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The role of intelligence for performance in the prototypical expertise domain of chess

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ABSTRACT

Prominent expertise researchers have repeatedly emphasized that individual differences in general cognitive abilities, in particular intelligence, do not play any role for the attained level of expertise in a given domain. This strong claim is opposed with the current body of evidence on the relevance of intelligence for expert performance in the prototypical expertise domain of chess. Although the findings are not unequivocal, presumably due to methodological aspects, several studies employing psychometric tests of intelligence have revealed that expert chess players display significantly higher intelligence than controls and that their playing strength is related to their intelligence level. In addition, by using the extended expert–novice paradigm (comparing experts with novices of different intelligence levels) it has been found that both, expertise and intelligence impact on the performance in expertise-related tasks. These studies suggest that expert chess play does not stand in isolation from intelligence and could stimulate interdisciplinary research on the role of general cognitive abilities in expertise development.
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1. Introduction

Individual differences in cognitive performance are the result of the interplay between an individual's cognitive potential and the exploitation of learning opportunities provided by the environment. The individual's cognitive potential is typically measured by means of psychometric intelligence tests, which have been developed and continuously improved since the beginning of the 20th century (Nisbett et al., 2012). The high predictive validity for later educational and (though to a lower degree) vocational success contributed to a meanwhile broad application of such tests (e.g., Schmidt & Hunter, 1998). More intelligent individuals are expected to be better able to exploit learning opportunities and to display a higher probability to succeed in a cognitive domain of interest.

The importance of intelligence as predictor of cognitive achievement, however, has been heavily questioned by expertise researchers (Ericsson, 2005; Ericsson, Krampe, & Tesch-Römer, 1993; Ericsson & Lehmann, 1996; Ericsson, Nandagopal, & Roring, 2005; Ericsson, Roring, & Nandagopal, 2007; Ericsson & Ward, 2007). The principal aim of expertise research is "to understand and account for what distinguishes outstanding individuals in a domain from less outstanding individuals, as well as from people in general" (Ericsson & Smith, 1991, p. 2). To this end, the cognitive characteristics of experts are contrasted with those of novices (expert–novice-paradigm; for a more detailed description of the expert performance approach, see Ericsson & Lehmann, 1996). This line of research has produced strong evidence showing that the superior performance of experts can be predominantly attributed to a large domain-specific knowledge base acquired during extensive practice (Ericsson et al., 1993; Rikers & Paas, 2005). Even though there is presumably no doubt about the necessity of domain-specific training during which such a knowledge base is built in order to attain expert performance levels, individual differences in general cognitive abilities such as intelligence have been frequently regarded to be entirely negligible for expert performance. Ericsson and Ward (2007), for instance, summarized the existing body of research by claiming that "individual differences in more 'basic' cognitive processes (e.g., intelligence, memory

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capacity, and perceptual functioning) have not, to date, been predictive of attained level of skilled performance" (p. 348). Rather, the achieved level of expertise is seen to be merely a function of the amount of invested deliberate domain-specific practice (Ericsson et al., 1993). Only individual differences in personality variables that affect the individual's capacity to engage in long-term deliberate practice (e.g., motivation, persistence) were considered as relevant for expertise development.

Such strong claims from prominent proponents of expertise research have not notably changed since the seminal paper on the (exclusive) role of deliberate practice for expertise development by Ericsson et al. (1993). The body of empirical evidence on the relationship between intelligence and expert performance, in contrast, has considerably grown in the past two decades. Among many other expertise domains, this holds particularly true for the domain of chess which has been of particular relevance for expertise research. It is not only the first domain in which expert performance was systematically investigated — research in chess, moreover, has undoubtedly provided the vast majority of empirical findings, and, thus, most strongly contributed to today's theories and understanding of expertise. Simon and Chase (1973) put it as follows: "As genetics needs its model organism, its Drosophila and Neurospora, so psychology needs standard task environments around which knowledge and understanding can cumulate. Chess has proved to be an excellent model environment for this purpose." (p. 394). In fact, investigating experts in the domain of chess has several advantages compared to other areas of expertise. First, this domain meets all theoretical and practical criteria of expert performance, in particular the necessity of long-term practice to achieve high performance levels (Ericsson, 1996). Second, an objective and valid indicator of players' expertise level exists in terms of an international performance ranking system (the ELO system; Elo, 1978). Third, over half a century of expertise research in chess has put forth some well-established expertise tasks which have been repeatedly applied to capture facets of expertise in this domain (e.g., Chase & Simon, 1973; Saariluoma, 1990). And, finally, chess seems to be particularly well suited for the evaluation of the role of intelligence for expert performance since it is an intrinsically cognitive domain which taps many cognitive processes that are typically associated with intelligence, such as mental speed, spatial abilities, working memory, and reasoning (Charness, 1992; Howard, 1999, 2005).

The aim of the present paper is to provide an overview of the current state-of-art regarding the question of how important intelligence is for performance in the expertise domain of chess. Mainly two research approaches have been applied to address this question. First, chess players' intellectual abilities were assessed using psychometric tests in order to examine (a) whether expert chess players exhibit higher abilities than non-experts and (b) whether individual differences in the attained expertise level are also a function of these abilities. Second, the traditional expert–novice paradigm was extended by the factor intelligence (resulting in a 2×2-design) to elucidate the interplay of both, expertise and intelligence, on the performance in experimental tasks devised to capture critical facets of expertise. In addition to a brief literature review of both research approaches, a major focus is laid on the previous work by the author (Grabner, Neubauer, & Stern, 2006; Grabner, Stern, & Neubauer, 2007).

1.1. Psychometric studies

As simple as the question of whether expert chess players are more intelligent than weaker players or non-experts is, so inconsistent are the positions addressing this issue. While Howard (1999, 2001, 2005) regarded the observation that the mean age of world-class chess players is progressively declining in the last decades as real-world evidence that human intelligence is rising, other researchers concluded that "remarkable chess skill can exist in isolation, unaccompanied by other noteworthy intellectual abilities" (Cranberg & Albert, 1988, p. 161). Notably, even among chess experts quite diverse opinions exists. José Raul Capablanca, a former chess world champion, once stated: "To play chess requires no intelligence at all." (cited in Cranberg & Albert, 1988, p. 159). The British grandmaster Jonathan Levitt, in contrast, answered the question about the connection between chess ability and IQ as follows: "There are many reasons, some of them simply common sense, to believe that the two are strongly correlated." (cited in Howard, 2005, p. 348).

In addition to the fundamental question about the relevance of intelligence, there are also conflicting views about which components of intelligence are required for expert chess play and may, consequently, be related to playing strength. In this context, a very plausible candidate is visuo-spatial ability. Already early studies by de Groot (1946) and Chase and Simon (1973) emphasized the relevance of visuo-spatial pattern recognition for strong chess play, and more recent investigations on different facets of chess cognition have also substantiated this view. For instance, the suppression of the visuo-spatial component of working memory more strongly affects chess performance than the distraction of the phonological loop (e.g., Robbins et al., 1996; Saariluoma, 1992). Furthermore, investigations of blindfold chess play have revealed that playing without sight of the board relies heavily on a strong visual imagery component (e.g., Chabris & Hearst, 2003; Saariluoma & Kalakoski, 1998). Thus, expert chess players could be assumed to have particularly strong visuo-spatial abilities, whereas other components (such as verbal or numerical intelligence) may not loom large.

Psychometric studies addressing the aforementioned issues have been conducted on both, child and adult chess experts. To date, four studies have investigated children. Frank and D'Hondt (1979) randomly allocated a sample of 90 adolescents (around 14 years old) to a chess training class and a control class. Several psychometric tests were administered before and after the intervention. Results revealed that the achieved playing strength after one year could be predicted by participants' 'spatial aptitude' and 'numeric ability' subtests from the Primary Mental Abilities test, the subscales 'administrative sense' and 'numeric aptitude' from the General Aptitude Tests Battery, and 'office work' from the Differential Aptitude Test. Horgan and Morgan (1990) investigated a small sample of 15 child elite players (average age of 12 years) using the Raven's figural matrices intelligence test. They reported (age-corrected partial) correlations of intelligence with ELO rating of .34 and with the performance in a chess-related task (Knight's tour task; requiring participants to move the knight so that it visits every square on the board) of .52. Frydman and Lynn (1992) tested 33 child tournament players (average age of 11 years) with the Wechsler Intelligence Scale for Children

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