

Research Article

The Effects of Speed on Skilled Chess Performance

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ABSTRACT

Two types of mechanisms may underlie chess skill: fast mechanisms, such as recognition, and slow mechanisms, such as search through the space of possible moves and responses. Speed distinguishes these mechanisms, so I examined archival data on blitz chess (5 min for the whole game), in which the opportunities for search are greatly reduced. If variation in fast processes accounts for substantial variation in chess skill, performance in blitz chess should correlate highly with a player's overall skill. In addition, restricting search processes should tend to equalize skill difference between players, but this effect should decrease as overall skill level increases. Analyses of three samples of blitz chess tournaments supported both hypotheses. Search is undoubtedly important, but up to 81% of variance in chess skill (measured by rating) was accounted for by how players performed with less than 5% of the normal time available.

Superior skill may be acquired predominantly through practice rather than be the product of some general ability or talent (Ericsson & Smith, 1991). Support for this viewpoint has come from studies of chess skill, starting with work by Chase and Simon (1973). They found that chess masters had better recall for regular chess positions than did less skilled players, but that the chess masters' superior recall did not generalize to other materials. Their work built on de Groot's (1965), and this skill difference has been replicated frequently (Simon & Gobet, 2000). De Groot explained his findings as due to chess masters' familiarity with the patterns that occur repeatedly in chess games. Consistent with his explanation is recent work showing that skilled players even have a small advantage for random positions (Gobet & Simon, 2000a), which may incidentally contain relevant patterns. Eyetracking studies indicate that chess masters focus on meaningful piece patterns (de Groot & Gobet, 1996), and that experts extract more perceptual information from a single fixation than nonexperts do (Reingold, Charness, Pomplun, & Stampe, 2001). This documentation of chess experts' perceptual advantage supports claims that becoming a chess grandmaster is a process of acquiring a vocabulary of patterns consisting of between 10,000 and 300,00 chunks (Gobet & Simon, 2000a; Simon & Gilmartin, 1973). Simon and Chase (1973) estimated that acquiring this vocabulary requires 10,000 to 50,000 hr of practice, and Chase and Simon (1973) proposed that this vocabulary provides cues for stored knowledge and for assisting with search and planning.

De Groot (1965) expected an association between chess skill and depth and breadth of serial search, yet found no difference between grandmasters' and experts' search. Grandmasters simply found the right move more often. Subsequently, Charness (1981) and Holding and Reynolds (1982) found some evidence of increased depth of search with increased skill, but the increase may be relatively small, and Charness suggested it may reach asymptote once players reach a rating of 2100. (However, a longitudinal single-case study by Charness, 1991, suggested the asymptote may be reached as early as 1600.) Thus, Charness (1981) concluded, "The search algorithm probably becomes uniform at high skill levels" (p. 475).

Despite these results, the fact that search is both important and used extensively by chess players led Holding (1985, 1992) to propose a model of chess skill based on search. Gobet and Simon (1998) criticized this model, but its existence points to a potential problem with the claim that chess skill is based on fast recognition processes: the lack of studies that test quantitative predictions about the performance of players in chess games. Some computational models (Gobet & Janssen, 1994; Gobet & Simon, 2000a) suggest how superior recognition might be translated into better play, but to empirically test the claim that chess skill is based on the use of fast processes requires testing the implications the claim has for performance in chess games.

PREVIOUS STUDIES

Gobet and Simon (1996) tried to determine the relative importance of recognition and search in chess by comparing performance under normal tournament conditions with performance when time is restricted. This may not be a completely clean comparison because, as Chase and Simon (1973) suggested, recognition may help performance via search, but it is based on the reasonable assumption that because search is a serial process, restricting time will reduce search quality whereas because recognition is a fast process, it should be less degraded by time restrictions. Gobet and Simon used this approach in examining the performance of former world champion Gary Kasparov in simultaneous chess exhibitions.

All tournament chess players have a numerical measure of their skill called a *rating*. The outcome of a game between any two players is predicted by their rating difference. Ratings are based on players' previous results and updated as players continue to compete, which keeps the system in calibration. Gobet and Simon (1996) used ratings to analyze nine simultaneous exhibition matches played by Gary Kasparov against teams of four to eight weaker players. Because he played each team member simultaneously, Kasparov had much less time available than did each of his opponents. Gobet and Simon found that Kasparov's median rating based on his performance in these matches was 2646, whereas his regular tournament rating at that time was 2750. They stated, "In view of the slight extent to which lack of time lowered the quality of Kasparov's play in the simultaneous matches, we conclude that memory and access to memory through the recognition of cues is the predominant basis for his skill" (p. 54; but see Lassiter, 2000, and Gobet & Simon's, 2000b, response). Studies of a single exceptional individual have often been used to study skill, but they raise the issue of generalizability. Data from a larger sample are required in order to make a general statement about chess skill.

Gobet and Simon (1996) pointed to one previous study that used time restrictions to evaluate the contribution of search and recognition to chess skill: Calderwood, Klein, and Crandall (1988) had players compete in both blitz and normal chess games. In blitz, each player is given only 5 min to complete a whole chess game. Thus, players have to decide on each move in an average of only 7.5 s (assuming a 40-move game), which includes the time to physically move a chess piece and then press a clock button. As in any chess game, players can think while their opponent is contemplating a move, but the maximum time an entire game can last (10 min) is less than the time players often spend considering a single move in nonblitz chess. The Fédération Internationale des Échecs (FIDE, the world chess association) prescribes that games contributing to players' ratings allow each player at least 2 hr for all his or her moves. Thus, in blitz, players have less than 5% of the time available in the games used to calculate their ratings. Even in blitz, some search is possible, and players might choose to allocate extra time to a critical move. However, there is constant pressure to move as fast as possible (players lose if they run out of time, even if they are winning the game), and thus the opportunity to search is greatly restricted. Except for the rules regarding timing, blitz chess is identical to nonblitz chess.

Calderwood et al. (1988) had grandmasters rate the quality of moves by three weaker and three stronger players in a set of blitz and nonblitz games. They found an interaction between skill level and game type suggesting that skill was more based on search for weaker players than for stronger players. However, the quality measure could not distinguish between stronger and weaker players in nonblitz games, even though their ratings indicated that the stronger players should win almost 100% of the time if they played the weaker players. Thus, the move-quality measure was not sensitive to whatever it is that makes the more skilled players so much better, which throws doubt on its validity.

A NEW BLITZ STUDY

I used chess players' performance in blitz chess to test two hypotheses about the contribution of fast processes (such as recognition) to overall level of skill. The first hypothesis was that much of the variance in players' skill (as measured by their ratings calculated from nonblitz chess games) can be accounted for by their performance in blitz, during which search is greatly curtailed. The second hypothesis tested a more detailed implication that seems to flow from Simon and Gilmarin's (1973) claim that acquiring chess skill is due to the acquisition of the patterns that make up the vocabulary of chess: that as a player's overall skill increases, proportionally more of that skill should be based on fast process.

The first hypothesis extends Gobet and Simon's (1996) logic that when the opportunity to use search is restricted, strong players should still perform well, if their skill is based on fast processes. If not just Kasparov's but all players' skill levels depend extensively on their fast processes, then when players have little time to utilize search, the winner should be the same player expected to win a game played at normal speed. However, if overall skill is largely based on slow search processes, then removing most search would remove most of the skill difference between players, and thus lead to game results largely unrelated to those predicted by the players' ratings.

The second hypothesis tested an implication of the empirical evidence that memory and pattern recognition improve as skill increases, whereas search ability increases only slowly (if at all) with overall skill. Assuming that the quality of both fast and slow processes has a monotonic relation to overall skill level, this implies that as a player's overall skill increases, proportionally more of that skill is attributable to fast process. An analogous situation might be the possible role of vocabulary in the quality of students' essays. When two students are 10 years old, the major factor distinguishing the quality of their essays may be differences in vocabulary. However, as the students become older, their improving vocabularies may converge and cease to be the major factor distinguishing their essays. Analogously, the ability to search effectively is critical for master chess players, but masters may no longer be distinguished by this ability, just as the older students' essays may cease to be distinguished by vocabulary even though a good vocabulary is still critical.

Restricting the time that players have to move reduces their ability to utilize slow processes, such as search. To the extent that players' skill levels are due to slow processes, restricting playing time should, in effect, add a random element to who wins a chess game, and the result of a blitz game should tend to deviate from what would be expected if the same two players competed in nonblitz. If the proportion of skill due to slow processes is greatest at low skill levels, when two weak players compete against each other in blitz, a relatively large amount of what determines their normal ratings may have been removed. In effect, blitz equalizes their skill level and thus disadvantages the stronger player. However, at higher levels of skill, where fast processes play a greater role, equalization should decrease. Thus, the degree to which

playing blitz chess equalizes the differences between players should decrease as their absolute levels of skill increase. Other hypotheses about the relationship between blitz performance and skill level are possible, but the *equalization hypothesis* was tested here: Equalization decreases with skill level.

Dutch, American, and Australian samples of blitz chess tournaments were analyzed. Table 1 provides information about the tournaments included in each sample. Whereas thousands of nonblitz tournaments are held each year, relatively few blitz tournaments are held, and even fewer involve a wide range of skills and many participants. The tournaments analyzed were all those I could find that provided sufficient information (players' ratings and the result of each game), had at least 40 players, and included at least six rounds of play.

I used three samples partly for greater generalizability, but also because ratings may not be directly comparable between countries. Ratings are calculated from the results of players competing against each other; thus, within a population of players, they should be internally consistent. However, they may not be externally consistent between populations of players. For this reason, FIDE maintains an international rating system, but only the best players have such ratings (the minimum FIDE rating is 2000). Most players compete only within their own country, so national associations maintain their own ratings calculated in the same way as FIDE ratings. How directly comparable are FIDE and national ratings, and different national ratings to each other, is debated. Using samples from within different countries minimized this potential problem.

ANALYSIS

The first hypothesis predicts that players' performance in blitz tournaments should be highly correlated with their ratings, even though those ratings are based on games played when much more time is available. Players' scores (i.e., how many games were won or drawn) in a blitz tournament represent their performance, but a player's score will be partly a product of the quality of the other players in the tournament. Thus, in order to combine different tournaments into one sample, I assigned players within each tournament percentage ranks for their scores and percentage ranks for their ratings. The correlation between rating and score ranks should be positive if blitz performance and ratings are related, and the correlation's magnitude can be used as an estimate of how much common variance blitz and nonblitz chess performance have.

Testing the equalization hypothesis required operationalizing the concept of equalization. The rating system provides an estimate of the probability of the stronger player winning a nonblitz game between two players with a given rating difference (see Elo, 1978). Thus, ratings can be used to calculate the expected score for games between a player and Set X of opponents. A deviation measure can be calculated by subtracting this expected score from the sum of the actual scores against that set of opponents (1 for a win, 1/2 for a draw, 0 for a loss), then dividing by the number of games:

$$\text{deviation against X} = \frac{(\text{actual score against X}) - (\text{expected score against X})}{\text{number of games against X}} \quad (1)$$

If playing blitz tends to reduce the skill differences between players implied by their ratings (because part of that difference is due to slow processes that are harder to utilize in blitz than in nonblitz games), then there would be no reason to expect playing blitz to have similar consequences for all of a player's games. Instead, the consequences for an individual's blitz games against stronger opponents should be opposite the consequences for that individual's blitz games against weaker opponents. More precisely, equalization implies that when Player A

competes against a weaker opponent, the probability of a win for Player A should decrease, but when Player A competes against a stronger opponent, the probability of Player A winning should increase. Therefore, an *equalization factor* (EF) can be defined as follows:

$$EF = (\text{deviation against stronger opponents}) - (\text{deviation against weaker opponents}) \quad (2)$$

EFs (range: -1 to +1) can be calculated by examining the results of blitz tournaments in which most players compete against some opponents who are stronger than them and some opponents who are weaker than them (according to the ratings). Thus, for each tournament, each player's EF was calculated using Equations 1 and 2. Novices who did not yet have a rating and players who did not have opponents both weaker and stronger than themselves were eliminated from the analysis of EFs.

A positive EF indicates that a player is doing better than expected against stronger opponents, but worse against weaker opponents. In effect, positive EFs in blitz tournaments would indicate that the differences between players' skill levels have been reduced, suggesting that what blitz removed was at least partly responsible for the differences in skill those players displayed in nonblitz chess. In blitz, what is reduced is the opportunity to utilize slow processes. Thus, the bigger the positive EF, the more a player's overall skill appears to be based on slow processes. Therefore, the equalization hypothesis was tested by examining the relationship between EF and rating. If proportionally more of players' skill is based on fast processes as players become more skilled, then EF should be negatively correlated with rating, because equalization should be lessened as skill level increases.

The shape of the relation between EFs and ratings can be examined by dividing players into classes of skill and plotting mean EF for each skill level. The skill categories chosen were the following ones used by the United States Chess Federation (USCF): 1200 through 1399 (Class D according to the USCF), 1400 through 1599 (Class C), 1600 through 1799 (Class B), 1800 through 1999 (Class A), 2000 through 2199 (Expert), 2200 through 2399 (Master), 2400 through 2599 (Senior Master), above 2600 (also Senior Master). (Note that the FIDE title of Grandmaster requires a rating of at least 2500, though it has performance requirements as well). Using these 200-point categories is consistent with convention but resulted in different amounts of data in each category. However, a reasonable amount of data in each category was obtained by combining across tournaments within a sample.

RESULTS

Dutch Blitz Sample

These blitz tournaments are the biggest regularly held blitz tournaments in the world. The three tournaments yielded 584 data points (ratings: $M = 1972$, $SD = 323$). The correlation between rating ranks and score ranks was high, $r(584) = .90$, $p < .001$, suggesting that most of the variance in ratings could be accounted for by variance in blitz performance.

As predicted, there was a statistically significant negative correlation between ratings and EFs, $r(558) = -.22$, $p < .001$. (Some players lacked EFs because they did not play both better and worse opponents.) The top panel in Figure 1 plots mean EF for each rating category in the Dutch blitz sample. A one-way analysis of variance (ANOVA; unweighted) found a significant linear trend for rating category, $F(1, 550) = 24.2$, $p < .001$. (The assumption of independence may be violated in this analysis, but is unlikely to account for this result.)

American Blitz Sample

Five blitz tournaments yielded 346 data points (ratings: $M = 1717$, $SD = 331$). The correlation between rating ranks and score ranks was again high, $r(346) = .80$, $p < .001$. There was again a statistically significant negative correlation between ratings and EFs, $r(279) = -.35$, $p < .001$. The middle panel in Figure 1 plots mean EFs for the combined sample (2 players had ratings below 1200, but were placed into the 1200 category). A one-way ANOVA found a significant linear trend for rating category, $F(1, 271) = 32.1$, $p < .001$.

Although the results for the Dutch and American samples were consistent, one problem with the American sample is that it included players with FIDE instead of USCF ratings, especially among the best players. However, USCF ratings are considered by many players to be inflated relative to FIDE ratings, and in some American tournaments FIDE ratings will have as many as 100 points added to them. Thus, the assumption that all ratings are directly comparable may be violated, at least for players above rating 2000.

The Dutch tournaments also involved a mixture of players with FIDE ratings and Dutch national ratings. Although Dutch ratings and FIDE ratings are considered comparable (M. de Hoon, personal communication, February 28, 2003), this potential problem could be addressed by examining tournaments in which all players have national ratings. For geographical reasons, Australia has such tournaments.

Australian Blitz Sample

Five Australian blitz tournaments yielding 247 data points (ratings: $M = 1760$, $SD = 349$) were analyzed. Again, there was a large correlation between rating and blitz performance ranks, $r(247) = .78$, $p < .001$. EFs and ratings were also again correlated significantly, $r(213) = -.34$, $p < .001$. The bottom panel in Figure 1 plots mean EF for each rating category (1 player with a rating above 2400 was included in the 2200 category). A one-way ANOVA found a significant linear trend for rating category, $F(1, 207) = 18.4$, $p < .001$.

Australian Nonblitz Sample

If ratings are accurate predictors of performance in nonblitz games, then EFs calculated from nonblitz tournaments would be expected to be zero. Any other result would indicate some systematic flaw in the rating system. However, one might wonder if some such flaw might explain the obtained results. To validate the analysis of the blitz samples, I carried out an equivalent analysis of nonblitz tournaments. I chose an Australian sample so as to avoid the problem of mixing players with ratings calculated by different organizations, and also to place a constraint on which tournaments to include in the analysis. There are many nonblitz tournaments held every year that would meet my criteria.

The largest annual tournaments conducted in Australia were analyzed: the Australian Open and Australian Championship and the Doeberl Cup. The Australian Open and Australian Championship are 11-round tournaments for which I could find complete data for 1999, 2000, and 2002. For the 9-round Doeberl Cup, I could find complete data for 2001 and 2002. These five tournaments yielded 624 data points (ratings: $M = 1717$, $SD = 331$). EFs were calculated exactly as for the blitz tournaments, but EFs did not correlate with ratings, $r(451) = -.046$, $p = .33$. Figure 2 plots mean EF for each rating category, but a one-way ANOVA found no significant linear trend for skill, $F(1, 443) = 1.26$, $p = .26$. For the combined Australian blitz and nonblitz samples, there was a significant interaction between game type (blitz vs. nonblitz) and the linear trend for skill, $F(1, 630) = 10.8$, $p = .001$.

DISCUSSION

Two major results were consistently found across a diverse sample of 13 blitz tournaments involving 1,177 data points. First, although blitz chess allows little time for slow processes (such as search), performance in blitz chess correlated between .78 and .90 with performance in nonblitz chess. Thus, up to 81% of the performance variance in nonblitz chess was shared with blitz chess, which strongly suggests that variance in the effectiveness of fast processes (such as recognition) accounts for most of the variance in chess skill. Second, EFs decreased with rating and became essentially zero for highly skilled players. Thus, skill differences were equalized by playing blitz, but less so as players increased in skill. The transition from positive to zero (or near zero) EFs occurred at the same point in each of the three blitz samples, the 2200 rating category. This is consistent both with the USCF labeling 2200 the first "master" level and with Charness's (1981) claim that search processes may reach a plateau for players who reach a 2100 rating. Once such a plateau is reached, differences between players should not be based on search processes. These results paint a consistent picture, but there are some provisos.

The results were based on archival research because it would be impossible otherwise to obtain a sample of this size and breadth of skill. Therefore, only players who both had ratings (calculated from nonblitz games) and chose to enter the blitz tournaments were part of the blitz samples; thus, the results may apply only to such players. Maybe only players with good fast processes choose to play blitz as well as nonblitz chess, so the results may indicate not that high chess skill is always based on effective fast processes, but only that it can be. However, blitz is not a rare activity for chess players. As Divinsky (1991) commented, "Blitz is a favorite pastime of tournament players during their free time. It seems to relieve tension as well as giving practice and pleasure" (p. 23). Hooper and Whyld (1984) further pointed out that "[blitz] chess has become part of the training of masters, developing their ability to make quick judgements and decisions" (p. 186). Thus, the blitz samples, which included players at all levels of skill, are unlikely to have consisted of just blitz specialists, and the existence of such specialists would be inconsistent with the high correlations between blitz and nonblitz performance.

These results do not show that search in chess is irrelevant. Players given only 5 min to play all their moves may utilize some limited search, but they would almost certainly perform well below their ratings if their opponents had the amount of time provided in nonblitz tournaments. However, the results are consistent with the finding that search does not improve much as players' skill levels rise (e.g., Charness, 1981, 1991; de Groot, 1965), which implies that search should not account for much of the variance in players' performance. The contribution of search processes to performance may be real but fairly constant past a certain skill level.

This study did not indicate which fast processes are important. Perceptual recognition processes may be an important component of fast processes, but there are other possibilities consistent with the data reported. For example, Saariluoma and Hohlfeld (1994) proposed that apperception is important. Charness (1991) discussed the contribution of chess knowledge to chess skill, and some aspects of knowledge should be applicable in the limited time available during blitz (e.g., opening theory).

The general methodology used here might be applicable to other domains of skill that involve fast and slow processes. If fast processes acquired through practice are a critical component of the improvement in performance of chess players, who at the highest level have 2.5 hr for their first 40 moves, then they may underlie a whole range of skills.

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(Received 1/6/00; Revision accepted 4/16/03)

Fig. 1. Mean equalization factor (EF) for each rating category (numbers shown are lower bounds of the categories) in the three samples. Vertical bars represent the standard errors of the mean. Note that the number of data points varies across the rating categories. The top panel depicts results for the Dutch blitz sample (1200, $n = 13$; 1400, $n = 41$; 1600, $n = 100$; 1800, $n = 159$; 2000, $n = 106$; 2200, $n = 83$; 2400, $n = 30$; 2600, $n = 26$), the middle panel depicts results for the American blitz sample (1200, $n = 11$; 1400, $n = 18$; 1600, $n = 36$; 1800, $n = 48$; 2000, $n = 54$; 2200, $n = 67$; 2400, $n = 29$; 2600, $n = 16$), and the bottom panel shows results for the Australian blitz sample (1200, $n = 22$; 1400, $n = 32$; 1600, $n = 49$; 1800, $n = 50$; 2000, $n = 50$; 2200, $n = 10$). Because of the way it is calculated, not all players had an EF score.

Fig. 2. Mean equalization factor for each rating category (numbers are lower bounds of the categories) in the Australian nonblitz sample. Vertical bars represent the standard errors of the mean. Note that the number of data points varies across the rating categories (1000, $n = 12$; 1200, $n = 50$; 1400, $n = 62$; 1600, $n = 130$; 1800, $n = 108$; 2000, $n = 53$; 2200, $n = 30$; 2400, $n = 10$).

Table 1.

Characteristics of each blitz chess tournament. Note that each round consisted of two games against the same opponent, except in the Australian tournaments in which only one game was played each round. Note that in Australia "blitz chess" is referred to as "lightning chess."

<i>Date played</i>	<i>Name and location</i>	<i>Rounds</i>	<i>Rating means (SD)</i>	<i>Number of players</i>
<i>American sample</i>				
8/10/96	U.S. Open Blitz, Alexandria, VA	7	1902 (349)	81
8/9/97	U.S. Open Blitz, Alexandria, VA	7	1855 (376)	58
4/6/97	NY City Blitz Championship, New York	7	2265 (280)	66
3/23/98	NY City Blitz Championship, New York	7	2256 (276)	70
12/29/00	North American Blitz Championship, Las Vegas	6	1906 (421)	73
<i>Dutch sample</i>				
2/27/99	FPO Snelschaak Marathon, Dordrecht	17	1994 (344)	199
2/16/01	AKD Blitz Marathon, Dordrecht	17	1950 (321)	187
2/14/02	AKD Blitz Marathon, Dordrecht	17	1968 (302)	198
<i>Australian sample</i>				
12/31/91	Australian Lightning Chess Championship, Melbourne	11	1750 (288)	48
1/6/00	Australian Lightning Chess Championship, Mingara, New South Wales	11	1789 (357)	40
2/23/01	City of Sydney Lightning, Sydney	11	1766 (336)	42
2/17/02	City of Sydney Lightning, Sydney	11	1710 (409)	48
1/5/03	Australian Lightning Chess Championship, Sydney	11	1781 (351)	69