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Practical Recommendations to Chess Players from Sports Science

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INTRODUCTION

Coaches and participants in many sports have paid increasing attention in recent years to the ways in which knowledge from the fields of biochemistry, exercise physiology, nutrition and psychology can be used to help raise performance levels. Some sports have been quicker to catch on than others, with athletics, swimming and weight-lifting being among the vanguard. The immensely popular sport of soccer has been comparatively slow to catch on, at least in the United Kingdom, although the influence of continental managers such as Arsene Wenger at Arsenal and Ruud Gullitt at Chelsea is beginning to spread change through that sport.

Chess, at least on the surface, apparently remains blissfully unaware of and untouched by these developments, at least in English-speaking countries. Today there are almost 160 national federations affiliated to FIDE (Federation Internationale des Echecs - the world chess federation) and of those some 80% are officially recognised as 'sport' organizations. The rump of countries which continue, in several cases stubbornly, to insist that chess is not a sport consists largely of countries where English is the first language (including USA, Canada, U.K., Ireland, Australia and New Zealand). Other countries, notably the Soviet Union, as was, and other Eastern European countries were largely in the forefront both of recognizing chess as a sport and in encouraging their players to apply training techniques developed in other sports.

Dr Willi Weyer gave a speech on the 100th anniversary of the German chess federation, celebrated in Bad Lauterberg on 12 March 1977, in the course of which he commented upon chess's status as a sport: "Whoever denies the high physical effort of a tournament player doesn't know what he's talking about. Many examinations prove that heart, frequency of breathing, blood pressure and skin are subjected to great strain, weight losses appear during a tournament - so chess players need a special way of life with regular training, practice of other keep-fit activities and healthy diet." In some respects Dr Weyer was ahead of his time, for it was only in the 1970s that chess began to be officially recognised as a sport in more than a handful of countries.

The principal objectives of this paper are to review some of the most significant developments which apply (or might be applied) to chess and, drawing conclusions therefrom, to make some practical recommendations which may be of benefit to tournament players, especially those aspiring to the elite. Inevitably I have had to skim the surface in many places, otherwise this would have ended up being not an article but a book.

Fig. 1. Feel the tension in Kasparov-Beliavsky

HISTORY

It is a little over 100 years ago that the first scientific study relating to chess was published (Binet, 1894), at least the first of modern times for we can only speculate upon what may have been written in Baghdad during the ninth and tenth centuries when that city was at the heart of scientific investigations and was also the 'chess capital of the world'. Binet was one of the founding fathers of quantitative psychology and his investigation into how players visualised and calculated without sight of the chessboard has been followed by many hundreds of papers in which the principal subject matter has been how chess players think, either human (following ground-breaking work by De Groot, 1946, 1965, Chase and Simon 1973 and Simon and Chase, 1973) or non-human (Shannon, 1950, Turing, 1953, Botvinnik, 1970, 1975). That is a huge area which I am leaving aside in this review, not only because it would need far more space than is available, but also because most chess players have at least some awareness of its existence and its importance to them, however little they may know of the actual detail. Anyone wishing to investigate this area should probably start with Holding, 1985, for the psychology of chess skill or Levy, 1988 followed by Marsland & Schaeffer, 1990 for the computer kind. Some useful strategies for humans may be found in O'Connell (1996). Since writing that paper I have found the details (Murakhvery, 1976) of an interesting experiment involving hypnosis which I will briefly relate here: "We invited the ex-world champion Mikhail Tal into our laboratory, where he played six games against one of our subjects. Our subject played three games under hypnosis, it having been suggested that he play like Paul Morphy[1], and three games without being hypnotised. Tal won. After the session he judged the subject as follows: 'Before he was hypnotised I was playing a man who barely knew how the pieces moved. Under hypnosis this was altogether a different person, expansive, energetic and audacious, playing two categories[2] higher than before'." (Tikhomirova *et al.,* 1975).

PHYSIOLOGY

Scientific study of the physiological aspects of chess seems to have commenced much more recently and, perhaps surprisingly, in the USA. The very first such study that I am aware of was carried out, apparently mainly in 1970, by Charlotte Leedy as part of her research for the Ed.D. degree at Temple University, Philadelphia, PA. An abstract of her work (Leedy & Dubeck, 1971) was published late in 1971 in a chess magazine which intriguingly added that a "more detailed report of the findings of these experiments, of interest mainly to physiologists, is due to be published in appropriate journals." This might be the work that Dr Weyer referred to. The article mentions that "players were monitored throughout their USCF-rated[3] games for changes in heart rate, breathing rate, systolic blood pressure, diastolic blood pressure, and galvanic skin response... During each round of two five-round tournaments, two players at one board were monitored by physiographs which continuously recorded these five physiological parameters." The players concerned were rather weak, being only average to above average club players (USCF ratings of 1300-1900, then approximately equal to FIDE ratings), which may well account for the comment that "If our interpretation of increased skin conductance as being indicative of deep concentration is correct, most of the players monitored were not concentrating on finding a move for a considerable portion of their elapsed clock time!" They reported momentary peak increases of heart rate between 26% and 120% over resting rate. "The maximum changes occurred in many cases immediately after the opponent made his move. These reflected the sudden awareness by the player that the move was perhaps a winning one. In fact, one of the authors successfully predicted from the score of the game the move at which the greatest changes in physiological parameters occurred. It may be of interest to note that 'surprise' could be identified by a sudden increase in all the measured parameters within a fraction of a second. On the other hand, when the diastolic blood pressure increased first, followed by increases in the other parameters, anger may have been the cause. The heart beating faster first, and then the blood pressure increasing, could indicate a fear response. These responses have been observed in other physiological studies to be characteristic of surprise, anger and fear." Their conclusion was certainly ahead of its time: "we consider that tournament chess playing does provide a reasonably good workout for some parts of the body" (Leedy and Dubeck, 1971).

Helmut Pfleger, a doctor of medicine and a chess Grandmaster, headed a team that conducted measurements of physiological parameters of eleven of the sixteen participants in the Munich Grandmaster tournament of February-March 1979 (Pfleger *et al.*, 1980). Pfleger himself was one of the players in that event and the strength of the competitors was of an entirely different class to that of the players examined by Leedy, since the reigning world champion, one of his predecessors and another eleven holders of the Grandmaster title were playing there. As Dubeck had done, in his work with Leedy, so Pfleger *et al.* examined the electrocardiogram print-outs in relation to the course of the gameand confirmed that heart rate peaks coincided with such elements as 'wild skirmishes', sharp complications and apparent sight of victory.

The work of Pfleger *et al.* was important for demonstrating that chess player's physiological exertions were on a par with those of other sports such as curling, golf and motor racing. The concluding part of the abstract of their study reads: "In their general physical capacity, their autonomic excitability and their circulatory parameters during the competition the chess players were completely comparable to other sportsmen of the 'light athletics' class, so that chess can also rightly be called a class of sport according to these criteria." This played an important part in the battle which developed in the 1980s between the German chess federation and the German Sportbund on the one hand and the German Minister of Finance on the other. The Minister of Finance insisted that chess was like 'pigeon breeding' or 'carnival clubs' and had no place in a sports organization. Thebattle was successfully resolved, in the German parliament, in favour of the chess federation and the Sportbund thanks in large part to this piece of research.

Last year Dr Christian Hollinsky led a team of researchers in Vienna who carried out investigations of 25 subjects who competed in the two open tournaments which were played alongside the ten-player grandmaster tournament to celebrate Austria's millenium. The subjects ranged in age from 25 to 80 (average 42) and had international ratings in the range 1745-2405 (average 2159). Aside from the normal barrage of physiological measurements, extended to include measurements of the stress hormones (adrenaline and noradrenaline) in the urine and full-scale blood analysis, the researchers introduced a new test to measure a player's speed of movement. The test, to measure how rapidly a player could move, consisted of moving a pawn on the board, then pressing the chess clock, all of which was repeated ten times and the elapsed time measured. In writing about this new departure, Hollinsky *et al.* mention that during the main grandmaster tournament the reigning world chess champion, Anatoly Karpov, had to make ten moves in a matter of seconds in his game against Shirov. He succeeded, won the game and tied for first place in the tournament. Failure to do so would have meant loss of the game by time forfeit and would have relegated him to seventh place in the field of ten players. Table 1 shows the results obtained in these tests of speed of movement, with a clear distinction between the chess players and the elite subjects of tennis, golf and weight-lifting, not only that but there is an interesting distinction among chess players with those more highly rated on the international scale being consistently faster (Hollinsky *et al.*, 1996).

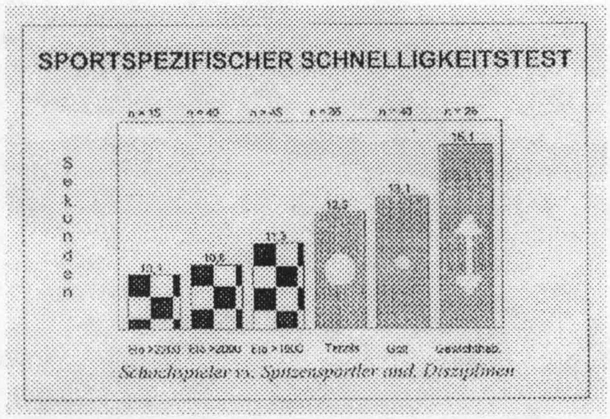

Table 1. Strong chess players are quickest

The heart rates measured by Hollinsky's team included peaks in excess of 220/min and a single maximum of 223/min. Table 2 shows the HR, and blood pressure graph for a player 27 years old and rated 2064 over the course of one game, from six p.m. until its conclusion just after midnight. Not surprisingly, at least to chess players, the peak HR is reached in the time-pressure phase towards the end of the sixth hour of play.

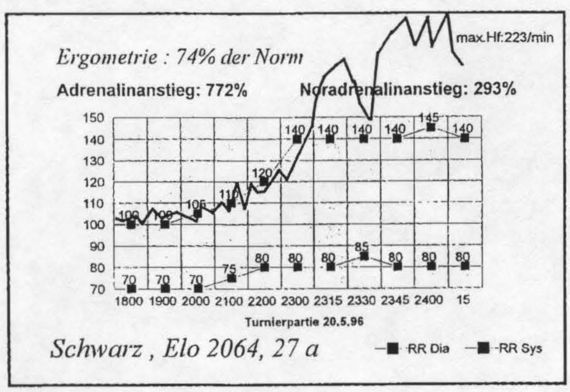

Table 2. A game with some excitement!

It is also interesting to note that this player's adrenaline level reached almost eight times his normal rate. Those figures are exceptional, the norm for adrenaline increase was double the resting rate, just as in other sports such as wind-surfing, table-tennis, football, cycling and tennis. In connection with which I find it interesting to recall remarks made to me by a couple of chess players, one who used to play as a striker for the Norwegian national soccer team before being forcibly retired by a cruciate ligament injury and by a Chilean tennis professional who made it into the world's top 50 as a tennis player, that chess is a harder sport, physically, than either of their other occupations. Hollinsky *et al.* noted that subjects experiencing HR in excess of 200/min and big increases in noradrenaline were prone to make simple mistakes on the chessboard because they were under extreme physical pressure. Players who were in particularly good condition physically were able to cope much better, having much lower HR, hardly any noradrenaline increase and made fewer simple errors. Their report stresses the possibility for chess players, who tend to concentrate on pure chess training alone, to optimise their capacity by adding regular physical training (and taking some dietary advice) and that by doing so blunders in their play could be eliminated.

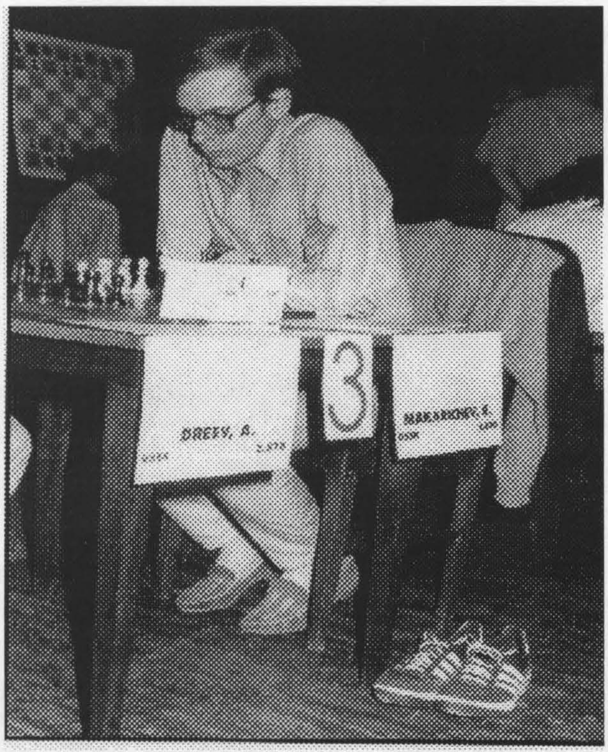

Fig. 2. Prepare to take regular exercise

The benefits of regular, but moderate physical exercise are well-established. The American College of Sports Medicine states that "Persuasive epidemiological and laboratory evidence shows that regular exercise protects against the development and progression of many chronic diseases and is an important component of a healthy lifestyle" (ACSM, 1995). Some of the benefits that they postulate, such as decreased anxiety and depression and enhanced performance of work, recreational and sport activities, would be of direct benefit to chess players. Not only that, but ongoing work at Manchester University's Age Research Centre suggests that there is a "robust correlation between cardiovascular and aerobic efficiency and mental ability" (Rabbitt, 1995). That sample (n=300) is to be re-tested after a three year interval and any changes in mental performance will be noted.

Andreassi (1995) reported evidence that brain activity is influenced by cardiac events, "for example, the decreased HR that occurs under instructions to detect signals leads to a decrease in the inhibitory influence of baroreceptors on cortical function, resulting in enhanced brain activity and improved performance."

All of this research points to the value for chess players of consulting a fitness adviser to establish a suitable exercise routine appropriate for the particular individual.

NUTRITION

Hollinsky *et al.* (1996) seemed horrified by the mess they found when investigating players diets. They found some players eating very heavy meals (even immediately before the game), some eating nothing but fruit, some eating no vegetables and others fasting for twelve hours a day. They were clear that professional dietary advice is required. Any sports person should adopt a healthy diet and chess players are no different, so they should, generally speaking, boost their carbohydrate intake to some 60% of their energy intake and reduce their fat consumption to no more than 30% of their energy intake. However, some elements of research suggest that some more closely targeted dietary recommendations may be valid.

High-protein meals should generally be avoided, especially prior to play. They raise resting metabolic rate substantially more than high-carbohydrate meals and "this metabolic heat adds additional strain to the body's heat-dissipating mechanisms ... concurrently, the breakdown of protein for energy facilitates dehydration during exercise" (McArdle *et al.,* 1996).

McArdle *et al.* (1996) state that it is not uncommon for an athlete to lose 1-5kg of water due to sweating during either practice or a game. Performance may be impaired by as little as 2% dehydration and losses in excess of 5% of body weight can decrease work capacity by about 30% (Saltin and Costill, 1988). Dehydration is a known problem faced by most players, especially those who are just below the top elite, for although the top hundred or so players can normally expect to compete in air-conditioned comfort, with no more than one round per day, the rest of the currently (FIDE, 1997) 22,500 internationally rated players more often compete in events which involve two or even three games per day, a possible total of some twelve hours competition daily, in events which are often held in overly warm venues. Therefore, it is important for players to ensure that they have sufficient fluid intake. Players must not wait until they feel thirsty - that itself is a sign of dehydration - but should monitor their urine output, for if it is clear and copious then there is no problem, while if it is dark and in limited supply, that is a sure sign of dehydration (Burke, 1994). Also it is important to note that body water represents approximately 60% of body mass and that this can be decreased by the ingestion of alcohol and caffeine - although this has been noted as conferring an advantage in jumping events this comes at the expense of endurance, so chess players should beware (unless they are playing only very short games that are full of knight moves!).

One route to tackling simultaneously the problems of carbohydrate/lipid/protein balance and dehydration, and one which would be especially appropriate for players faced with a possible twelve hour day when time available for meals may be extremely short and may anyway not coincide with restaurant opening hours, is that of commercially prepared liquid meals. "They are high in carbohydrates but contain enough lipids and proteins to contribute to a feeling of satiety. Because they are in liquid form, they contribute to the athlete's fluid requirements. The liquid meal also is advantageous because it is digested rapidly, leaving essentially no residue in the intestinal tract" (McArdle *et al.,* 1996).

The influence of diet on intellectual efficiency has featured in at least one study, Holck (1929) demonstrating that modifications in diet had a beneficial effect on solving chess problems[4]. David Bronstein, who drew a match for the world championship title in 1951, strongly recommends caviar as part of a chess player's diet (Bronstein, 1991). There is research which suggests that he may be right. Caviar is rich in omega-3 fatty acids. Various studies have correlated decreased omega-3 fatty acid consumption with increasing rates of depression (Hibbeln & Salem, 1995). Not only that, but there seem to be potentially large general health gains because there are indications that "a dietary intake of .5 to 1.0 grams of omega-3 fat per day reduces the risk of cardiovascular death in middle-age men by about 40 per cent" (Anderson, 1995). The addition of vitamin E (e.g. vegetable oils, nuts, seeds and wheatgerm) to the diet at the same time will help prevent the omega-3 fats from being oxidised. If omega-3

Fig. 3. caviar for chess players

fatty acids (especially DHA - docosahexaenoic acid - and also eicosapentaenoic acid) are beneficial to health in general (McArdle *et al.*, 1996) and help to minimise or reduce the development of depression (Hibbeln and Salem, 1995), they can be unreservedly recommended to chess players. "It's obvious that the less depressed you are, the higher will be your motivation and drive to succeed as an athlete, so inclusion of omega-3 fats in your diet may be favourable to performance from a mental standpoint" (Anderson, 1995). Of course, caviar may be regarded as a rather expensive source and most people, at least outside of Russia, are very much more likely to use oily fish such as herring, mackerel, salmon, sardines, trout and tuna to provide these fats. Andersson (1995) has a couple of other relevant conclusions: "the addition of fish to your diet several times weekly may decrease your risk of cardiovascular disease and depression" and "it's also possible that omega-3s might improve performance by upgrading blood flow."

Probably no sportsman or woman on earth is unaware of the fact that alcohol, other than in moderation (and even then it is important to note that it is diuretic), is likely to have a detrimental effect upon performance. However, many chess players have been known as great drinkers, so it is relevant to look at the likely effects of over-indulgence in this area and whether anything can be done to mitigate those effects. Taking in a lot of 'empty calories' from alcohol can lead to nutritional deficiencies, including a lack of B vitamins. Vitamin B1 (thiamine) "plays an important role in the oxidative decarboxylation of pyruvate to acetyl CoA, an essential step in energy production from CHO [carbohydrate]" (Brouns, 1993). Thiamine is generally deficient in alcoholics. Severe thiamine deficiency may result in irreversible pathological damage resulting in mental confusion, learning disability, and loss of recent memory (Dhopeshwarkar, 1983). Poor absorption could be due to a decreased level of the dephosphorylation of dietary thiamine phosphate (Baker *et al.,* 1975). Excess thiamine is cleared by the kidneys, so players at risk would be well advised to eat more pork, liver, heart, kidneys, fortified white bread, fortified breakfast cereals, potatoes, nuts and pulses, all of which are important sources of the vitamin. Even non-drinkers might wish to increase their intake of B vitamins since there are no reported dangers of even high levels of intake and Burke and Heeley (1994) state that Bonke and Nickel (1989) found that pentathletes who took large daily supplements (300mg/600mg/600µg of vitamins B1-thiamine/B6-pyridoxine/B12-cyanocobalamin) over an eight week period improved their shooting accuracy. As with almost everything else, chess-specific research is needed.

So called carbo-loading has been a 'hot' item in sports science in recent years, but its benefit for low-intensity exercise is considered negligible since such exercise is largely fuelled by the oxidation of lipids. However, it is possible that glucose feeding could be of relevance to chess players. McArdle *et al.* (1996) point out that such ingested glucose may either spare muscle glycogen (relevant only to high-intensity exercise) or "help maintain a more optimal level of blood glucose, which prevents headache, light-headedness, nausea, and other symptoms of central nervous system distress." That could certainly be beneficial to chess players, especially since glucose is the sole source of fuel for the brain and consumption increases greatly under load. However, such feedings should be at least one hour before the start of a game because within that hour they may negatively affect performance by "rapidly raising blood sugar, causing an excess release of insulin to produce a relative hypoglycemia" (McArdle *et al.,* 1996) and research has also indicated the early onset of fatigue in endurance activities (Foster *et al.,* 1979).

A good, healthy balanced diet should be followed, in line with any other sports person. Finally, it should be noted that vegetarians, of which there are several in the upper echelons of chess players, need to pay special attention to ensuring that they do not suffer a deficiency of vitamins and minerals. In particular, they should pay special attention to iron (a common deficiency among vegetarian athletes according to Brouns, 1993) and vitamin B12 (cyanocobalamin) which is a coenzyme in nucleic acid metabolism and also influences protein synthesis and for which meat is virtually the only source (fermented foods are also a source according to Cerqueira *et al.,* 1979), but since it apparently takes 20 years to deplete B12 stores (Frail, 1994), most players will have plenty of time to look for an appropriate supplement.

FATIGUE

Chess games are lost not won in the sense that from an initial position with no weaknesses players gradually unbalance the position and, in so doing, commit a number of mistakes which range in size from the imperceptible to the gross. The most important thing in practical chess is to avoid oversights (Purdy, 1962). It is clear that fatigue is a major contributory cause of error in chess and that two of the five main metabolic causes of human fatigue (Newsholme, 1995) are potentially relevant. These are the decrease of blood glucose concentration and an increase in the concentration ratio of the free tryptophan to branched chain amino acids in the bloodstream.

In brief, the central fatigue hypothesis (after Newsholme, 1995) runs as follows. During exercise there is an elevation in the blood adrenaline level and a decrease in that of insulin which results in fatty acid mobilization from adipose tissue, consequently increasing the level of fatty acids in plasma (formula one racing drivers, who experience similar adrenaline levels to chess players, have been noted for their 'milky' plasma). For some athletes there may be a close control between mobilization of fatty acids and oxidation thereof within muscle, but this mechanism probably plays only a very small part in the metabolism of racing drivers and chess players, hence the elevated levels of fatty acids in plasma. In this case the plasma concentration of free tryptophan will rise. It is believed that the free form of tryptophan (which also exists in a form bound to albumin) competes with branched-chain amino acids for entry into the brain. It is also predicted that the plasma concentration of free tryptophan influences the entry of tryptophan into the brain. In the brain tryptophan is converted to the neurotransmitter 5-hydroxytryptamine (5-HT, also known as serotonin) An increased level of tryptophan in the brain increases the formation of 5-HT and hence increases the level of this neurotransmitter. This could result in increased activity of some nerves in the brain and this might result in central fatigue since it is known that 5-HT is involved in sleep.

"Serotonin was first proposed as a potential mediator of central fatigue by Newsholme and colleagues in 1987. There is a large body of literature linking alterations in brain 5-HT activity to various psychological responses such as arousal, lethargy, sleepiness, and mood [Young, 1986], all of which could play a role in the central mechanisms of fatigue" (Davis, 1995). "An increase in the level of 5-HT in the brain is known to cause tiredness, improve the quality of sleep and improve mood, as well as causing a decrease in aggression" (Newsholme *et al.*, 1994), which sounds like very bad news indeed for the serious chess player who has been working at the board for four hours or more and needs to maintain his levels of energy output, alertness and focussed aggression. Just to make matters a little worse still "it may even play a part in explaining the phenomenon of excessive arousal in athletes prior to competition which decreases performance" (Newsholme *et al.,* 1994).

The key element, at least for chess players, appears to be the connection between the branched-chain amino acids (the BCCAs valine, leucine and isoleucine) and free tryptophan. Because they both compete for entry into the brain via the same carrier system, if the blood concentration of BCCAs increases, then less tryptophan will enter the brain, less 5-HT will be manufactured, resulting in a decrease in fatigue and an increase in aggression. Blomstrand *et al.* (1988, 1989, 1991a, 1991b) have reported a decrease in BCCAs for marathon runners, soccer players and cross-country skiers. Blomstrand *et al.* (1991a) report that a mixture of the three BCAA was given to subjects during a 30-km cross-country race or a marathon (42.2 km) and the effects on mental and physical performances were measured. The results showed that both mental and physical performance was improved by an intake of BCAA during exercise. On the other hand, Newsholme *et al.* (1994) state that "In other studies of a similar kind, no improvement in performance could be attributed to the consumption of BCAA drinks, but questionnaires showed the perceived effort to be significantly lower - it made the run that much easier!" Such products are now commercially available and in view of Professor Newsholme's (1997) statement that BCAA drinks apparently improve mental agility, it would seem that chess players should start to experiment with them pending further research and, preferably, a full scale chess study.

CAFFEINE

Interest in the effect of caffeine on exercise performance dates back to the early years of this century. Bock (1920) stated that all parts of the central nervous system are stimulated, but in man the cerebrum and its psychic functions are stimulated most. Sollmann (1932) found that moderate doses of caffeine (up to 0.3 gram) cause "a quicker and clearer flow of thought; disappearance of drowsiness and fatigue; more sustained intellectual effort; ... and more perfect association of ideas." The following year chess became the test-bed for another piece of research when Holck (1933) at the American University in Beirut carried out a host of tests on an unusual guinea pig who had not touched coffee or tea for some 25 years. The subject was tested on 255 chess problems (17 tests) with caffeine and a similar series with saline injections. The 34 sessions were spread over almost three months and in this period Holck went to considerable lengths to ensure as uniform conditions as possible, the subject spending 8.5 to 9 hours in bed the night before any test, then a breakfast (which may have become a little monotonous by the end) of "three heaping tablespoonfuls of clabbered milk (a common Syrian[5] dish) covered with grapenuts and flavoured with a little sugar; this was followed by a small dish of the cereal, wheatena, with a piece of butter and a little sugar; finally, a glass and a half of water was consumed." An hour after breakfast, and half an hour before the solving test began, the subject was injected with "200 mgm. of caffeine sodium benzoate, the United States' Pharmacopeial dose, in 0.4 ml. of distilled water, or administered 0.4 ml. of Ringer's solution subcutaneously into either one of the upper arms, but in such a manner that the subject would not know on which days he got caffeine and on which saline." The records show the following alternation of caffeine (C) and saline (s): CCsCCssCCsCsssCsCCssCssCsCCsCsCssC. The injection was followed by the drinking of 200 ml. of water "so as not to have the test interrupted by thirst." The results (tables 1, 2, and 3 and figure 1 - my composite Fig.4) showed that "with saline injections the production was 9.5 problems per hour, gross, and 9.0, net; with caffeine it was 10.2 and 9.8, respectively. This is 7 per cent improvement after caffeine in the gross and 9 per cent in the net. One can not safely conclude from this that the above dose of caffeine with certainty improves the capacity to solve two-move chess problems; the difference is too small. A further study of the data indicates that if one arranges all of the problems in order from slowest to fastest solving time per problem, there may be less tendency to use an unusually long time per problem after caffeine."

TABLE 1

Summary of analysis of chess-problem tests

	NUMBER OF PROBLEMS	MEDIAN	MEAN	PROBLEMS SOLVED		ACCURACY	PERCENTAGE OF PROBLEMS IN RELATION TO AVERAGE TIME AND TO ACCURACY			
				Per hour	Accurately per hour		++	+−	−+	−−
		minutes	*minutes*			*per cent*				
Saline........	255	4.4	6.3	9.5	9.0	95.7	64	3	31	1
Caffeine......	255	4.4	5.9	10.2	9.8	96.5	63	2	33	2

TABLE 2

Analysis of the complexity factor

	PIECES PER PROBLEM	NUMBER OF PROBLEMS	SOLVED PER HOUR	ACCURATELY SOLVED PER HOUR	PERCENTAGE OF ERRORS
Saline					
A	8-13	87	11.5	11.5	0
	14-17	94	9.2	8.5	7
	18-24	74	8.1	7.6	5
B	17-21	83	7.6	6.8	10
All others		172	10.8	10.6	2
Caffeine					
A	8-13	94	10.1	10.1	0
	14-17	96	10.2	9.6	5
	18-24	65	10.3	9.5	6
B	17-21	75	9.3	8.7	7
All others		180	10.6	10.4	2

TABLE 3

Analysis of factor of solving piece

SOLVING PIECE	PROBLEMS IN EITHER CASE	SALINE			CAFFEINE		
		Solved per hour	Accurately solved per hour	Percentage of errors	Solved per hour	Accurately solved per hour	Percentage of errors
Queen..........................	88	11.8	11.6	1	12.2	12.0	1
Rook...........................	45	7.0	6.5	7	9.7	9.5	2
Bishop.........................	38	10.9	9.8	10	10.5	9.7	8
Knight.........................	52	9.6	9.4	2	8.7	8.2	6

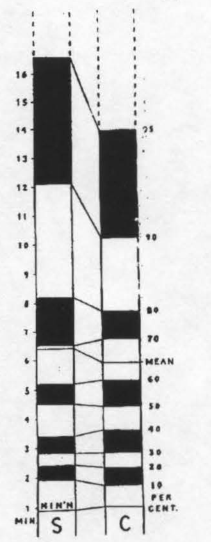

FIG. 1. SHOWING RANGE IN SPEED OF CERTAIN PERCENTAGES OF CHESS PROBLEM GROUPS AND A RATHER SLIGHT TENDENCY TO IMPROVEMENT AT THE SLOW END DURING THE CAFFEINE TESTS

Fig. 4. A composite of Holck's results

Part of Holck's (1933) summary was, for chess players, of potentially much greater interest, for it suggests avenues of research which might lead to a reduction in error: "... when there were fewer chess men in a problem (8-13), the tendency to make mistakes was less, both in case of saline and of caffeine injections. We also have further evidence to show that the solving piece must be considered; when the queen was to be used in the first move the efficiency was clearly better and the mistakes fewer than in the case of the rook, bishop or knight, respectively." This, however, is more relevant to the psychology of chess.

Van Handel (1983), reviewing the literature on caffeine and psychomotor performance, concluded that caffeine may help to improve reaction time, increase alertness and heighten a sense of well-being. Williams (1985) noted that others reviewing the same literature have concluded that the effect of caffeine on psychomotor performance is equivocal. It would be most interesting to see the results of a study to assess the impact of caffeine on the reaction times of chess players using the three simple tests developed by Cerny (1965). That is a piece of research waiting to be done.

So, does caffeine ingestion improve performance during exercise and sport competitions? And if it does, what are the mechanisms responsible for such improvements? Spriet (1995) points out that earlier equivocal evidence comes from less than perfectly conducted studies while recent studies "with more careful controls indicate that caffeine is an ergogenic aid during prolonged endurance exercise and short-term intense exercise." Certainly the International Olympic Committee seems to be convinced, for the maximum permitted level of 15µg/mL caffeine/urine was reduced to 12µg/mL for the 1988 Olympic Games, with higher levels being considered as doping, and is apparently considering moving it from the list of controlled substances to the list of those that are banned. Spriet also reviews the three major theories for the ergogenic effect of caffeine during exercise: "The first theory involves a direct effect on some portion of the central nervous system that affects the perception of effort and/or affects the propagation of neural signals somewhere between the brain and the neuromuscular junction. The second theory proposes a direct effect of caffeine or one of its by-products on skeletal muscle. ... The third theory involves an increase in fat oxidation and a decrease in carbohydrate (CHO) oxidation."

Although individual responses vary considerably, not only between individuals but also over time, the amount of caffeine that would need to be ingested to go 'over the limit' set by the IOC is considerable. "For example, if a 70-kg person drank ~3-4 mugs or 6 regular-size cups of drip-percolated coffee ~1 hr before exercise, exercised for 1-1.5 hr, and then gave a urine sample, the urinary caffeine limit would only be approached. The odds of reaching the limit through ingestion of coffee are low" (Spriet, 1995). According to Spriet the optimal dose for performance enhancement would be ~3-6 mg/kg since "at this dose, side effects are minimized, and urine levels will not approach illegal limits."

Since many researchers ask subjects to refrain from caffeine ingestion for two or three days prior to experiments, players might consider it worthwhile to take a break from caffeine for a few days prior to tournament competition even though habitual caffeine consumption does not seem to weaken caffeine's ergogenic power (Van Soeren *et al.,* 1993).

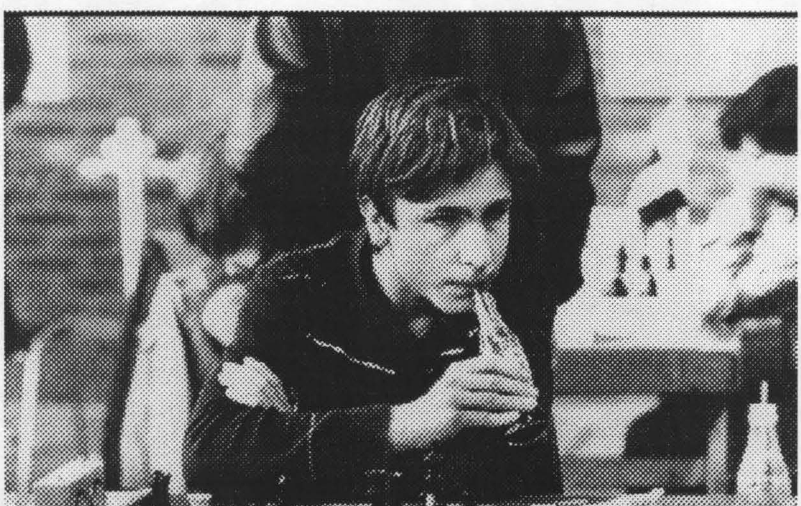

Fig. 5. Caffeine - ah yes, I remember it well

Research from other areas confirms caffeine's value as an ergogenic aid and points to an interesting possibility for chess players. Jarvis (1993) examined the relationship between habitual coffee and tea consumption and cognitive performance using data from a cross-sectional survey of a representative sample of 9003 British adults. After controlling extensively for potential confounding variables, a dose response trend to improved performance with higher levels of coffee consumption was observed. Similar but weaker associations were found for tea consumption, which were significant for simple reaction time and visuo-spatial reasoning. Older people appeared to be most susceptible to the performance-enhancing effects of caffeine. This confirmed the findings of Lieberman *et al.* (1987) that caffeine has stimulant-like behavioural effects on mood and performance. They had found that "as little as 32 mg (which elevated plasma caffeine concentration to less than 1 µg/ml), typical of the dose found in a single serving of a cola beverage, and less than that found in a single cup of coffee or a single dose of over-the-counter drugs, significantly improved auditory vigilance and visual reaction time." Consider also the work of Riedel *et al.* (1995) for they concluded, after their studies of caffeine and nicotine as attenuators of scopolamine-induced memory impairment, that caffeine possesses cholinergic cognition enhancing properties. Results which were put rather more memorably by *The Times*'s Nigel Hawkes, under the headline "Don't forget to drink coffee" as the finding that "coffee is an effective stimulant, able to reduce forgetfulness by half" (Hawkes, 1997). That was a reference to the 48% relative attenuation figure from Riedel *et al.*'s table 7 and was perhaps reading rather a lot into what was only one small item among a whole raft of data. Riedel *et al.* actually reported that "Caffeine would have been expected to increase speed in cognition tests rather than improve qualitative scores of cognitive performance such as free recall of words and perceptual sensitivity of word recognition and signal detection. The effects of caffeine on these latter parameters therefore seem to confirm our hypothesis that, at least when there is cholinergic dysfunction, caffeine acts as a cognition enhancer rather than a CNS stimulant." I feel sure that those researchers would be very interested in Holck's 1933 experiment. My own conclusion from all this is that for chess players the timing of caffeine ingestion is likely to be important, aiming for the maximum effect during the first hour or two of play when the importance of memory will be at its greatest, in trying to recall as much as possible from one's database[6] concerning the opening variation used in the game.

Players scarcely need reminding how serious a failure of memory can be, but here is an example of one of the most notable examples to have occurred in recent years at the absolute top level. The game Kasparov-Lautier, Amsterdam 1995, was effectively decided by the strongest player in the history of chess forgetting a piece of opening preparation which would have given him a decisive advantage.

Garry Kasparov – Joel Lautier

Amsterdam, Euwe Mem (4) 1995

1.e4 c5 2.♘f3 e6 3.d4 cxd4 4.♘xd4 ♘c6 5.♘c3 ♕c7 6.♗e3 a6 7.♗d3 ♘f6 8.0–0 ♘e5 9.h3 ♗c5 10.♔h1 d6 11.f4 ♘ed7 12.a3 b5 13.♗xb5 axb5 14.♘dxb5 ♕b6 15.♗xc5 dxc5 (Fig. 6) **16.♘d6+?** Kasparov declared after the game that the following line, which he had in his notebook (i.e. his notebook computer), would have won. But he totally forgot about the move e5 during the game. As a direct result of that forgetfulness (repeated by him just two rounds later when he also forgot some of his notebook material for the opening of his game against Piket), Kasparov lost this game and Lautier went on to win the tournament. [16.e5 ♗a6 17.a4 ♗xb5 18.♘xb5 ♘e4 19.♕f3 f5 20.exf6 ♘dxf6 21.♘c3 ♕b7 22.♖fe1] **16...♔e7 17.♘xc8+ ♖hxc8 18.e5 ♘e8 19.♕h5 h6 20.♖ae1 f5 21.♖f3 c4 22.g4 fxg4 23.♕xg4 ♖a5 24.♘e4 ♕c6 25.♘d6 ♘xd6 26.exd6+ ♔f8 27.♖g1 g5 28.♖gg3 ♖f5 29.♕h5 ♘f6 30.♕xh6+ ♔f7 31.♔g1 ♖g8** Lautier's post game comment was "I think he should read his 'notebook' more often" (Welling, 1995). But we now know that 'I think he forgot to drink his coffee' might be more appropriate. **0–1**.

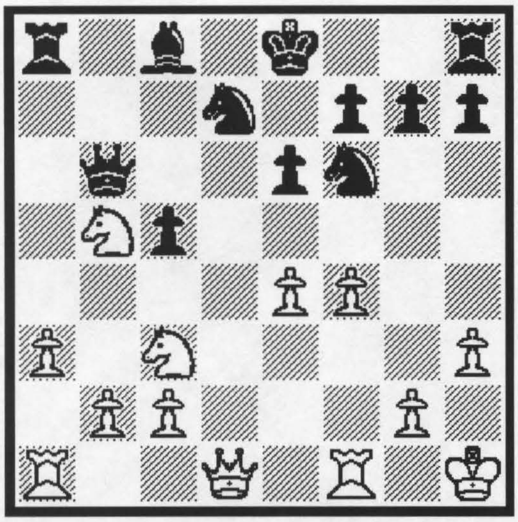

Fig. 6. Kasparov-Lautier

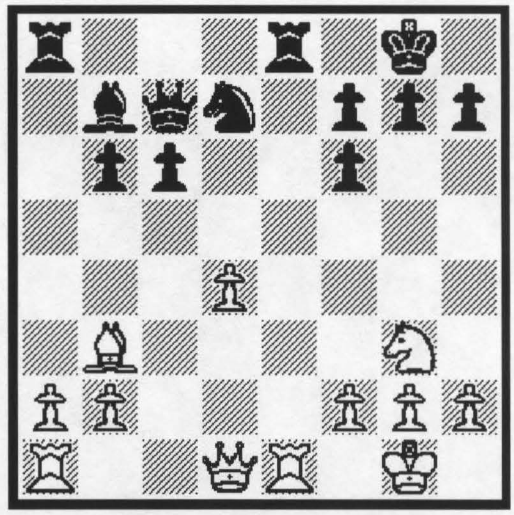

Fig. 7. Spassky-Pfleger

BETA-BLOCKERS

In the cause of science Dr Pfleger played one game after taking a 'beta-blocker' (a tablet of Beloc). Such drugs nowadays are much used by people with heart problems. Beta-blockers slow heart rate and reduce tremor, hence they have been, at least allegedly, popular with many snooker players, rifle and pistol shooters. In Pfleger's own words he did this "for the first (and last) time." His heart rate varied between 40 and 65 (instead of his normal range of 80-110) and his blood pressure was also much below normal. He played feeling that he had no worries, even after his gross blunder of Rf8-e8. Newsholme *et al.* (1994) mention that beta-blockers might also play a role in some sports to reduce the effects of adrenaline released in massive amounts "in 'scary' sports such as ski-jumping and bob-sleighing, in which fine control is still essential." Perhaps players such as the 27-year-old rated 2064 in the Hollinsky study (table 2 above) could benefit from beta-blockers, but for the rest let Pfleger's experience, which follows in all its gory detail, be a lesson.

Boris Spassky – Helmut Pfleger

Munich 1979

1.e4 c6 2.d4 d5 3.♘c3 dxe4 4.♘xe4 ♘d7 5.♗c4 ♘gf6 6.♘xf6+ exf6 7.♘e2 ♘b6 8.♗b3 ♗d6 9.c4 ♗c7 10.♗f4 0–0 11.♗xc7 ♕xc7 12.c5 ♘d7 13.0–0 b6 14.cxb6 axb6 15.♖e1 ♗b7 16.♘g3 The game so far has given the impression that Black was being very careful to keep the position as quiet as possible, but his next move gives more the impression that Black was asleep or, at the very least, had his sense of danger dulled. **16...♖fe8?** (Fig. 7) **17.♗xf7+! ♔xf7 18.♕h5+ g6** [18...♔f8 19.♕xh7 ♕f4 20.♘f5 ♕g5 21.♕h8+ ♔f7 22.♘d6+ winning (Stean, Informator 27/205).] **19.♕xh7+ ♔f8 20.h4!** with the idea of 21 h5 gxh5 22 Nf5 being decisive. **1–0.**

CONCLUSION

In almost all of the areas that I have considered above chess-specific research is needed, without which the prevailing level of uncertainty of the validity of applying existing research to the field of chess must be high. However, chess players are only too familiar with uncertainty since a player's working life is largely spent in this very state (being uncertain about who stands better in the position on the board in front of him and being uncertain about how best to handle the position and therefore being uncertain about what to do) but procrastination is not an option - chess players receive constant feedback that procrastination at best leads into time pressure and often directly to a loss. No, chess players are good at making decisions, as best they can on the basis of whatever knowledge they have available. For all these reasons I conclude with the following recommendations:

- follow a programme of regular physical exercise, even if this consists only of a brisk 30-minute walk a minimum of three or four times a week;
- adopt a healthy diet which is likely to be similar to that favoured by most athletes with more carbohydrate (especially bread, pasta, rice, potatoes) and less fat (especially less animal fat) and increased consumption of fish (caviar if you can afford it and like it);
- take special care that your fluid intake is sufficient, especially when travelling from tournament to tournament;
- experiment with liquid meals, especially for use in events when it is necessary to play more than one game per day;
- moderate your alcohol intake;
- drink a couple of cups of black coffee or a couple of cans of caffeine containing cola in the hour prior to commencing a game, with a third one during the first half hour of play. Not only should the stimulant effect of caffeine be useful but there is the added attraction that it may improve memory, hence the timing of the ingestion so that maximum benefit may be derived during the opening phase when memory is at its most important.
- finally, steer clear of beta-blockers.

But the last word I leave to Hollinsky *et al.* (1996): "As a result of our studies, all the participants should really have a rethink - players and organizers alike - because chess is not played only with the head but with the whole body and a change of your training towards physical activities as well as a balanced diet are as important as good coaching or theoretical preparation."

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[1]Paul Morphy (1837-1884) demonstrated himself to be the world's strongest player in the period 1857-1858 and then retired from the game. His special contribution to the development of chess was that he was the first leading player successfully to blend the prevalent combinational style with positional play.

[2]Categories were the rating bands then used in the Soviet Union, each approximately equivalent to 150-200 points on the international rating scale. A difference of two categories is roughly that between beginner-club player-county player-international-elite grandmaster-world champion.

[3]Included in the United States Chess Federation's computer.

[4]a chess problem is a composed position, the solving of which may be considered as an element of chess training.

[5]at this time Beirut was the capital of Syria and Lebanon under French mandate.

[6]Serious players almost without exception have a computer database of previously played chess games (often a million or more) and may spend six to eight hours a day working on openings preparation (which will then be added into the player's private database) when not otherwise engaged in tournament competition.

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