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Deliberate Practice: Necessary But Not Sufficient

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Abstract

Deliberate practice (DP) occurs when an individual intentionally repeats an activity in order to improve performance. The claim of the DP framework is that such behavior is *necessary* to achieve high levels of expert performance. The proponents of the framework reject evidence that suggests that other variables are also necessary to achieve high levels of expert performance, or they claim that the relationship between those variables and expert performance is mediated by DP. Therefore, the DP framework also implies that DP is *sufficient* to achieve high levels of expert performance. We test these claims by reviewing studies on chess expertise. We found strong evidence that abundant DP is necessary (but not sufficient) and estimated that the minimum requirement to achieve master level is 3,000 hours of DP. We also review evidence showing that other factors play a role in chess skill: general cognitive abilities, sensitive period, handedness, and season of birth.

Keywords

chess, deliberate practice, expertise, skill, talent

The deliberate-practice (DP) framework (Ericsson, 2007; Ericsson, Krampe, & Tesch-Römer, 1993) proposes that the key to achieving high levels of expert performance in sports, science, and intellectual games is to dedicate a high number of hours to DP. The DP framework has taken the extreme position that innate individual differences do not constrain the top levels of performance but that performance can be further increased by DP. The DP framework rejects innate talent as an explanation for cognitive abilities, arguing that the evidence for it is weak. Rather, it proposes that expert performance is a monotonic function of the amount of DP (i.e., accumulation of practice leads to improvement or maintenance of skill). DP consists of training activities, the goal of which is to improve performance by optimizing feedback and, thus, the correction of errors. These activities, which are typically effortful and not enjoyable, should be carried out for just a few hours a day. Excessive practice is not optimal because it increases the risk of injuries and burnout (especially in sports). The proponents of DP acknowledge the involvement of inherited factors, but these are limited to motivation, general activity levels (which may influence the amount of DP), and (in some sports) height.

Meinz and Hambrick (2010) showed that DP is a necessary but not sufficient condition for music expertise. In this article, we examine this issue in chess. A number of studies have investigated the role of DP in chess skill, and now we have substantial amounts of data collected cross-culturally (Argentina, Canada, Germany, the Netherlands, Russia, United Kingdom, United States), which affords us the possibility of evaluating the role of DP in chess skill. This article will address the following questions: Is DP necessary to achieve high levels of expert performance in chess? If so, how much DP is necessary? Is DP a sufficient condition? If not, which other variables do contribute?

Is Deliberate Practice a Necessary Condition to Achieve High Levels of Expert Performance in Chess?

Following Ericsson et al.'s (1993) study of musicians, the studies having investigated the relationship between DP and chess skill used structured questionnaires to estimate the number of DP hours that players had dedicated to chess since they started playing (see Table 1). Categories of practice consisted of individual practice, group practice (including playing in tournaments), and total practice (the sum of individual and group practice). There were some differences between the studies with respect to the activities that were included in the

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Table 1. Correlations Between Skill Level in Chess and Three Types of Practice (Individual, Group, and Total)

Study	Individual practice	Group practice	Total practice	Sample size	Mean age (SD)
Charness, Tuffiash, Krampe, Reingold, and Vasyukova (2005), sample 1	.54	.41	–	239	34.7 (14.1)
Charness et al. (2005), sample 2	.48	.26	–	180	44.3 (15.9)
Gobet and Campitelli (2007)	.42	.54	.57	104	30.8 (14.6)
de Bruin, Smits, Rikers, and Schmidt (2008)	.45	.42	–	81	16.2 (2.7)
Bilalić, McLeod, and Gobet (2007)	–	–	from .76 to .90	57	10.7 (1.2)

Note: "–" indicates that the value was not reported in the original study. Correlations indicate the degree of linear relationship and range from –1 (perfect negative correlation) to 1 (perfect positive correlation). A zero-correlation indicates a total lack of relationship.

various types of practice, but these differences do not affect our main conclusions. Chess skill was measured with the Elo rating system (Elo, 1978). The world champion has above 2,800 points and an average player has 1,500 points; players who achieve 2,200 are considered masters. The international chess federation (FIDE) awards players with official titles: FIDE master (approximately 2,300 points), international master (approximately 2,400 points), and grandmaster (approximately 2,550 points).

Table 1 shows that all studies found a positive (and statistically significant) correlation between practice and chess skill, and Figure 1 shows the accumulated number of hours of DP in four chess skill levels and the frequency distribution of this variable in our 2007 (Gobet & Campitelli, 2007) study. Considering that correlations larger than .50 show strong effects, between .30 and .50 show medium effects, and between .10 and .30 show small effects, we can also identify that the effects were strong and medium in individual practice; strong, medium, and small in group practice; and only strong in total practice. The significance and magnitude of the correlations suggest that abundant practice is a necessary condition for achieving high levels of chess performance. However, these correlations describe a general trend in the population, and there might be exceptional individuals who do not need to spend much time practicing to reach high levels. Finding such uniquely talented (low-practice, high-ability) individuals would provide a striking refutation of the main claim of the DP framework. We explore this possibility in the next section.

How Much Deliberate Practice Is Necessary to Achieve High Levels of Expert Performance in Chess?

Simon and Chase (1973) estimated that between 10,000 and 50,000 hours of intense dedication to chess (including studying and playing) were necessary to achieve master level. We (Gobet & Campitelli, 2007) calculated the accumulated number of hours of practice by the time chess players had achieved master level. The minimum value was 730 hours with individual practice, 1,600 hours with group practice, and 3,000 hours with total practice. These values indicate that no individuals achieved master level after only a few hours of dedication to chess. Therefore, the evidence supports the claim that DP is a necessary condition to achieve high levels of performance in chess (i.e., even the most talented individuals need to practice).

The mean values of total practice, individual practice, and group practice when attaining master level were 11,000 hours, 4,300 hours, and 6,700 hours, respectively. These results suggest that Simon and Chase's (1973) estimate of 10,000 hours reflects the average amount of practice rather than the minimum requirement. Based on our data, we estimate that the minimum amount of time of dedication to achieve master level is 3,000 hours.

Is Deliberate Practice a Sufficient Condition to Achieve High Levels of Expert Performance in Chess?

The main criterion to support the claim that DP is a sufficient condition is that there should not be individuals who engage in abundant DP but still fail to achieve master level. Given measurement errors, this criterion may be considered too strict. Thus, we propose two additional and less stringent criteria. First, the variability on the number of hours to achieve high levels of expertise (master level in chess) should not be large. Second, everyone should benefit similarly from DP.

None of these three criteria were met in our results. First, not only were there several non-masters who dedicated more than 20,000 hours to chess, but there was also huge variability in the total number of hours of practice to achieve master level (Gobet & Campitelli, 2007): individual practice (min = 730 hr; max = 16,000 hr), group practice (min = 1,600 hr; max = 14,200 hr), and total practice (min = 3,000 hr; max = 23,600

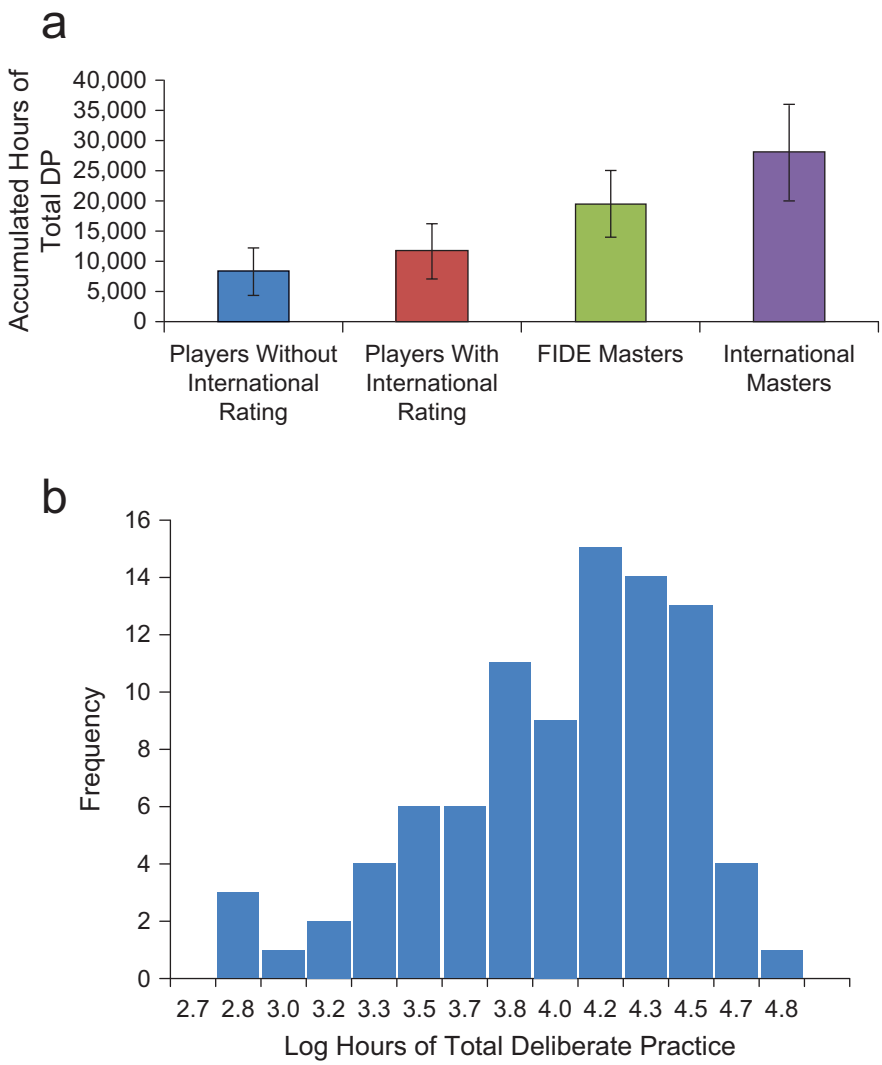

Fig. 1. Accumulated number of hours of total deliberate practice (DP; a) as a function of skill and (b) frequency distribution, based on Gobet and Campitelli (2007). In panel (a), the solid bars indicate the average accumulated number of hours of total DP in each group. The black lines at the top of the bars illustrate the standard deviations. Panel (b) shows the number of cases (frequency) in a number of intervals of hours of total DP. Note that the variable total DP was transformed logarithmically. The lowest boundary (2.67) is equivalent to 468 hr and the highest boundary (4.83) is equivalent to 67,608 hr.

hr). Second, we (Campitelli & Gobet, 2008) showed that, although titled masters and untitled international players (players with international rating but without title) did not differ in the amount of hours of practice in the first 3 years of serious dedication to chess, differences in their ratings were already apparent. This result suggests that the former benefited more from the same amount of practice than the latter.

Which Other Variables Contribute to Achieving High Levels of Performance in Chess?

Since DP is not sufficient to achieve high levels of expertise, it is important to investigate which other variables contribute to this achievement. Here we discuss general cognitive abilities, sensitive period, handedness, and season of birth.

General cognitive abilities

The relationship between chess skill and cognitive abilities has been studied with children and adults. Three studies showed that the general cognitive abilities of chess-playing children were higher than those of the general population (Bilalić, McLeod, & Gobet, 2007; Frydman & Lynn, 1992; Horgan & Morgan, 1990). Moreover, these studies showed that there was a positive correlation between chess skill and IQ.

With adults, the results were mixed: Djakow, Petrowski, and Rudik (1927) did not find evidence of above-average general intelligence or visuospatial memory in a sample of top

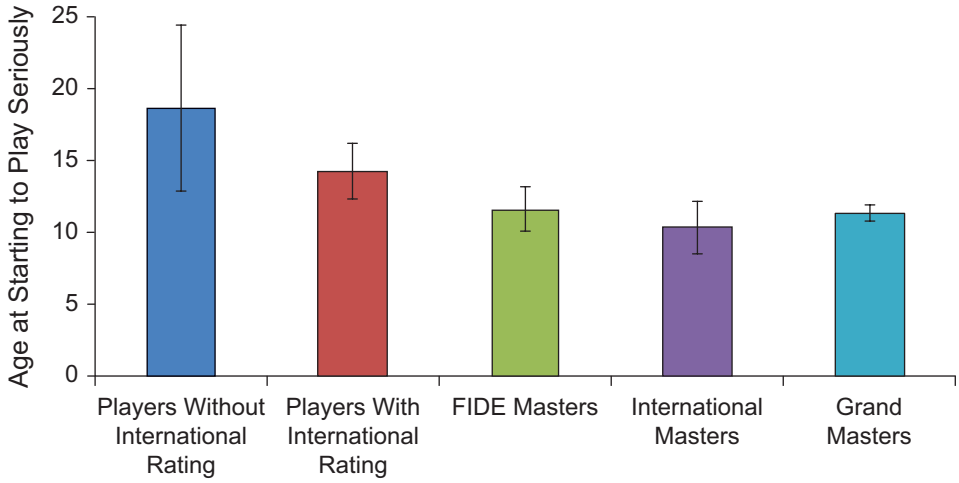

Fig. 2. Age at starting to play seriously as a function of chess skill, based on Gobet and Campitelli (2007). The solid bars indicate the average age at starting to play seriously in each group; the black lines at the top of the bars illustrate the standard deviations.

grandmasters. Waters, Gobet, and Leyden (2002) found no differences between chess players and non-chess players in a visual-memory test. On the other hand, Doll and Mayr (1987) found significant differences between chess players and control samples in the overall scores of the Berlin Intelligence Structure test, the Cattell's Culture Fair Intelligence Test, and in subtests measuring processing speed, information-processing capacity, and numeric skills. Grabner, Stern, and Neubauer (2007) found significant differences between chess players and reference samples in the verbal, numerical, and figural components of the German Intelligence Structure Test, as well as in the overall general-intelligence score. This study was the only one that found a significant correlation between chess skill and general cognitive abilities (overall score and verbal and numeric subtests) in adults. Importantly, they also found that general cognitive abilities predicted chess skill above and beyond DP.

Based on these findings, we propose three hypotheses. First, individuals with high cognitive abilities are more attracted to chess than those with lower cognitive abilities are. This is reflected in the significant difference in general cognitive abilities between chess players and non-chess players in most studies. Second, the difference in cognitive abilities within chess players influences chess performance in children. This is reflected by correlations between general cognitive abilities and chess skill in all the studies with children. Third, as soon as children start dedicating themselves seriously to chess, DP is a more important factor than general cognitive abilities. This is reflected in the lack of correlations between general cognitive abilities and chess skill in most adult studies. This shift in the role of general cognitive abilities in chess skill has been shown in Bilalić et al.'s (2007) analysis of an elite subsample of chess-playing children. This subsample had higher IQs than the rest of the sample, but the correlation between IQ and chess skill within this subsample was negative. However, Grabner et al.'s (2007) data suggest that the relationship between general abilities and chess skill may not disappear completely and that a certain level of cognitive abilities may be a necessary condition to achieve high levels of expert performance. In their study, no master had verbal IQ below 110 or numerical IQ below 115.

Sensitive period

According to Ericsson et al. (1993), the fact that children who start playing chess earlier tend to become good players supports the DP framework. Namely, the earlier they start playing, the more DP they accumulate, hence the higher the skill level. Indeed, the correlations between starting age and chess skill showed medium effects in Charness, Tuffiash, Krampe, Reingold, and Vasyukova (2005) sample 1 (−.41) and sample 2 (−.30) and Gobet and Campitelli (2007; −.37) and a large effect (−.50) in Grabner et al. (2007). Figure 2 illustrates this by showing the decrease of serious starting age as a function of skill in our (Gobet & Campitelli, 2007) study. However, this study also found that when controlling for the amount of DP, the partial correlation between starting age and skill was still significant ($r = -.40$). Almost all players who had achieved the FIDE master title or higher had started playing seriously at the age of 12 or earlier. This result suggests that starting playing chess at young ages contributes to the acquisition of expert performance beyond DP, possibly due to higher brain plasticity at younger ages.

Handedness and season of birth

These two variables are considered proxies of atypical brain development. Geschwind and Galaburda (1985) proposed that high exposure to testosterone in the uterus leads to a higher development of the brain's right hemisphere, which increases

the probability of being non-right handed (i.e., left-handed and ambidextrous). Cranberg and Albert (1988) investigated whether this may be related to chess skill by asking chess players to report their hand preference. They found a higher proportion of non-right handers in the chess population (18%) than in the general population (10 to 13.5%). However, they did not find differences between chess players of different levels. Gobet and Campitelli (2007) replicated these results. We found a proportion of 17.9% non-right handers in the chess population and a proportion of 10.2% non-right handers in a matching sample. Furthermore, we did not find differences in handedness between different skill levels.

The season in which one is born may also affect brain development, possibly due to the effect of viruses during pregnancy. Gobet and Chassy (2008) showed that expert chess players in the Northern hemisphere (N = 41,771) are more likely to be born in the first half of the year (52.3% of births). This difference is significant in comparison to a 50-50 distribution and to the birth distribution of the general population of European Union countries. Interestingly, the distribution is even more biased toward the first half of the year in chess grandmasters (56.9% of births). Unlike in physical sports, in which children compete with peers of the same age, in chess, children compete with children of different ages and with adults; thus, a dropout effect does not explain this finding.

Conclusions and Future Directions

In this review, we have presented evidence in favor of the claim that abundant DP is a necessary condition to achieve high levels of performance in chess. We estimated that a minimum of 3,000 hours of total practice is required to achieve master level. We also presented evidence against the claim that DP is a sufficient condition: None of the three criteria we proposed for practice to be considered a sufficient condition was met. Given the amount of data on chess skill, we are confident in concluding that abundant DP is a necessary but not sufficient condition to achieve high levels of skill in chess and probably in other intellectual domains. We also showed that other variables are related to expertise. Handedness and season of birth play a role in participation in chess, general cognitive abilities are important in the first stages of a chess career, and starting to play seriously at an early age is essential to achieve high levels of expertise.

As DP research has tended to focus only on practice at the expense of other factors such as innate talent, we know little about how DP activities interact with individual differences in the long path leading to expertise. We also know little about the role of genetic differences on the acquisition of expert knowledge and how they affect the benefits yielded by DP activities, although some theoretical work has been recently carried out in this direction (Chassy & Gobet, 2010). While the research reviewed in this article has generally addressed broad-brush hypotheses, future research should collect data to test specific hypotheses, some of which we have highlighted here.

Recommended Reading

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Ericsson, K.A., Prietula, M.J., & Cokely, E.T. (2007). The making of an expert. *Harvard Business Review, 85*, 114–121. A short paper that shows how deliberate practice can be applied to business.

Gobet, F., & Campitelli, G. (2007). (See References). Provides a detailed analysis of deliberate practice in chess and shows that other factors are important as well.

Simon, H.A., & Chase, W.G. (1973). (See References). A classic paper emphasizing the importance of practice in chess skill.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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