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Practice, intelligence, and enjoyment in novice chess players: A prospective study at the earliest stage of a chess career

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ABSTRACT

Previous studies have generally found no relation between IQ and chess skill in chess experts. This lack of a relation could be due to the influence of practice being more important than IQ in chess expertise. An alternative explanation is that IQ is relatively high and might therefore be restricted in range in chess experts. The current study investigated the contribution of practice, IQ and motivation to chess performance prospectively in a group of young, novice chess players in which IQ restriction of range did not play a role. Children who entered their first chess course were asked to complete weekly diaries indicating the amount of practice and their enjoyment of the course. IQ and motivation were measured using standardized tests. Using path analysis, we found that IQ and practice independently predicted chess performance on a chess test at the end of the course. Motivation influenced performance indirectly, by moderating the amount of practice that was undertaken. The results indicate that, at the early stages of expertise development, IQ and motivation influence chess performance.

1. Introduction

It has been twenty years since Ericsson's seminal paper (Ericsson, Krampe, & Tesch-Römer, 1993) on the importance of deliberate practice for achieving expert performance was published. In this classic article, the authors demonstrate how the exceptional performance of elite, German violinists was determined chiefly by their engagement in dedicated, focused practice for several hours a day, over a period of at least a decade. Ericsson's deliberate practice theory leaves no room for an influence of individual differences of an innate nature, except for height in certain sports such as basketball. Many studies have added to these findings by replicating the results in diverse domains such as soccer (Helsen, Starkes, & Hodges, 1998), martial arts (Hodge & Deakin, 1998), triathlon and swimming (Hodges, Kerr, Starkes, Weir, & Nananidou, 2004), chess (Charness, Krampe, & Mayr, 1996; Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005), music (Sloboda, Davidson, Howe, & Moore, 1996), and teaching (Dunn & Shriner, 1999). Deliberate practice was defined as practice that (1) is primarily focused at improving performance, (2) is of an adequate difficulty level, (3) contains informative feedback, usually by a coach or teacher, and (4) provides numerous opportunities for repetition and correction of errors. As it requires full concentration, it can only be performed for around 5 h a day, and because its main goal is performance improvement, deliberate practice has been described as the opposite of regular work activities.

This ultimate nurture view on expert performance, as any extreme theoretical standpoint, has encountered quite some critique along the way. Sternberg (1996) argued that deliberate practice and talent might have been confounded in studies showing a relation between deliberate practice and expert performance. In typical expertise research, experts are compared with non-experts, but not with dropouts. Those who have made it might also be the ones who benefited more from deliberate practice, whereas those who have dropped out

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might have profited less from the same amount of deliberate practice, which would falsify the deliberate practice theory. More recently, counterevidence for this assumption was put forward in a study by De Bruin, Smits, Rikers, and Schmidt (2008), who showed that elite, adolescent chess players improved to an equal extent by 1 h of deliberate practice compared to their peers who dropped out. Moreover, little research has focused on how motivation might influence people's willingness to put in thousands of hours of deliberate practice to become experts (De Bruin, Rikers, & Schmidt, 2007). It could be that in the end, motivation contributes to a large extent to expertise, because differences in deliberate practice might be the result of differences in motivation.

The most pronounced point of critique on the deliberate practice theory is directed at Ericsson's denial of an influence of innate abilities, or 'talent'. Most social scientists agree that the era of extreme behaviorism or the opposite, a strong belief in a genetic cause of individual differences, both lie in the past. Instead, the commonly held view nowadays is that individual differences in behavior are explained by an interaction of environmental and genetic factors. Translated to the deliberate practice theory of expert performance, this would mean that Ericsson overestimated the importance of practice and underestimated the role of genetic influences. Whether and how nature and nurture interact during expertise development has been studied quite abundantly in the domain of chess (for an overview, see Campitelli & Gobet, 2011). Chess is particularly suitable in this regard as it has clear performance indicators, that is, chess ratings, which are usually measured longitudinally. Moreover, IQ can be considered a proxy for an innate factor that contributes to chess performance (Howard, 1999). We will shortly summarize previous research on the influence of practice (nurture) and intelligence (nature) on the development of chess expertise, before introducing the current study. To foreshadow, in the present study we examined the influence of enjoyment, practice and intelligence on chess performance when children just started playing chess, to test whether intelligence might be of a determining nature at the very beginning of a possible chess career. In contrast to the majority of studies in the field, this study was of a prospective nature, which eliminates issues of reliability of retrospective practice measurements.

The studies that have investigated the influence of intelligence on chess performance have generally found that chess players have an above average IQ (e.g., Frydman & Lynn, 1992; Horgan & Morgan, 1990), but that *among* chess players there is hardly any evidence for a link between intelligence and chess performance (e.g., Doll & Mayr, 1987; Grabner, Neubauer, & Stern, 2006; Unterrainer, Kaller, Halsband, & Rahm, 2006; Waters, Gobet, & Leyden, 2002). This lack of a relation holds for general intelligence tests such as Raven's Progressive Matrices (Unterrainer et al., 2006), the Intelligenz-Struktur Test (Grabner, Stern, & Neubauer, 2007), or the Berlin Structural Model of Intelligence Test (Doll & Mayr, 1987), but also for memory capacity tests (Digit Span) (Unterrainer et al., 2006), and visuo-spatial tasks (Unterrainer et al., 2006; Waters et al., 2002). Grabner et al. (2007) were the only ones who found significant positive correlations between measures of general intelligence, verbal intelligence, and numerical intelligence on one hand and chess ratings on the other hand.

Two reasons have been put forward to explain the unexpected lack of a relation between intelligence and chess skill (Bilalić, McLeod, & Gobet, 2007). First, current theories of chess expertise often emphasize the importance of knowledge more than visual analytic abilities (e.g., Chunking Theory by Chase & Simon, 1973a,b; Template Theory by Gobet & Simon, 1996; Long Term Working Memory Theory by Ericsson & Kintsch, 1995). These theories propose that chess experts have stored a huge amount of chess configurations in an abstract manner in their memory, in the form of so-called chunks or templates. It is logical to assume that this enormous database of chess constellations is mostly a direct result of excessive practice, and much less of extraordinary innate analytic abilities. Second, the lack of a relation between intelligence and chess skill might be due to a restriction of range in intelligence scores in chess experts. We return to this issue at the end of the introduction.

What evidence exists for the influence of practice on chess expertise? A recent study by Campitelli and Gobet (2011) summarized the findings of studies on this issue. Up to date, there are five studies that have related deliberate practice to chess expertise using structured questionnaires to obtain retrospective estimates of hours invested in studying chess (Bilalić et al., 2007; Charness et al., 2005; De Bruin et al., 2008; Gobet & Campitelli, 2007). Practice estimates consisted of individual practice, group practice (including playing chess matches), and total practice (the sum of individual and group practice). Chess expertise was typically measured by ELO ratings (Elo, 1978). All studies found a significant, positive correlation between practice and chess performance. Correlations were rather strong for individual practice (.42 to .54), medium to strong for group practice (.26 to .54), and strong for total practice (.76 to .90). Campitelli and Gobet (2011) conclude that abundant deliberate practice is necessary to obtain expertise in chess. However, as the title of their paper clearly states, it is not a sufficient condition. Contrary to what the deliberate practice theory postulates, they found wide inter-individual variability in the number of practice hours needed to achieve grand master level in chess. In individual practice, these numbers ranged from 730 to 16,000 h, whereas in group practice this ranged from 1600 to 14,200 h. Further, their data showed that even when practice hours were similar across individuals large chess skill differences were observed. These data indicate that some chess players benefit more from deliberate practice than others.

In sum, previous research has found little evidence for an effect of general intelligence on chess expertise, and moderate to strong evidence for an effect of practice on chess expertise. Still, there is a lot of variance in chess performance that is unexplained when practice is measured, and the effect of practice on performance differs widely across individuals (Campitelli & Gobet, 2011). How can this be explained? Most studies on chess expertise have taken only one of the factors intelligence, practice and motivation into account, whereas a multifaceted approach is more suitable given the complex nature of the game of chess and the long time that is needed to obtain expertise level (e.g., Bilalić et al., 2007; Gobet & Campitelli, 2007; Grabner et al., 2006). Moreover, it is possible that most of the studies on intelligence suffer from a restriction of range (Bilalić et al., 2007). That is, those who

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have come a long way in chess are typically of above average intelligence and do not differ to a large extent in IQ scores. Given the small variance in IQ scores, this factor does not contribute significantly in statistical analyses, even though it might have played a crucial role in chess development at an earlier stage. Bilalić et al. (2007) therefore studied the relation between practice, intelligence and chess performance in young children. However, given that these children had been playing chess for about four years, it is not impossible that this was also a selected group of strong players and intelligence was restricted to a certain extent in this sample as well. The mean above average IQ score reported for this sample (121.6) seems to support this notion. The present study was designed to tackle a number of issues that troubled previous research and to study the effect of practice, intelligence, and motivational factors on chess performance in young children who had only just started playing chess. The present study differs from previous ones in this domain on three crucial aspects. First, these children had no experience playing chess, and therefore no effects of selective dropout and subsequent effects on IQ range were possible. Children had just entered a chess course at school and received chess training once a week. Moreover, we not only took practice and intelligence into account, but also measured motivation at two levels. That is, we tested children's general achievement motivation, which is considered a stable personality trait, by means of the Work and Family Orientation questionnaire (WOFO, Spence & Helmreich, 1983). Moreover, we asked children each week of the chess course how much they enjoyed playing chess. The third factor that distinguishes the present study from previous ones is that we measured practice and motivation prospectively, by having the children complete a diary during each week of the chess course. Previous studies have always had a retrospective approach, asking chess players to estimate their practice hours sometimes for decades ago, raising issues of memory reliability. Chess performance was measured by a chess test specifically adapted to the content of the chess course.

We hypothesized that in such a young, inexperienced sample of chess players, intelligence (as measured by crucial subtests of the WISC-III) would contribute to variation in chess performance, next to practice and motivation. We also predicted that motivation would have a direct effect on time invested in practice. The data were analyzed by means of path analysis.

2. Method

2.1. Sample

A total of 24 (8 girls, 16 boys) elementary school students (Mean age = 8.12 years, *SD* = 1.51, range 6–11 years) participated. All children were right handed. We controlled for the effect of chess training environment and background of the children by only taking into account children who were trained by the same teacher in a similar course at three different schools in after school hours. Due to these requirements, the tested sample was relatively limited. These children were about to start a chess course for beginners offered to several elementary schools in the South West of the Netherlands. The children had no experience in playing chess. All children who entered the chess course participated in the study. Since the chess course was not related to the school education programs, we aggregated all analyses over the three schools. All lessons were given by the same chess teacher, who was unrelated to the schools, and who was not involved in any of the other parts of the study.

2.2. Materials

The study consisted of three measurements with separate materials. First, all participants completed four subscales of the WISC-III (Wechsler, 1991) to obtain an estimation of their overall IQ (See Bilalić et al., 2007, for a similar approach). These subscales were block design, digit span, vocabulary, and symbol search. Vocabulary (defining a series of orally presented words) and block design (copying an arrangement of red and white cubes from two and three-dimensional models) are considered most suitable to obtain an accurate estimate of the full range IQ. The correlation between these subtests and overall IQ is above .80 (Sattler, 1992). Symbol search (indicating whether a target symbol appears in a series of symbols) was added to measure processing speed, and digit span (repeating a series of orally presented numbers) was applied to measure working memory capacity. Moreover, children completed the Work and Family Orientation Questionnaire (WOFO, Helmreich & Spence, 1978; Spence & Helmreich, 1983). The WOFO measures general achievement motivation and compares motivational systems of men and women (Spence & Helmreich, 1983). Its reliability and validity have been tested and confirmed in different domains (Die, Seelbach, & Sherman, 1987; Gill, 1988; Schroth & Lund, 1994). We used a version of the WOFO that was adapted to children (De Bruin et al., 2007). The WOFO assesses four dimensions of achievement motivation: work (the desire to work hard and perform well on a task), mastery (having a preference for challenging tasks to meet internal standards of excellence), competitiveness (the enjoyment of personal competition and the desire to win and be better than others), and personal unconcern (the lack of concern with negative reactions of others). We excluded the latter dimension as it was irrelevant to our study. The three scales together consisted of 19 statements (work: 6, mastery: 8, and competitiveness: 5), such as: "I enjoy trying out difficult things". All items were rated on a five-point scale (1 = completely disagree, 5 = completely agree).

Second, participants completed a diary during the entire length of the chess course. The diary assessed the amount of time children practiced playing chess outside of the training and the degree to which they enjoyed playing chess. The diary consisted of 6 questions regarding amount of practice, and three related to enjoyment. Students filled in the questions related to practice daily and the questions regarding motivation once every week. Some children did not hand in all of the diaries. In the results section we describe how we handled these missing data.

Finally, at the end of the chess course, all children completed a chess test, consisting of twelve items that assessed their understanding of the course content. The test was developed by the chess teacher. Children were shown a picture of a chess game on paper and asked to predict the best next move. Only

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one move was correct. The items covered four chess concepts with three items each; taking a chess piece, getting out of check, exchanging a chess piece, and checkmate in one move. Each correct item was awarded a point. Thus, children could obtain maximally 3 points for each concept. The Cronbach's alpha for the total score (sum of the four concepts) was .713.

2.3. Procedure

All children who signed up for the chess course had parental permission to participate in the study prior to starting the course. On the first day of the course, a research assistant visited the course and explained the diary. Children were handed out the diary for the first week and a letter explaining to their parents how to use the diary. Children and parents were encouraged to complete the diary together each week at the last evening before the next chess lesson. The research assistant visited the courses each week to collect the completed diaries and hand out the diaries for the week to come. During one of the first three weeks of the course, the research assistant met individually with each of the participants on a separate occasion to administer the WISC-III and the WOFO. Finally, the chess teacher administered the chess test at the end of the final chess training during the last week of the course. Course duration varied between the schools, durations were 9 to 11 weeks, but covered the same content. Note that we did not analyze the content of the chess course, as this was equal across groups, and because no performance data were collected during the course.

2.4. Analysis

2.4.1. WISC-III and WOFO

The subscale scores on the WISC-III were transformed into norm scores and subsequently summed to obtain an estimate of the overall IQ of each child. This average was used in the path analysis. Cronbach's alpha of the average was .565. Sattler (2001) provides tables to estimate Full Scale IQ based on summed subscales. We estimated the full scale IQ based on the block design subscale and the vocabulary subscale, using table A-22 (p. 774) of Sattler (2001). The WOFO was used previously for adolescents and adults, but not for children of this age. This might explain why ten items had negative item-rest correlations. We excluded these items from the scale. The revised Work scale consisted of two items, and had a Cronbach's alpha of .55. The revised Mastery scale consisted of four items and had a Cronbach's alpha of .55. The revised competiveness scale consisted of three items and had a Cronbach's alpha of .69.

2.4.2. Chess practice

Based on the diary, the total amount of chess practice was calculated by summing the time in minutes that the participants reported spending on the six different chess activities (see Table 1), over all diaries for each participant. The average amount of practice per week was also calculated. Individual items that were left blank in a diary that was mostly filled in, were interpreted as zero practice for that item. If a diary was not filled in at all, we interpreted this as missing data. As the distribution of practice time was very skewed to the right with minimum 0 and some extremely high amounts of practice (i.e., the maximum amount of practice was 2358 min in total), a square root-transformed practice variable was used in the path analysis to test for practice effects.

2.4.3. Chess enjoyment

Again based on the diary, we determined how much children enjoyed playing chess, by averaging the three questions related to enjoyment: how much pleasure did you experience in the chess course (Q1), while making homework (Q2) and while playing chess against others or on the computer (Q3)? The participants rated the amount of enjoyment on a five-point scale. Not all questions were deemed applicable by all children. Therefore the reported average over the three questions was based only on the questions that were filled in.

2.4.4. Chess test

The chess teacher determined the correctness of each item and calculated each participant's total score. Since understanding of specific chess concepts was not relevant, all analyses were performed on participants' total score.

2.4.5. Missing data

As two children (ages 7 and 8) showed a clear lack of motivation and did not comply with the study demands, they were excluded from all analyses, meaning that all analyses were performed on the data from $N = 22$ children. As can be expected in field data, 11 children had missingness on some of the variables. Missingness due to dropout, non-compliance during the study, or simply no activity in a particular period of time cannot and should not be corrected for. However, missingness due to other reasons (here mostly forgetting to write down the number of minutes practice in a week) can be treated by using appropriate algorithms that leave the effects and correlations of interest unchanged but may lead to a substantial increase of precision of the estimation of these effects and correlations, as well as higher power. All of the corrections for missingness were done for participants who completed the final chess test, indicating that missingness was not the result of non-compliance or dropout in these cases.

Generally, if imputation of missingness is applied, multiple imputation constitutes a best practice (Harel & Zhou, 2007;

Table 1
Mean (and standard deviation, SD) and range of all background variables and variables of interest before multiple imputation.

Variable	N	Mean	SD	Min	Max
Age (years)	22	8.18	1.56	6	11
Test performance	22	8.36	2.24	3	12
WISC vocabulary (norm score)	22	10.86	3.55	3	17
WISC digit span (norm score)	22	11.77	3.15	4	18
WISC block design (norm score)	21	11.24	3.59	5	19
WISC symbol search (norm score)	21	12.95	3.28	6	18
WISC estimate full scale IQ	21	105.52	17.12	71	132
WOFO work	22	4.30	0.78	2.50	5
WOFO mastery	22	3.90	0.63	2.75	5
WOFO competitiveness	22	3.30	1.07	1	5
Average amount of practice per week (in minutes)	16	136.37	150.45	0	589.5
Total amount of practice (in minutes)	16	786.69	667.19	60	2358
Average enjoyment	15	3.71	1.11	1.00	4.90

Molenberghs & Kenward, 2007; Rubin, 1978, 1987; Schäfer, 1999; Yucel, 2008). Other approaches, such as listwise or casewise deletion, mean substitution, last observation carried forward (LOCF) or single imputation methods are not preferred, because they can lead to bias and/or loss of statistical power (Molenberghs & Kenward, 2007).

Within IBM SPSS version 21, we used Markov Chain Monte Carlo (MCMC) Fully Conditional Specification (FCS) as imputation method, with predictive mean matching (Little, 1988, 2005) for the imputation of quantitative variables. This Bayesian method is suitable for data with an arbitrary pattern of missingness. A total of 10 completed datasets was generated, each of which being a combination of observed values (which are of course the same for all M datasets) and of imputed values (with probably different values for the M datasets). For each missingness point (i.e., a particular case on a particular variable) we used the average value across the 10 completed datasets as value for imputation.

2.4.6. Path analysis

On the imputed dataset of $N = 22$ children we performed path analysis using Mplus version 7 (Muthén & Muthén, 2012). This enabled us to test specific hypotheses with regard to effects of WISC norm scores, practice time, enjoyment, and mastery on test performance and fixing non-significant paths to zero to increase statistical power and precision for other effects.

Finally, all variables included in the path analyses were standardized. This way, standardized regression coefficients can be interpreted as measures of effect size, where coefficients around 0.1, 0.25, and 0.4 represent small, medium, and large effects, respectively (Lipsey & Wilson, 2001).

3. Results

Table 1 presents means and standard deviations of all background variables and variables of interest before multiple imputation.

The estimated IQ in our sample was 105.52 ($SD = 17.12$). This average is not significantly different from 100 (one-sample t-test: $t(20) = 1.478, p = .155$) which indicates that there is no selection effect in this study. The children practiced on average around 2.3 h each week, including the chess course. The variation between the children was very high, with a standard deviation of 2.5 h. Five of the children spent on average less than half an hour of practice outside the chess class, while four children spent on average at least 2 h each week on practice outside the chess class. If children played chess outside of the chess course, they mainly played chess with adults and friends. In Table 2, the average amount of practice for the six chess activities is specified.

In Table 3, the average scores on the questions related to enjoyment of the chess course are presented.

A total of 11 children had missingness on at least one variable, and most missingness occurred due to failing to register the number of minutes practice in a particular week or failure to answer the pleasure questions in a particular week. Furthermore, for one participant, two of the WISC subscales were missing due to mistakes during test administration. Multiple imputation was applied using gender, age, scores on the four WISC subscales, practice time per week, average enjoyment, and the adjusted WOFO subscales (i.e., work, mastery, and competitiveness) as predictor variables. Table 4 presents the correlations between all variables of interest to the path analysis. Note that non-significant correlations were set to zero in the analysis to gain a degree of freedom. Hence, the correlations in the table differ somewhat from those in the path model.

Table 2
Average number of minutes spent on chess activities and standard deviations.

Which chess activity did you do today?	Mean	SD
How many minutes did you spend on this activity?		
Playing chess with friends	34.38	21.63
Playing chess with adults	35.68	12.79
Playing chess on a computer	19.42	4.33
Playing a chess tournament	1.25	43.74
Doing homework for the chess course	6.03	63.68
Attending the chess course	37.53	63.41

The partial correlation between enjoyment and each of the three scales of the revised WOFO was calculated, while controlling for the other two scales. The correlation of the Mastery scale was highest ($r = .454$, $p = .12$), while Competitiveness ($r = -.269$, $p = .38$) and Work ($r = -.004$, $p = .99$) did not correlate well with enjoyment, and were therefore not included in the model. Age was not significantly correlated with performance ($r = -0.088$, $p = 0.697$), and was thus not included in the model.

Test performance was predicted by WISC-III sum score ($\beta = 0.53$, $SE = 0.13$, $p < 0.001$) and practice time ($\beta = 0.32$, $SE = 0.16$, $p = 0.043$). Together, WISC-III sum score and transformed practice time explain about 38% of the variance in test performance. Mastery and enjoyment do not contribute to the prediction of test performance but do correlate with each other ($r = 0.43$, $SE = 0.13$, $p = 0.001$), and enjoyment is correlated with transformed practice time ($r = 0.54$, $SE = 0.12$, $p < 0.001$). The full model can be found in Fig. 1.

4. Discussion

In the present study, we examined to what extent intelligence, practice, and motivation contribute to chess performance in young children who had just started playing chess. In the domain of chess, moderate to strong evidence has been found for an effect of practice on chess expertise, whereas little evidence exists for an effect of general intelligence on chess expertise (Campitelli & Gobet, 2011). However, as is argued by Bilalić et al.

Table 3
Questions related to enjoyment, their averages and standard deviations.

Question	N	Mean	SD
1. How much pleasure did you experience this week in the chess course?	15	3.94	1.28
2. How much pleasure did you experience this week while making homework for the chess course?	10	3.62	.79
3. How much pleasure did you experience this week while playing chess against others or against the computer?	12	4.00	.74

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Table 4
Correlations (and *p*-values) for all variables in the path model.

Variable	Test performance	WISC norm score	Practice	WOFO mastery	Enjoyment
Test Performance		.465[a] (.029)	.188 (.401)	.019 (.932)	0.026 (.908)
WISC-III			−.253 (.256)	−.229 (.306)	−.291 (.189)
Practice				−.062 (.786)	.510[a] (.015)
Mastery					0.402 (.064)

[a] Correlation is significant at the 0.05 level (2-tailed).

(2007), the absence of a relation between chess expertise and IQ may be due to a restriction of range: There is only a small variance in IQ scores among expert chess players, which makes the factor non-significant in statistical analyses. Perhaps those of lower IQ have already dropped out at an early stage due to lack of success. To explore the possible underestimation of the effect of IQ, the current study is – to our knowledge – the first to investigate a group of young, complete novices in chess, which should preclude problems of dropout or restriction of range. This was confirmed by the fact that the IQ of our participants did not differ from the population mean. Now, in absence of both restriction of range effects and negligence of dropouts in the analyses, IQ (represented by a WISC-III sum score) does appear to be a predictor of chess mastery (see Fig. 1). In fact, the path analysis model shows independent contributions of IQ and practice to chess performance. The independent contribution of IQ to chess performance is a novel finding and fits well with Campitelli and Gobet's (2011) observation that practice alone is not sufficient to acquire expertise. Even though IQ does not appear to predict performance at higher skill levels (e.g, Doll & Mayr, 1987; Grabner et al., 2006; Unterrainer et al., 2006; Waters et al., 2002), the current results seem to indicate that in the early stage of a chess career IQ does contribute significantly.

When trying to align our findings with those from research at higher skills levels, it is possible that a certain minimum IQ is necessary to *be able* to become an expert chess player, but an abundant amount of deliberate practice is needed to actually become one. Because those below the minimum IQ typically drop out, the remaining chess players all have relatively high IQs, and therefore little variance exists between them, leading to an absence of a relation between IQ and chess performance. The common sense belief that intelligence influences chess performance is reasoned from the perspective of the general population, but research studying it has typically only considered the high IQ end of the general population. In the present study, we show that, when looking at the broader IQ range support seems to emerge for the common sense belief. Caution is needed when interpreting these findings since we only studied absolute novices. To provide more support for this line of reasoning, a study is needed that follows beginning chess players longer to analyze who drops out and what characterizes them: Lower IQ, less practice, or both?

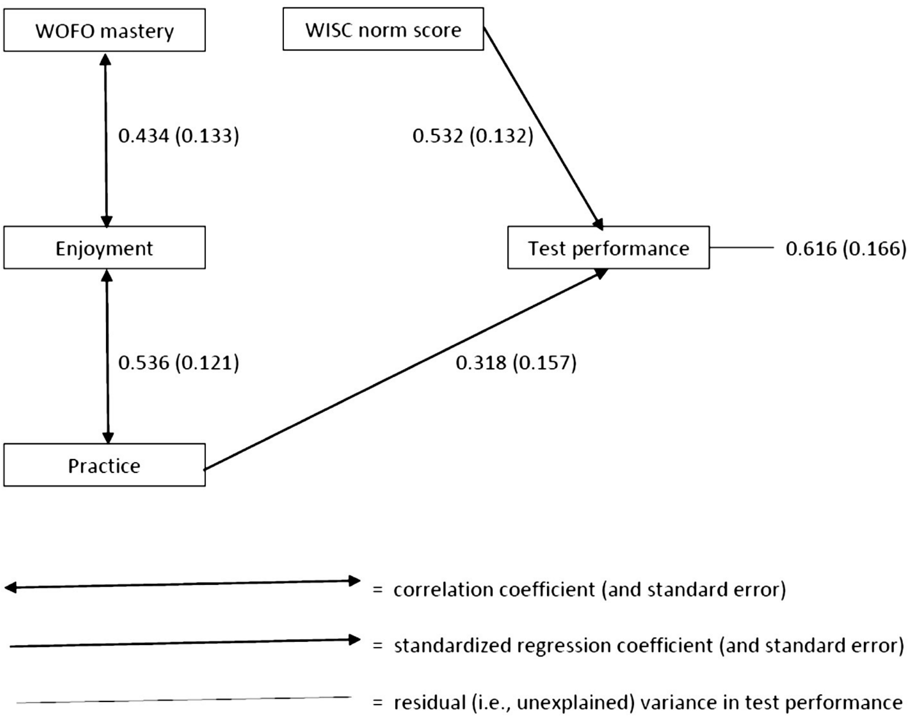

Fig. 1. Path model for test performance, practice, WISC-III norm score, WOFO mastery, and enjoyment.

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A second issue we addressed was the role of motivation in acquiring expertise, a topic that has been largely neglected in previous research (but see De Bruin et al., 2007). Although motivation did not directly predict chess performance in the current study, the enjoyment of the chess course and the chess activities correlated significantly with mastery, and, more importantly, enjoyment correlated significantly with the amount of practice. Even though we are unable to draw conclusions with regard to directionality, it is unlikely that enjoyment contributed to mastery, as the latter is considered a stable personality trait and the first was a time specified measurement of how much they liked playing chess. Instead, it seems that children who in general liked challenging tasks enjoyed playing chess. How enjoyment and practice influenced each other, however, is difficult to interpret given the current study set up. It is logical to assume that high enjoyment led to more practice time, but the reverse could also be true: After more practice, children started enjoying chess more. All in all, this is to our knowledge the first study to find that even in young, novice chess players, general achievement motivation and enjoyment are related to time dedicated to playing chess. As for practical implications, this could mean that it is relevant for chess teachers to monitor motivation and enjoyment at an early stage. To further unearth the possible influence of motivation on practice, and thus chess performance, more research is needed in which the direction of causality is tested by measuring motivation and practice longitudinally in a larger group for a longer period of time. Note that this study was the first to apply a prospective approach in examining the relation between practice and chess performance. If we desire to bring theory further, there is a need for more prospective research. Such a study could also shed more light on the underlying cause of the observed contribution of motivation to the amount of practice. It could be argued that mastery and enjoyment are largely innate factors. In contrast, one could argue that these factors are influenced by experiences such as having success at playing chess or receiving compliments. A longitudinal study would make it possible to study the relation between practice and motivation over longer periods of time, which could shed new light on this issue.

In sum, the current study is the first to demonstrate an effect of IQ on chess performance in the early stages of expertise development and provides a first insight into the role of motivation in young, novice chess players. These results were obtained in the absence of restriction of range effects or dropout effects and using prospective rather than retrospective measures, thereby eliminating a number of methodological issues of previous studies. This could be seen as a first step in unraveling the complex relation between motivation, practice and IQ in acquiring expertise among young novices.

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