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The relationship between cognitive ability and chess skill: A comprehensive meta-analysis

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ABSTRACT

Why are some people more skilled in complex domains than other people? Here, we conducted a meta-analysis to evaluate the relationship between cognitive ability and skill in chess. Chess skill correlated positively and significantly with fluid reasoning (Gf) ($\bar{r} = 0.24$), comprehension-knowledge (Gc) ($\bar{r} = 0.22$), short-term memory (Gsm) ($\bar{r} = 0.25$), and processing speed (Gs) ($\bar{r} = 0.24$); the meta-analytic average of the correlations was ($\bar{r} = 0.24$). Moreover, the correlation between Gf and chess skill was moderated by age ($\bar{r} = 0.32$ for youth samples vs. $\bar{r} = 0.11$ for adult samples), and skill level ($\bar{r} = 0.32$ for unranked samples vs. $\bar{r} = 0.14$ for ranked samples). Interestingly, chess skill correlated more strongly with numerical ability ($\bar{r} = 0.35$) than with verbal ability ($\bar{r} = 0.19$) or visuospatial ability ($\bar{r} = 0.13$). The results suggest that cognitive ability contributes meaningfully to individual differences in chess skill, particularly in young chess players and/or at lower levels of skill.

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1. Introduction

Research has convincingly established that cognitive ability (or intelligence) is a statistically and practically significant predictor of a wide range of socially relevant outcomes. For example, cognitive ability is the single best predictor of both work performance (Schmidt & Hunter, 2004) and educational achievement (Deary, Strand, Smith, & Fernandes, 2007). People who do well on tests of cognitive ability tend to perform better at work and in school, and even to live longer (Batty, Deary, & Gottfredson, 2007), than people who do less well on these tests.

Here, we consider the question of whether cognitive ability contributes to individual differences in expertise—that is, skill in a specific domain. This question has been hotly debated in psychology for well over a century. Using biographical dictionaries, Francis Galton (1869) found that eminence in fields such as music, science, and art tends to run in families, and that the likelihood of two relatives both having achieved eminent status varies with degree of biological relation. For example, considering the 300 most distinguished men in his sample, 36% of their sons achieved eminence, compared to 9.5% of their grandsons and 1.5% of their great-grandsons (see Plomin, DeFries, McClearn, & McGuffin, 2008). Galton concluded that eminence arises from "natural ability." John Watson (1930), the founder of behaviorism, countered that "practicing more intensively than others…is probably the most reasonable explanation we have today not only for success in any line, but even for genius" (p. 212).

More recently, in the spirit of Watson (1930), Ericsson and colleagues proposed that individual differences in skill largely reflect engagement in a long period of *deliberate practice* (Ericsson, Krampe, & Tesch-Römer, 1993). This view has been challenged by the finding that although deliberate practice accounts for a sizeable amount of variance in domain-specific performance, it leaves an even larger amount unexplained and potentially explainable by other factors (Macnamara, Hambrick, & Oswald, 2014; Macnamara, Moreau, & Hambrick, 2016). Ericsson and colleagues have further argued that cognitive ability, which is substantially heritable (Jensen, 1999; Plomin et al., 2008), does not correlate with expert performance. For example, in a *Harvard Business Review* article, Ericsson, Prietula, and Cokely (2007) claimed that "there is no correlation between IQ and expert performance in fields such as chess, music, sports, and medicine" (p. 116).

Nevertheless, there have been few attempts to evaluate evidence for the relationship between cognitive ability and skill through formal meta-analyses. Here, we report the first ever meta-analysis of the relationship between cognitive ability and skill in chess, the original domain for research on expertise (Simon & Chase, 1973; de Groot, 1946/1978).

1.1. Present study

Chess is an ideal domain for a meta-analysis of the relationship between cognitive ability and skill, for three reasons. First, chess is one of, if not the, single most studied domains in research on expertise—the "Drosophila" (fruit fly) of expertise research (e.g., Simon & Chase, 1973). Second, unlike in many domains, there is an objective measure of skill in chess—the Elo (1978) rating.[2] Finally, chess is a complex and purely intellectual activity.

It is somewhat surprising, then, that evidence for the relationship between chess skill and cognitive ability is inconsistent. In an early study, Djakow, Petrowski, and Rudik (1927) reported that there were no differences in visuospatial memory and general intelligence between eight grandmasters and non-chess players. More recently, in two studies, Unterrainer and colleagues found near-zero correlations between measures of cognitive ability (full-scale IQ and Raven's) and chess rating (see Unterrainer, Kaller, Halsband, & Rahm, 2006; Unterrainer, Kaller, Leonhart, & Rahm, 2011). By contrast, Frydman and Lynn (1992) found that elite Belgian youth chess players were approximately one standard deviation higher than the population mean on the performance subscale of the Wechsler Intelligence Scale for Children (WISC), which primarily reflects fluid reasoning. Furthermore, the stronger players had higher WISC performance IQ scores than the weaker players. More recently, using a relatively large sample with a wide range of chess skill, Grabner, Stern, and Neubauer (2007) found a significant positive correlation ($r = 0.35$) between full-scale IQ and chess rating. Similarly, Ferreira and Palhares (2008) studied ranked youth chess players and found a significant positive correlation ($rs = 0.32$–0.46) between fluid reasoning and Elo rating. de Bruin, Kok, Leppink, and Camp (2014) had beginning youth chess students complete a chess test, in which they were shown a chess game position and asked to predict the best next move. Performance on the chess test correlated moderately ($r = 0.47$) with scores on the WISC.

For a number of reasons, it is not clear what can be concluded from this mixed evidence (see a recent special issue of *Intelligence* for discussions of methodological issues in expertise research; Detterman, 2014). Sample sizes in studies of chess are often very small, leading to low statistical power and precision (e.g., $N = 25$ for Unterrainer et al., 2006; $N = 21$ for de Bruin et al., 2014). Moreover, samples are sometimes restricted in ranges of both cognitive ability and chess skill, limiting the degree to which the variables can correlate with each other (Ackerman, 2014). Further complicating matters, cognitive ability is sometimes assessed using tests with unknown reliability and validity, and sometimes with only a single test, leaving open the question of whether the results are test-specific (see, e.g., Li et al., 2015). Finally, samples sometimes consist of children and other times adults.

A narrative review by Campitelli and Gobet (2011) sheds more light on the inconsistent evidence for the relationship between cognitive ability and chess skill. They concluded that people high in cognitive ability are more attracted to chess than people lower in cognitive ability. More relevant to the present study, they concluded that the positive relationship between cognitive ability and chess skill is stronger in children than in adults, and at low rather than high levels of chess skill. In this study, we formally tested predictions following from the latter two of these conclusions via meta-analysis.

1.2. Research questions

The purpose of this study was to synthesize the available evidence for the relationship between cognitive ability and chess skill via meta-analysis. Our major question was whether there is a significant positive correlation between cognitive ability and chess skill. That is, do skilled chess players tend to be higher in cognitive ability than less skilled players? Using the Cattell-Horn-Carroll model of intelligence as an organizing framework (see McGrew, 2009), we considered this question in terms of both global cognitive ability (full-scale IQ) and four broad cognitive abilities: fluid reasoning (Gf), comprehension-knowledge (Gc), short-term memory (Gsm), and processing speed (Gs).

[2] This rating gives points to and ranks chess players based on their tournament games, and has been used by the International Chess Federation since 1971. Moreover, similar versions of it were adopted by national federations (for a comparison of the rating of the International Chess Federation and national ratings see Vaci, Gula, & Bilalić, 2014). Players with >2000 points are typically considered chess experts, whereas players with <800 points are considered beginners.