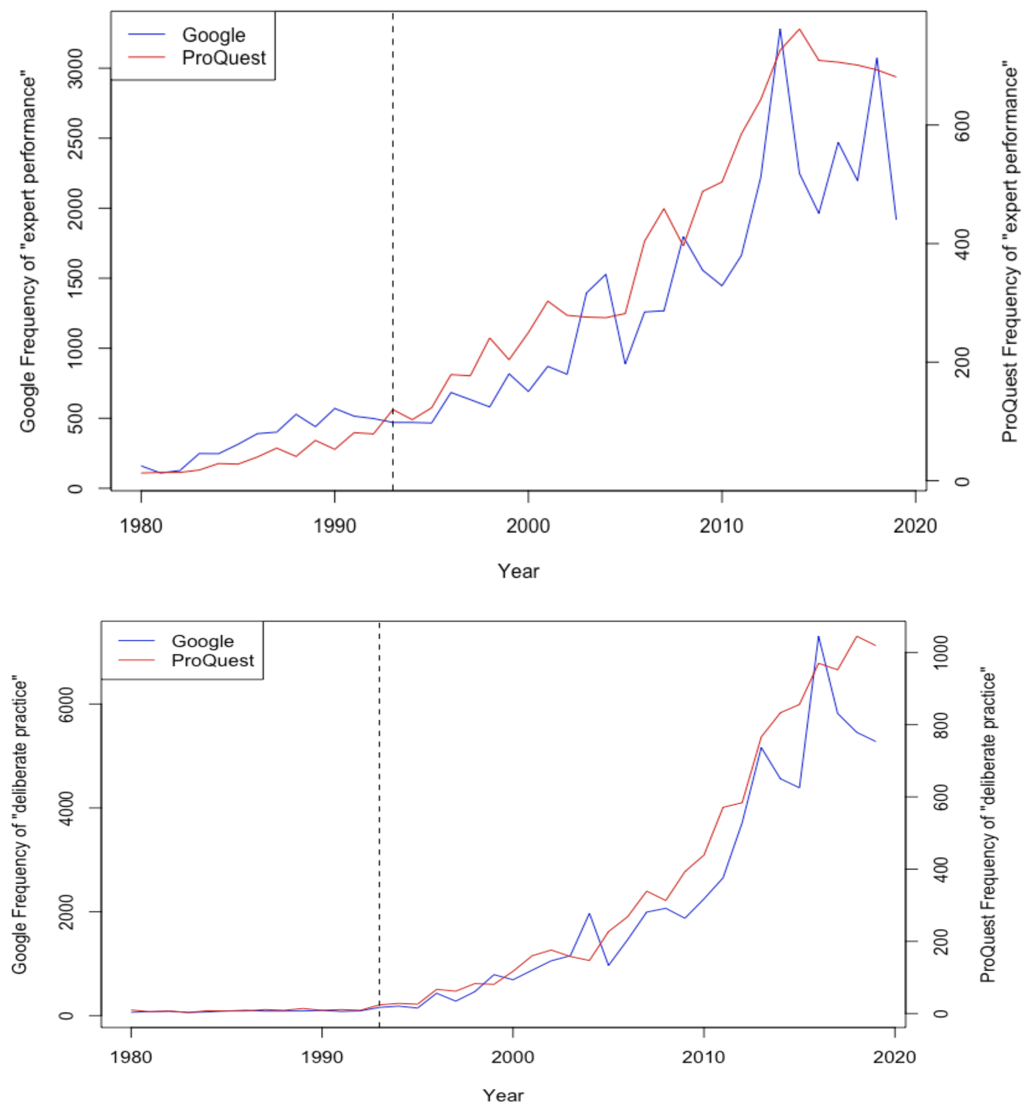

Figure 1. The frequency of appearance of "expert performance" (top) and "deliberate practice" (bottom) in printed material within Google's text corpus database (blue) and the number of records identified by these keywords in ProQuest academic databases (red) from 1980 to 2019. Dashed line denotes the publication year of Ericsson et al. (1993).

Unfortunately, many interpretations of the expert performance approach are incomplete or even incorrect. Nevertheless, these misconceptions have gained wide acceptance, perhaps because Ericsson waited until 2016 to explicate his research to a non-scholarly audience in a popular book, co-authored with journalist Robert Pool, entitled *Peak: Secrets from the New Science of Expertise*. While a complete summary is beyond the scope of the present discussion, we have selected key arguments from *Peak* as well as Ericsson's academic publications to address four common misconceptions: (1) anyone can become an expert by putting in 10,000 hours of any kind of practice, (2) the expert performance approach is exclusively concerned with deliberate practice, (3) expert performers can be identified based on reputation or experience, and (4) Ericsson's claims require that a majority of the variance in performance is explained by deliberate practice. We conclude by suggesting promising new directions for integrating the expert performance approach into applied settings.

Misconception #1: Anyone Can Become an Expert by Putting in 10,000 Hours of any Kind of Practice

Some people outside academia may recognize the name of K. Anders Ericsson, but many more have heard of the "10,000-hour rule" and widely interpreted it to mean that logging this magic number of practice hours is necessary and sufficient for becoming world-class at what you do. This term was first popularized by Malcom Gladwell (2011) in *Outliers*—a book which itself is an outlier in that it has maintained a spot on the *New York Times* best seller list for hundreds of weeks. Gladwell recounts a study of expert musicians conducted by Ericsson et al. (1993), noting that the top performers had accumulated around 10,000 hours of practice by age 20 and concluding, "Researchers have settled on what they believe is the magic number for true expertise: ten thousand hours" (Gladwell, 2011, pp. 39-40). Similarly, in *The Talent Code* (2009), Daniel Coyle wrote, "Along with researchers like Herbert Simon and Bill Chase, Ericsson validated hallmarks like the Ten-Year Rule, an intriguing finding dating back to 1899, which says that world-class expertise in every domain (violin, math, chess, and so on) requires roughly a decade of committed practice" (pp. 51-52), later referring to this as the "Ten-Year/Ten-Thousand-Hour Rule." And in *Moonwalking with Einstein*, Joshua Foer (2011) describes Ericsson as having "achieved a degree of popular fame in recent years thanks to his research showing that experts tend to require at least ten thousand hours of training to achieve their world-class status" (pp. 53-54).

In actuality, Ericsson's research suggested that the development of expert performance depends as much on quality of practice as on quantity. In *Peak*, Ericsson suggests that the simplified message received by the public lacked the nuance that the authors of these books tried to communicate: "Although Gladwell himself didn't say this, many people have interpreted [the 10,000-hour rule] as a promise that almost anyone can become an expert in a given field by putting in ten thousand hours of practice. But nothing in my study implied this" (Ericsson & Pool, 2016, p. 112). He continues, "Becoming accomplished in any field in which there is a well-established history of people working to become experts requires a tremendous amount of effort exerted over many years. It may not require exactly ten thousand hours, but it will take a lot" (Ericsson & Pool, 2016, p. 112). Most important, much of the narrative in *Peak* is devoted to the distinction between less and more effective types of practice, and we have summarized Ericsson's classification of practice activities in Table 1. For example, *naive practice* is characterized as "doing something repeatedly, and expecting that the repetition alone will improve one's performance" (Ericsson & Pool, 2016, p. 14). This approach is quite typical for individuals who wish to develop a new skill and do not have the motivation or resources to seek out a teacher or coach to guide their training. A primary limitation of naive practice is that it often leads to reaching a performance plateau once the period of automaticity has been achieved.

Table 1. Ericsson's Classification of Differentiated Practice[1]

Practice feature	Deliberate practice	Purposeful practice	Naive practice
Repeated engagement in domain-related activities	✓	✓	✓
Practice has an explicit goal for improvement	✓	✓	
Complete attention is devoted toward the practice task	✓	✓	
Each performance trial has immediate formative feedback	✓	✓	
The trainee has the opportunity to repeatedly perform the same or similar tasks	✓	✓	
Individualized design of effective practice with adaptive difficulty	✓	✓	
Teacher initiates appropriate sequence of training and provides explicit instructions about the best method for improvement	✓		

Purposeful practice, which Ericsson and Pool (2016) suggest is a more effective alternative, can be differentiated from naive practice by several necessary criteria. First, purposeful practice must have well-defined, specific goals. Establishing a specific goal for each practice session allows an individual to make judgements about the quality of their performance and make comparisons over time. The second criterion is that a training activity must be "focused," requiring full attention to the present practice activity. Third, purposeful practice activities must incorporate some mechanism through which the learner can receive feedback. Such feedback is critical for identifying areas for improvement and designing future practice activities to address them. The fourth is that "purposeful practice requires getting out of one's comfort zone" (Ericsson & Pool, 2016, p. 17) or attempting to achieve some performance just beyond one's current level of skill. This criterion shifts the objective of training from achieving automatic performance of well-established skills to one of continual development of new domain-relevant abilities.

Finally, *deliberate practice* is "the gold standard" for training for any skill (Ericsson & Pool, 2016, p. 84). While deliberate practice shares many features with purposeful practice, there are two important differences. First, deliberate practice is viable only for well-developed domains "in which the best performers have attained a level of performance that clearly sets them apart from people who are just entering the field" (Ericsson & Pool, 2016, p. 98). Such established domains are likely to have not only a long recorded history against which to compare modern performers, but also a sufficiently large accumulation of knowledge about techniques for training new generations of experts. The second major difference between deliberate and purposeful practice is that "deliberate practice requires a teacher who can provide practice activities designed to help a student improve his or her performance" (Ericsson & Pool, 2016, p. 98). A knowledgeable teacher or coach takes up the responsibility of designing practice activities and providing feedback for deliberate practice, in contrast to the learner-designed activities in purposeful practice. Deliberate practice is therefore both "purposeful and *informed"* (p. 98, emphasis original).

Notably, the focus on the relationship of practice hours to attained performance without accounting for different types of practice is also present in the scientific literature. For example, Macnamara et al. (2014, 2016) challenged Ericsson's proposed account of skill acquisition, claiming that deliberate practice failed to account for the majority (i.e., more than 50%) of the variance in performance measures in their meta-analyses. We will return to the issue of "variance explained" later in this review, but for now, we consider Ericsson's critique of Macnamara and colleagues' interpretation of the sorts of activities that qualified as deliberate practice. He notes that their broad criteria (i.e., "engagement in structured activities created specifically to improve performance in a domain," Macnamara et al., 2014, p. 914) did not reflect the type of systematic, targeted training that he observed in his original studies of the practice histories of expert performers (Ericsson, 2016, 2020a, 2020b; Ericsson & Harwell, 2019; Ericsson et al., 1993). Aggregating estimates across practice types (e.g., combining hours spent in naive practice with hours spent in deliberate practice) may lead to underestimating the importance of quality practice for development of expert performance.

Ericsson (2016; Ericsson & Harwell, 2019) also points out that many of the studies included by Macnamara et al. (2014, 2016) provided very little information about the practice activities included in their estimates of accumulated practice, which makes appropriate classification difficult. To better approximate the relationship between practice and performance, future studies should include more detailed reporting on the type of training activities beyond just estimates of the amount of total practice time. Ideally, typical training activities would be elicited from expert performers or their teachers, and they would be categorized according to the criteria described here to facilitate appropriate comparisons across studies, domains of performance, and categories of practice.

Misconception #2: Deliberate Practice Is All There Is to the Expert Performance Approach

Popular accounts of Ericsson's research associate him with the claim that it takes many hours of practice to achieve expertise but often devote far less space to the specific changes in behavior that result from practice. In many of the stories, expertise tends to be described in terms of initial and ending states, and practice is portrayed as a struggle necessary to get from point A to point B rather than represented as a dynamic developmental process. Omitting technical discussion of the mechanisms through which practice influences performance is understandable for books published for a lay audience, but more surprising is the observation of this trend in the scientific literature. Several prominent expertise scholars have published reviews that use the term "deliberate practice view" (e.g., Hambrick et al., 2014; Hambrick et al., 2018; Hambrick et al., 2020; Macnamara et al., 2014; Macnamara et al., 2016) or, alternatively, "deliberate practice theory" (e.g., Macnamara & Maitra., 2019; Ullén et al., 2016) to refer to Ericsson's views on the importance of deliberate practice for expert performance, with some going so far as to "raise serious concerns about the viability of the deliberate practice view as a scientific theory" (Hambrick et al., 2020, p. 12). But these published critiques nearly exclusively focus on deliberate practice as a predictive variable and largely disregard another critical feature of the expert performance approach: the role of mental representations.

In addition to arguing for the importance of deliberate practice, the expert performance framework also proposes theoretical mechanisms that mediate experts' superior performance (see Figure 2). Ericsson (2018d) asserts that expert performance can be largely attributed to the development of increasingly sophisticated domain-specific mental representations. Students work to refine their mental representations of the target performance to match the model presented by their coach or teacher. Through engaging in extensive practice, they gradually modify behaviors and monitor how they influence performance outcomes. By developing their abilities to discriminate and reduce differences between their own performance and the goal performance, students eventually obtain sufficiently similar representations and are able to replicate it. The framework hypothesizes that engagement in this process over many, many iterations explains the acquisition of expert performance (Ericsson & Charness, 1994; Ericsson et al., 1993). Experts are able to demonstrate high levels of performance because these representations allow them to execute more complex and effective behaviors and strategies that are unavailable to novices. This is facilitated by enhanced information processing through retrieval of organized structures stored in long-term memory (Ericsson, 2018c; Ericsson & Kintsch, 1995). Ericsson et al. (1993) argued that engaging in extensive deliberate practice is an effective method for developing mental representations and proposed that individuals accumulating more deliberate practice should, on average, display superior performance to those with less deliberate practice.

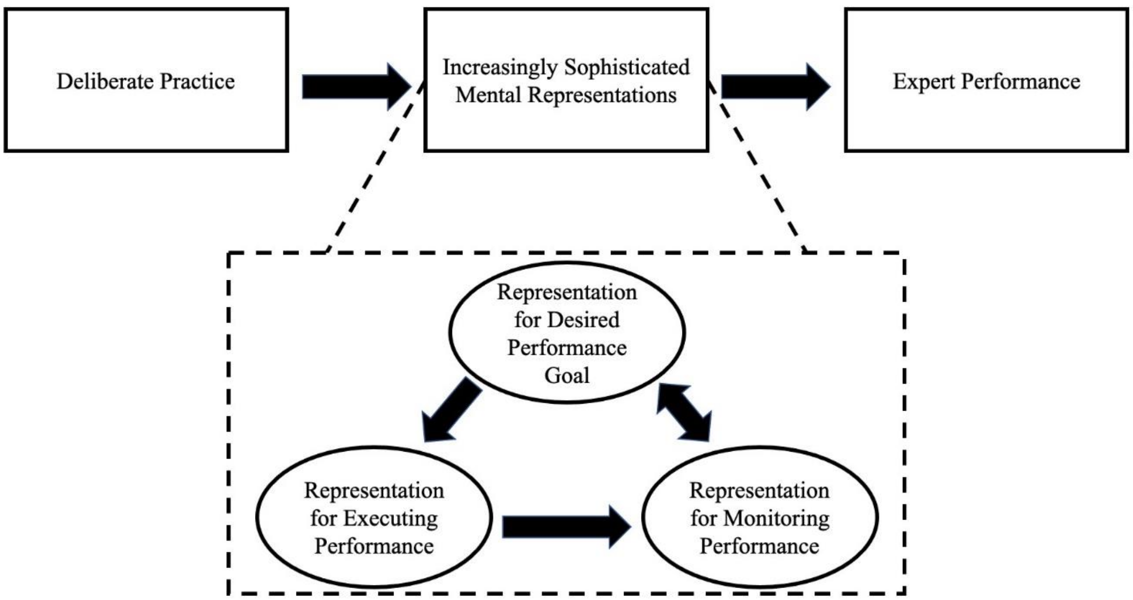

Figure 2. The often-overlooked proposed mediating mechanism in Ericsson's expert performance framework. Adapted with permission from figure 38.4 in K. A. Ericsson (2018), "The differential influence of experience, practice, and deliberate practice on the development of superior individual performance of experts," *The Cambridge Handbook of Expertise and Expert Performance* (p. 757).

The expert performance framework arose from the tradition of studying the cognitive states of expert performers during performance of representative tasks in controlled environments (Charness, 2021, this issue; Ericsson, 2018d). Process tracing techniques such as verbal protocol analysis (Ericsson & Simon, 1980) have been used to successfully study and validate changes in cognitive processes and strategies with increasing skill. Ericsson and Pool (2016) provide an example of this, highlighting Roger Chaffin's work with international concert pianist Gabriella Imreh. By examining Imreh's thoughts spoken aloud during preparation to play a difficult concerto, as well as video recordings of her practice sessions, Chaffin gained insight into her mental representations and how they changed over time. For instance, Imreh reported that she first sight-read the piece to develop an "'artistic image'—a representation of what the piece should sound like when she performed it" (Ericsson & Pool, 2016, p. 80). She next went through the piece measure by measure to make decisions on such techniques as finger positioning or whether to change her timing or emotional expression at certain points. Across numerous practice sessions, she made notes on the printed score to keep track of the changes she wanted to experiment with. Over time, Chaffin observed a transition in Imreh's focus from playing the piece correctly (which had become more or less automatic) to these more nuanced features that characterize world-class musical performance. Ericsson claims this is evidence she had constructed a mental map of the piece and that "her mental representations combined what she thought the music was supposed to sound like with what Imreh had figured out about how to make it sound that way" (Ericsson & Pool, 2016, p. 81).

Process tracing methods have long been a valuable tool for studying experts (Charness, 2021, this issue; Ericsson, 2018b); however, as the field has evolved, we have seen a shift in the ways that researchers conceptualize and investigate the phenomenon of expertise. This shift has coincided with an increased focus on identifying variables that correlate with performance rather than investigating the underlying processes that mediate performance. An illustrative example is the model proposed by Ullén et al. (2016). As the authors describe it, "An essential difference between deliberate practice theory and the [multifactorial gene-environment interaction model] is that the latter assumes, as a central tenet of the model, that expert performance can be influenced directly by a number of other variables than practice… These could potentially include different modalities of psychological individual differences—abilities, personality, interests, social attitudes, motivational variables—as well as physical traits"[2] (p. 438). Contrasting with the expert performance approach's "bottom-up" strategy of observing expert performers and attempting to isolate the behavioral differences that distinguish them from novices, it appears that proponents of an individual differences-focused model have adopted a more "top-down" view. To accept this perspective, one must begin with a general principle, specifically the existence of latent factors that correlate with performance differences, and then infer mechanisms for how they might causally influence performance. However, the effects of these factors on performance must also be traceable through observable differences in participants' thoughts and behaviors. It is surprising, then, that surveying journals that regularly publish studies of expertise reveals comparatively few experimental investigations of the processes that mediate experts' superior performance.

There is no question that deliberate practice is one of the most defining features of the expert performance framework. However, any thorough discussion of Ericsson's views of skill acquisition, whether in support or in disagreement, must also address the central role of mental representations in expert performance. Ericsson's early work established a standard for scientifically decomposing expertise in the laboratory (Charness, 2021, this issue), and we contend this approach is as valuable today as it was decades ago. Indeed, its focus on monitoring changes in thinking and behavior has already been applied to reform training in disciplines such as sport (Williams et al., 2018) and medicine (Ericsson, 2004, 2007, 2015; Hashimoto et al., 2015). Additional studies of the detailed mechanisms of expert performance will be crucial as researchers look toward designing more effective training programs across a variety of new domains.

Misconception # 3: Expert Performers Can Be Identified by Reputation Alone

In a 2016 interview, television host Larry King questioned Ericsson about the meaning of "expert," asking whether various famous people, including Leonardo DiCaprio, Serena Williams, and Steve Jobs, would be considered experts by Ericsson's standards. Ericsson explained, "I think there are two different ways of thinking about experts—you can either be an expert because other people, including yourself, claim that you're an expert [. . . But,] what we're interested in are people who really can objectively demonstrate their superior performance" (Ericsson, 2016). Ericsson went on to describe the distinction between people who have demonstrated such performance and other experts who have merely accumulated many hours of experience or who are popular within a given field. As illustrated by a 2018

Newsweek article entitled “Trump has been in office for 10,000 hours, does that make him an expert president?” (Croucher, 2018) and a 2017 *Huffington Post* article titled “10,000 hours of love” (Paul, 2017), there are significant inconsistencies between the public’s notions of expertise and the narrower brand of expert performance that Ericsson studied. Likewise, many of the previously mentioned popular books present Ericsson’s work alongside examples of people who had attained significant professional success or popularity. However, while these qualities may confer high social status, they are not necessarily diagnostic of differences in domain-specific performance.

Ericsson and Pool (2016) summarized the issue: “This distinction between knowledge and skills lies at the heart of the difference between traditional paths toward expertise and the deliberate-practice approach. Traditionally, the focus is nearly always on knowledge. Even when the ultimate outcome is being able to do something—solve a particular type of math problem, say, or write a good essay—the traditional approach has been to provide information about the right way to proceed and then mostly rely on the student to apply that knowledge. Deliberate practice, by contrast, focuses solely on performance and how to improve it” (p. 131). In the first and second editions of the *Cambridge Handbook of Expertise and Expert Performance,* of which Ericsson was the lead editor, he opens with a discussion of the differences between expertise and expert performance (Ericsson, 2006a, 2018a). Referencing dictionary and encyclopedia definitions of “expert,” Ericsson proposes that expertise “refers to the characteristics, skills, and knowledge that distinguish experts from novices and less experienced people” (Ericsson, 2006a, p. 3). Noting that expertise is a much broader concept with a wide variety of qualifying features, he distinguishes it from expert performance, or “superior reproducible performance of representative tasks [that] capture the essence of their respective domains” (Ericsson, 2006a, p. 3). Additionally, peer nomination for expert status might be influenced by secondary and nonspecific factors, such as popularity, a person’s years working in the field, or their number of presentations or performances (Ericsson, 2018d). While these metrics may be useful for establishing that a person is experienced or well-respected in a particular domain, they are less useful for assessing current levels of performance. Put another way, expert performers have achieved expertise, but not all people with expertise have achieved or maintained expert performance. Ericsson and colleagues therefore set out to understand the origins of elite performance, and their theoretical model and the role of deliberate practice within that model were based primarily on investigations of highly skilled performers (Ericsson et al., 1993; Ericsson & Charness, 1994; Ericsson & Smith, 1991). This research strategy of investigating a relatively small number of expert performers directly contrasts with the modern trend of large-sample correlational studies of expertise.

Two notable limitations of the individual differences approach to studying expertise raise questions about its generalizability to expert performance. First, collecting detailed behavioral data from a large number of participants is challenging, so it is common to instead deploy survey techniques where participants respond to self-report items related to the domain being studied. Or, if objective estimates of performance are desired but not available through established measures used by the field, it is common for the researchers to develop novel tasks that test general skills instead of using indicators more representative of holistic performance (e.g., testing note discrimination or sight-reading ability instead of evaluating performance of a studied piece of music) (Ericsson, 2016; Ericsson & Harwell, 2019). However, in many cases it is difficult to determine how accurately these measures capture differences in expert-level performance. By contrast, if one musician is consistently rated more highly than another by a diverse group of judges, or if one chess player has achieved a better chess rating (based on their record of wins and losses at certified tournaments) than another player, it is clear which individual would be considered more skilled. In the case of interpreting differences in self-reported estimates of skill or novel performance measures, it is important to establish the degree to which these measures correlate with the accepted indicators and make generalized claims within the constraint of that relationship.

Another relevant issue is that many of the correlational studies of expertise present data from large samples drawn from the general population of performers. The statistical models employed are usually dependent upon having large samples (hundreds of participants) and recruiting that many individuals displaying superior performance is often infeasible. Instead, it is much more common to assume that, in regard to the influence of individual difference factors on performance, experts represent the extremes of a general distribution of performers (but see Ericsson, 2014). Thus, these studies observe patterns in a sample of lower-skilled individuals and then extrapolate their findings when discussing expert performance. For this assumption to hold, it must be true that these factors influence performance to a similar degree across different levels of performance. However, as it currently stands, there is limited evidence to support the claim that the individual differences that may play an important role in discriminating performance among novice performers also reliably explain performance differences at the highest levels of skill (see Burgoyne et al., 2016; Ericsson, 2014; Ericsson & Harwell, 2019). To that end, we recommend future studies use ecologically valid measures for estimating performance differences. Additionally, whenever possible, it is advisable to recruit a sample of individuals expected to display reproducible superior performance relative to the general population of performers. These efforts will strengthen claims regarding the generalizability of a study's findings to the population of expert performers.

Misconception # 4: Ericsson's Claims Require That a Majority of the Variance in Performance Is Explained by Deliberate Practice

As is often the case when scientists produce path-breaking research, Ericsson's work has drawn substantial criticism from fellow scholars (e.g., Moreau, 2019; Hambrick et al., 2020) and journalists (e.g., Epstein, 2014). These critiques are based in part on interpretations of Ericsson's own findings, such as David Epstein's contention in *The Sports Gene* that deliberate practice "only" accounted for 28 percent of the variance in a study of expert darts players (Epstein, 2013, p. 37), as well as meta-analytic research that found, for example, that deliberate practice accounted for 26% of the variance in performance in games (e.g. chess, Scrabble), 21% of the variance of performance in music, and 18% in sports (Macnamara et al., 2014). Based on these effect sizes, the authors of the meta-analysis argued that "deliberate practice is important, but not as important as has been argued" (Macnamara et al., 2014, p. 1608). Leaving aside, for a moment, the ongoing debate about how deliberate practice and performance were defined in these meta-analyses,[3] and assuming the effects are valid indicators of the relationship between these variables, what about these effect sizes is underwhelming? They are *much* larger than what is typically observed in psychological science. In fact, a recent project reviewed 708 meta-analytically derived correlations in the social and personality psychology literatures and found that the average variance explained was 3 to 4% (Gignac & Szodorai, 2016).[4]

Surprisingly, researchers have implied that 50% variance explained and above as being a reasonable benchmark for validating Ericsson's claims about expert performance. For example, following a meta-analysis on the relationship between deliberate practice and sports, Macnamara and colleagues remarked that Ericsson's claims were not supported because "deliberate practice did not account for nearly all or even the majority (> 50%) of the variance in sports performance" (Macnamara et al., 2016, p. 346). Is greater than 50% variance a reasonable expectation to validate Ericsson's claims that deliberate practice is the major driver of expert performance? We do not think so. First, the reliability of the measures of expertise and, especially, of the quantity of deliberate practice that a person engages in are far from perfect. As a result, computed effect sizes are very likely to be attenuated. For example, Ericsson and Harwell (2019) reexamined Macnamara and colleagues' (2014) meta-analysis dataset, and after adjusting for attenuation of effect size based on reliability estimates, they found that deliberate practice explained approximately 61% of the variance in performance, up from around 29% uncorrected.[5] Second, factors that have little to do with the performers themselves, such as luck, can play a large role in why some individuals achieve success (Liu & De Rond, 2016: Mauboussin, 2012). This concern may be especially true in expert samples in which there is restriction on range in skill (Mauboussin, 2012). Measurement error and luck are examples of *unsystematic variance* that may greatly reduce the overall proportion of expert performance that can be explained by any individual predictor.

Rather than merely comparing the amount of explained versus unexplained variance in performance that can be accounted for by deliberate practice, we recommend interpreting effect sizes that are meaningful in context (see Funder & Ozer, 2019). One way to do this is by benchmarking effect sizes against other measured predictors of performance to gain an intuitively useful comparison of the magnitude of each effect. For example, the finding that deliberate practice explains 26% of the variance in performance in games like Scrabble and chess (Macnamara et al., 2014) is much more meaningful when benchmarked against the meta-analytic finding that measures of intelligence explain 1% of the variance in chess skill for ranked adult chess players (Burgoyne et al., 2016). In the context of such comparisons, it is more understandable why Ericsson and colleagues contend that deliberate practice provides "a sufficient account of the major facts about the nature and scarcity of exceptional performance" (Ericsson et al., 1993, p. 392). It remains to be seen whether future research on individual differences will reveal other factors (or a combination of factors) that exert comparably large influence on expert performance. However, in our view, considering the large differences in variance that is explained by deliberate practice and other common individual difference measures (Ericsson, 2018c, Ericsson & Harwell, 2019), the empirical support for Ericsson's original hypothesis currently remains intact.

Conclusion and Future Directions

In this review, we addressed four misconceptions that depart from the claims of the expert performance approach proposed by K. Anders Ericsson. First, we countered the notion that accumulating 10,000 hours of any kind of practice is necessary and sufficient for achieving expert performance. Second, we noted the serious omission, in both popular and scientific work, of mental representations as mediating the effects of deliberate practice on skill development. Third, we challenged the assumption that expert performance can be inferred through reputation rather than directly assayed through reproducible superior performance. Finally, we addressed the common practice of comparing the effects of deliberate practice on performance against "unexplained variance" and argued that, instead, researchers should compare the effects of deliberate practice with the effects of other measured predictors.

Given these corrections, how can we make progress toward Ericsson's career-defining mission: the identification of "optimal training conditions for improving the reproducible objective performance in domains of expertise"? (Ericsson & Harwell, 2019, p. 16). Ericsson noted that the majority of training activities that individuals engage in within the two most common learning environments, work and school, would not qualify as deliberate or even purposeful practice (Ericsson & Pool, 2016; Plant et al., 2005), but this is not to say that meaningful changes are impossible. In particular, Ericsson argued for the development of "new skills-based training programs that will supplement or completely replace the knowledge-based approaches that are the norm now in many places...training should focus on doing rather than on knowing—and, in particular, on bringing everyone's skills closer to the level of the best performers" (Ericsson & Pool, 2016, p. 137-138). Currently, systematic comparisons of traditional training and programs that instead reflect the expert performance approach (e.g., Deslauriers et al., 2011) are rare but show promising results. Regardless, individuals who come to appreciate the insights Ericsson accumulated over more than four decades of study can, without delay, improve the process by which they pursue their personal long-term performance goals.

Anyone who knew Anders Ericsson personally can attest to his optimistic view of the human potential for greatness, as well as his passion for making the insights of the expert performance approach accessible and practical to as many people as possible. This spirit is perhaps best captured by the closing passage of *Peak*:

> Ultimately, it may be that the only answer to a world in which rapidly improving technologies are constantly changing the conditions under which we work, play, and live will be to create a society of people who recognize that they can control their development and understand how to do it. This world of *Homo exercens* may well be the ultimate result of what we have learned and will learn about deliberate practice and the power it gives us to take our future into our own hands. (Ericsson & Pool, 2016, p. 259

Endnotes

1. Ericsson also used the term *structured practice* as a catchall phrase to describe any type of organized practice (Ericsson & Harwell, 2019; see Huetterman et al., 2014). Structured practice may include deliberate practice, purposeful practice, or naive practice depending on the characteristics of a particular training session. It may also describe group practice—which is also not listed above (Ericsson, 2020a, 2020b).
2. It should be noted that Ericsson, too, felt that physical traits, such as "height and body size" (Ericsson et al., 2007, p. 41) were important factors for expertise in certain sports. He also argued that personality factors "such as individual differences in activity levels and emotionality may differentially predispose individuals toward deliberate practice" and to "sustain very high levels of it for extended periods" may play an important role in the acquisition of expertise (Ericsson et al., 1993, p. 393).
3. Ericsson and Harwell (2019) provided a review of these meta-analyses, arguing that Macnamara et al. (2014; 2016) operationalized deliberate practice and expert performance in ways that were inconsistent with Ericsson and colleagues' original framework (1993). In response, Hambrick, Macnamara, and Oswald (2020) argued that deliberate practice has been inconsistently defined, making it difficult to operationalize the construct for empirical testing.
4. The study reported that the mean-level effect size across studies was r = .19, which, when converted to variance explained, equals 3.61%. However, see Funder and Ozer (2019) for limitations of using R-squared as an effect size metric.
5. In addition to adjusting for attenuation of effect size, Ericsson and Harwell (2019) also excluded studies from the Macnamara et al. (2014) meta-analysis that could not reasonably be considered as tests of the expert performance framework. For example, studies of students listening to lectures in classrooms (which is a clear deviation from the type of highly focused, feedback-driven practice Ericsson prescribed) and studies that used performance measures unrepresentative of skill in the domain were excluded.

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Authors' Declarations

The authors declare there are no personal or financial conflicts of interest regarding the research reviewed in this article.

The authors declare that the research review reported in this article was conducted in accordance with the Ethical Principles of the *Journal of Expertise*.

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Submitted: 29 March 2021
Accepted: 19 April 2021