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Summing Up Hours of Any Type of Practice Versus Identifying Optimal Practice Activities: Commentary on Macnamara, Moreau, & Hambrick (2016)

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Abstract

In their original article, Ericsson, Krampe, and Tesch-Römer (1993) reviewed the evidence concerning the conditions of optimal learning and found that individualized practice with training tasks (selected by a supervising teacher) with a clear performance goal and immediate informative feedback was associated with marked improvement. We found that this type of *deliberate practice* was prevalent when advanced musicians practice alone and found its accumulated duration related to attained music performance. In contrast, Macnamara, Moreau, and Hambrick's (2016, this issue) main meta-analysis examines the use of the term *deliberate practice* to refer to a much broader and less defined concept including virtually any type of sport-specific activity, such as group activities, watching games on television, and even play and competitions. Summing up every hour of any type of practice during an individual's career implies that the impact of all types of practice activity on performance is equal—an assumption that I show is inconsistent with the evidence. Future research should collect objective measures of representative performance with a longitudinal description of all the changes in different aspects of the performance so that any proximal conditions of deliberate practice related to effective improvements can be identified and analyzed experimentally.

Keywords

deliberate practice, expert performance, expertise

Macnamara, Moreau, and Hambrick (2016, this issue) identified a single value that measures all types of accumulated practice during an individual's career by simply adding up all hours of any type of practice and then correlating the sum with attained performance. In direct contrast, Ericsson, Krampe, and Tesch-Römer (1993) searched for evidence on "conditions for optimal learning and improvement of performance" (p. 367), where "[T]the most cited condition concerns the subjects' motivation to attend to the task and exert effort to improve their performance. . . . The subjects should receive immediate informative feedback and knowledge of results of their performance. The subjects should repeatedly perform the same or similar tasks" (p. 367). As an example, we cited Chase and Ericsson's (1982; Ericsson, 2013a) study of a college student who improved his memory span from 7 to 82 digits (an effect size [*d*] that exceeds 50) by acquiring components of skill verified by experiments. We argued that this type of effective training had been developed in real-world domains of expertise, where aspiring musicians are given individualized instruction and "the teacher designs practice activities that the individual can engage between meetings with the teacher. We call these practice activities *deliberate practice*" (p. 368). We collected data on objective performance of representative tasks that capture the essence of expertise in music, such as success at music competitions and blind ratings of the musical quality of taped music performance. We found that the estimated amount of engagement in practicing alone while improving teacher-recommended aspects of their performance was related to musicians' attained levels of objective music performance. Ericsson and Lehmann (1996) stated clearly that

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deliberate practice referred to "the individualized training activities specially designed by a coach or teacher to improve specific aspects of an individual's performance through repetition and successive refinement." (pp. 278–279).

This theoretical framework viewed the acquisition of expert performance as a sequence of improved aspects associated with measurable changes in performance and refined mediating representations (see Fig. 1). Each successive step in the acquisition is mediated by different practice activities designed to improve measurable aspects while providing immediate feedback and opportunities for gradual improvement with repetitions (Ericsson, 2006). As skill acquisition is conceived as a process of building and refining different skills, the nature of the concrete practice activities will differ as the level of acquired performance increases. Experts have acquired skills and mechanisms, such as long-term working memory (Ericsson & Kintsch, 1995), that allow them to perform tasks that amateurs are unable to perform successfully. For example, beginners' performance is frequently correlated with their performance on general ability tests, such as IQ. In contrast experts rely on domain-specific acquired cognitive mechanisms, which replace the reliance on anything measured by tests of general abilities and thus removes correlations between such abilities and objective performances among experts (Ericsson, 2014). Consequently, studies of the effects of practice in mostly nonmusicians and amateurs (such as fraternal and identical twins) by Hambrick and Tucker-Drob (2015) and Mosing, Madison, Pedersen, Kuja-Halkola, and Ullén (2014) cannot be generalized to expert musicians. To test this claim, I restricted Hambrick and Tucker-Drob's (2015) sample to individuals who had competed in national competitions with good outcomes to find individuals comparable to the musicians studied by Ericsson et al. (1993). There were only two pairs of identical twins (2/507 = 0.004) in which both twins met the criteria and five cases in which only one of the identical twin pairs reached the specified high level—the concordance pattern was similar for fraternal twins (National Merit Twin Study, 2014). Similarly, the proportion of prize-winning musicians was only 0.0045 in Mosing et al.'s (2014) study, which included adults singing in choirs as practice (Ullén, 2014).

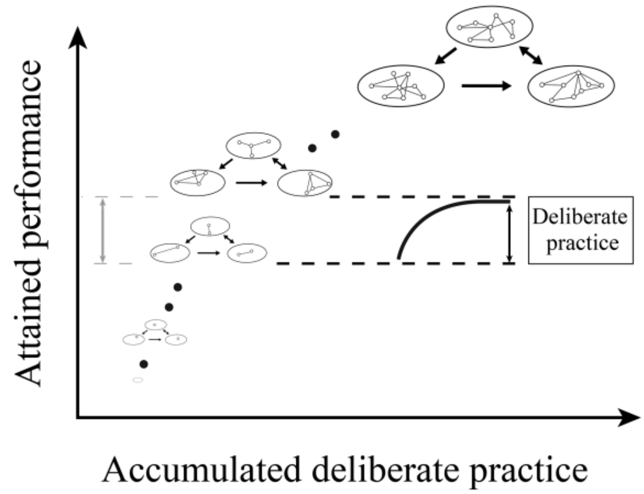

Fig. 1. A schematic illustration of the acquisition of expert performance as a series of states with increasingly complex representations for planning (top oval in each triplet), for executing a plan (left bottom oval), and for monitoring performance (right bottom oval) that mediate superior performance and further improvements of specific aspects of performance. (Adapted from "The Scientific Study of Expert Levels of Performance Can Guide Training for Producing Superior Achievement in Creative Domains" by K. A. Ericsson in proceedings from *International Conference on the Cultivation and Education of Creativity and Innovation* (p. 14). Beijing, China: Chinese Academy of Sciences. Copyright 2009 by International Research Association for Talent Development and Excellence).

Deliberate Practice in Sports

A reasonable translation of our definition (Ericsson et al., 1993) of deliberate practice in music to the domains of sports would search for one-on-one instruction of an athlete by a coach, who assigns practice activities with explicit goals and effective practice activities with immediate feedback and opportunities for repetition. This type of individualized one-on-one instruction is, however, quite infrequent in sports. Rare estimates for this type of practice is available for rhythmic gymnastics (Law, Cote, & Ericsson, 2007) and as one component of training by international and national athletes (Baker, Côté, & Abernethy, 2003a, 2003b). Both estimates showed a very high point-biserial correlation between amounts of coach-led individual training and performance for international and national athletes (r_{pb} = 0.87, calculated from a t of 9.5 in Baker, Côté, & Abernethy, 2003a; Baker et al., 2003b) and (r_{pb} = .92; Law et al., 2007), yet both estimates were excluded from Macnamara et al.'s (2016) meta-analysis.

Macnamara et al. (2016) searched for a single estimate of individuals' total amount of accumulated practice during their career in sports using the same procedure as Macnamara, Hambrick, and Oswald (2014). After reviewing their collected estimates, they found that 9 of the 52 identified effect sizes (17%) were not even pure estimates of different types of practice, but these 9 estimates analyzed by Macnamara et al. (2014) included hours for play and competition. Most of their other estimates of practice reflected a mixture of very different sport-specific activities. For example, Baker et al. (2003a) estimated correlations with performance for several types of activities—such as "Watching games on television," "Weight training," and "Organized training"—that ranged from −0.51 to 0.62 and then calculated an average correlation of 0.17 for the study and included it in their meta-analysis. Similar evidence for different effects of accumulated practice activities was found in Young's (1998) dissertation, where the total sum of all practice had a nonsignificant correlation (r = 0.12) with performance for middle distance runners. In the published reanalysis of the males in this study (the vast majority of participants), Young and Salmela (2010) found that accumulated estimates of several specific training activities, such as weight training for power, significantly differentiated national-level, regional-level and club-level male runners. Macnamara et al. (2016) only included the nonsignificant correlation with total sum of all practice (Young, 1998) and disregarded the significant correlations with specialized training activities (Young & Salmela, 2010).

In contrast to our efforts to focus on objective measures of performance, Macnamara et al. (2016) included subjective ratings by a single coach and categorical variables, such as being selected or not selected to a national team. Their meta-analysis showed that subjective ratings by coaches revealed reliably lower correlations with practice. Without an objective performance measure it is not possible to measure the individuals' changes in performance longitudinally and relate such changes to designed coach-led practice. It is also not possible to make appropriate corrections for restriction of range (Schmidt & Hunter, 2014), so studies with a wide range of performance (expert vs. amateur bowlers, r = 0.89; Harris, 2008) can be integrated with studies with a small range of performance, such as selected versus nonselected full-time athletes, which is the more typical case in studies comparing skilled individuals (Ackerman, 2014).

Conclusions

Macnamara et al.'s (2016) general assumption is simply incorrect, namely that a single sum of all hours of practice can accurately measure the effects of practice on performance. There is a fundamental difference between their estimation of the total effects of practice from analyses of correlations involving such sums (c.f. Macnamara et al., 2016) and our original study assessing whether accumulated solitary practice could predict adult performance better than chance (c.f. Ericsson et al.,1993). We had no intent to identify the upper bounds for the effects of training. It is relevant to note that surprisingly few individual characteristics have been measured that cannot be modified by designed training. One exceptional attribute is height, which cannot be changed by training yet is predictive of some sports performance and has a high heritability (Ericsson, 1990, 2000). However, according to my recent review (Ericsson, 2014), no specific genes have yet been conclusively identified that account for statistically reliable individual differences in attained expert performance.

Our two approaches would converge more if Macnamara et al. (2016) restricted their analysis to objectively measured performance and analyzed yearly estimates of hours of particular types of practice for athletes' careers, such as coach-guided individualized practice, team scrimmage, weight training, and so on, and if they then used these numerous predictors to predict individual differences in performance at different career stages in specific domains of sports. These regression analyses could even include predictors of innate characteristics, such as individual genes and physical attributes of height and body size, as I suggested recently (Ericsson, 2013b). Practice activities that successfully predict improvements in some aspect of performance can then be studied in depth to identify the detailed structure of the mechanisms mediating performance before and after that type of practice in a particular domain (see Fig. 1). As our knowledge of these effective learning processes increases, it is possible to design more effective practice environments. In these improved practice environments, the correlation between amounts of accumulated practice and attained performance will likely change, so science should focus on the invariant and generalizable aspects of acquisition of expert performance.

Declaration of Conflicting Interests

The author declared no conflicts of interest with respect to the authorship or the publication of this article.

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