ADRIAAN DE GROOT: MARRIAGE OF TWO PASSIONS

A PERSONAL SUMMARY

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TRIBUTE

In this contribution, which is a tribute to Adriaan de Groot in relation to his recent passing away, I would like to introduce the reader to his remarkable personality and to present the main tenets of his psychology of chess skill. I shall start by giving an overview of his chess and academic life. Then, basing my account on his seminal thesis and on more recent empirical and theoretical work, I shall focus on his contributions to chess psychology.

1. Chess and psychology: a double career

Whatever their level, chess players are interested, even fascinated, by the mental processes that allow them to choose a move in a position. There are multiple reasons for this interest: a better knowledge of their decision-making processes may allow them to improve their chess level; it may offer a glimpse on why some chess players have reached the grandmaster level, while others have not; and above all, it may quench the perennial curiosity of most about mental life and its workings.

A groundbreaking response to this question was offered more than sixty years ago by Adriaan de Groot, in a monumental thesis that was published in 1946 (English translation in 1965), and that was devoted, as its title in translation "Thought and Choice in Chess" indicates, to the psychology of thinking and decision making in chess. De Groot's thesis did not, however, attract the interest of chess players only; it was a harbinger of the cognitive revolution in psychology that would occur in the early sixties. Because of its strong impact on cognitive psychology, and because of the breadth of the study, de Groot's thesis can safely be considered a classic in the field.

Adriaan D. de Groot was born on October 26th, 1914, in Santpoort, a village near Haarlem, in a family where education and chess were held in high esteem. After the Gymnasium, de Groot took physics and mathematics at the University of Amsterdam. At the time, there was no direct curriculum for studying psychology in the Netherlands, and students had to take psychology as a post-candidate addendum to established disciplines. Among his teachers in mathematics, one finds Brouwer, the famous founder of the intuitionist school. In addition to being a rich time for his scientific education, this was also an exciting time for his chess career. As he put it: "I was half a student, half a chess player".

1.1 The chess experiments

Early on, de Groot decided to combine his interests in chess and in psychology. In 1938, he published an essay on the role of talent in chess. More importantly at this time, he started to collect data on what was to become his Ph.D. thesis. His main interest was on the processes that allow chess players to choose a move. Two main tasks were designed to explore the mind of chess players. In the first, chess players had to think aloud when studying a position unknown to them. The *protocols* – that is, the transcripts of players' verbal utterances – obtained in this way were subjected to a deep statistical and interpretative analysis. The results were surprising: grandmasters do play better moves, but do not differ substantially from candidate masters in structural variables such as the number of moves, the depth of search, the number of positions visited, and so on. These results led de Groot to suspect that the obvious superiority of masters in chess skill had to do with how they perceive a position. This induced him to devise a second type of experiment that attempted to shed light on chess players' perception and memory. In this task, a position was presented for a short amount of time (from 2 to 15 seconds), after which subjects had to reconstruct it as precisely as possible. De Groot found a huge

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superiority of masters over candidate masters and amateurs. We will have more to say about these results and their theoretical interpretation in the second part of this contribution.

The way de Groot collected the data of his thesis is interesting in itself. Then still a student, he used to earn some money as a chess journalist. In 1938, he was covering the AVRO tournament, which was held in Amsterdam with the world's best eight players. Through the intervention of his friend Max Euwe, de Groot managed to convince, among others, most of the AVRO players to participate in his experiments. Chess giants such as Alekhine, Euwe, Fine, Flohr, and Keres agreed to act as subjects. Some of the experiments – for example, the one with Tartakover – were run on the steamer carrying the players to the 1939 Olympiads in Argentina. The protocols are reproduced in the English edition of de Groot's thesis and, apart from their scientific value, are great fun for chess aficionados to read.

1.2 The war years

As it was to be rapidly overtaken by his scientific duties, de Groot's (active) chess career was short, and took place mainly during his student years. During his first participation in a tournament abroad, he defended the Netherlands in the Nations' Tournament (unofficial Olympiads) held in Munich (1936). Later, he played in the Stockholm (1937) and Buenos Aires (1939) Olympiads (Holland finished 6th and 8th, respectively). In 1937, he was champion of Amsterdam, and then, in 1938, he finished fourth in a very strong version of the Dutch Championship, in which the best players of the country took part, including the (ex-)world champion Max Euwe. The war and the preparation of his dissertation slowed down his chess activity. His last participation in an international tournament was in 1947, in the Hoogoven tournament. In general, his style may be characterised as an active search for initiative, as will be clear from the games presented below.

Although rich for research in chess psychology, the early forties, a tragic period in history of humankind, had their share of sadness for de Groot. Friends disappeared or were killed by the Nazis. An important loss for de Groot was the death of the German psychologist Otto Selz, who was deported to a German concentration camp in 1943 because of his Jewish origins. Selz, who landed in Amsterdam (1938) as a late refugee professor of psychology, has had a profound impact on de Groot's thought throughout his entire career. The main thrust of de Groot's thesis was to provide evidence for Selz' proposition that human thought can be described as a linear chain of operations.

1.3 Academic career

During the war, de Groot's career swung away from chess. He did some work as a secondary school teacher in mathematics and as a staff psychologist in an institute for industrial and vocational testing. In 1946, he was psychological advisor to Philips' Electrical in Eindhoven. He became lecturer in 1948 and then a professor in 1950 at the University of Amsterdam. Here, he started his long-term research on methodology, applied psychology and education, which earned him wide recognition in the Netherlands. His main contribution was raising the level of expertise in the fields of achievement testing and psychometrics, a sub-field of psychology devoted to the development of instruments for measuring psychological aptitudes and traits. This resulted in the establishment of an Institute for achievement test development at the disposal of the Netherlands educational system and in founding a strong Dutch tradition in psychometrics. He also published an influential book on methodology (1961, 12th edition 1994) in which, in addition to more technical material, he presented some of his views on the philosophy of science. Note the broad range of scientific contributions: cognitive psychology, education, methodology, and the philosophy of science. Curiously, we can add psychoanalysis to this list, as he published early in his career a psychoanalytically oriented book on the legend of Saint Nicholas (1949), a legend that is to be found in many parts of Europe.

In the sixties, his interest in chess psychology, which had somewhat faded since the completion of his thesis, was revived. During the year he spent at the Stanford Center for Advanced Study in the Behavioral Sciences, de Groot and his young Dutch colleague Nico Frijda had a brief stay at the Carnegie Mellon Institute of Technology, to visit Artificial Intelligence researchers and psychologists Herbert Simon (see game 4) and Allan Newell, who were working on programming a computer to play chess. On his return to the Netherlands, he started with Frijda a project called "Thought and Memory," part of which was an experimentation program on chess perception and memory. The project included an application of information theory to chess and the study of chess players' eye movements. Riekent Jongman, then a student of de Groot and a strong chess expert,

played an instrumental role in the research. His thesis (Jongman, 1968) gives a good overview of the main questions addressed by the Amsterdam group.

1.4 Later interests

Retired since 1985, de Groot resided with his wife Elsa in Schiermonnikoog, a Friesian Island north of Groningen. His many interests kept him quite busy: completion of some old scientific projects, music – both as a piano improviser and violinist in an amateur chamber music ensemble – and ... chess. And, of course, taking care of his many guests.

During his retirement, de Groot spent much of his energy on philosophical questions, most of them related to psychology. A first theme is related to the notion of *truth* in science. The *Forum Theory*, which he had been developing over thirty years, insists on the idea that science is a communal activity directed towards rational consensus. As there is no absolute truth in science, all that scientists can do is to strive for truth, that is, to strive for theories having the highest possible level of certainty. This criterion is met in the case of statements that are unanimously endorsed by all pertinent scientific experts. Such statements then are scientifically *true* to the best of our present knowledge. Neither are the rules for the correct way of conducting science unchangeable or indisputable. These, too, are to be discussed, and agreed upon in what de Groot calls the *forum of expert opinion.* A second important theme in de Groot's reflections was a conception of *unifying psychology*, a field that is now split into innumerable schools. His approach to this gigantic task was to strive for *agreements on the definitions* of basic concepts in scientific psychology. De Groot conceded that the task of bridging methodological and terminological differences between schools will not promise any early success. However, connectibility of terminology and method is a necessary requirement for any mature scientific discipline, he argued. Working on it is a must.

For many years, chess remained among his scientific interests. With Dap Hartmann, Jaap van den Herik, Fester Medendorp, and the late IGM Lodewijk Prins, he analysed material based on the interviews with chess players, computer scientists, and social scientists on various aspects of the game of chess. He published with me a book devoted to previously unpublished research on chess perception and memory (see the second part of this article). Finally, his research on intuition used chess as an exemplar task domain.

Up to 2000, de Groot was active. However, except for some occasional tournaments with friends and a few correspondence games, competitive chess had disappeared from de Groot's life. Yet, he remained very interested in the world of chess, and in particular in computer chess – the *International Computer Chess Association Journal* being one of his favourite things to read. On chess computers, and on the simulation of cognitive processes with computers, de Groot had a very strong position: both are useful, and are likely to teach us a great deal about computer science, psychology, and chess. However, both were in his opinion limited whenever intuition entered the picture. According to de Groot, the vagueness and flexibility of the intuitive capabilities of highly experimented experts in a field were not amenable to programming.

De Groot, often with a smile on his face, always gave the impression of being a nice person. "People say this because I'm an old professor", he used to joke. It is hard not to be taken by his conviction that life is fun. Fun was for example the book in Latin (!) he once finished reading with his wife Elsa. Fun also was the challenge offered by the sociology and philosophy of scientific research. Fun was to replay games between chess computers and humans, even if computers won too often …

2. The mind of a chess player

Why should psychologists be interested in chess players? Besides the fact that it is, for many of them, an agreeable way of mixing their work and their favourite hobby, some more persuasive reasons should be mentioned. First, chess is a difficult task, requiring years of practice to be – partly – mastered. Second, chess is relatively easy to formalise. Third, there is a clear-cut distinction in skill levels, both with the system of titles and with the ELO ratings, the latter offering the advantage of being a quantitative measurement of skill.

2.1 "Thought and choice in chess": the foundations

De Groot's thesis was motivated by two ambitious questions. First, how do the thought and decision processes of chess masters operate? Second, what are the differences in cognitive processing between chess

(grand)masters, candidate masters and amateurs? These two questions, when one substitutes "chess masters" by "experts" and "chess amateurs" by "novices", are still highly topical and are the focus of an active subfield of psychology.

Chess folklore offers two contradictory answers. On the one hand, there is the conception that extraordinary capabilities of looking ahead and computation are at the source of chess mastership. On the other hand, there is the stringent answer of Reti, that, when thinking about his next move, he did not look more than one move ahead. Selectivity, then, is the name of the game, and not looking ahead.

We have already described de Groot's main experimental procedure: to ask subjects to think aloud when thinking about their next move – as they would do in one of their games – in a position previously unknown to them. A very simple experimental design indeed, which does not require more than a chess board, a chess clock, and paper and pencil[4] to jot down subjects' statements. His subjects were six world class players, four Dutch masters, five candidate masters, two female Dutch champions, and five weaker players. Not surprisingly, strong players did choose better moves than weaker players. The real question was how this choice took place.

De Groot submitted his data to two kinds of analysis: quantitative and interpretative. The first type of analysis, the one that is almost exclusively mentioned in modern technical literature, addressed mainly the question of the differences, if any, between experts and non-experts. The second type of analysis attempted to describe in detail how a choice was made by players.

Various measurements were taken from the protocols, such as the time to choose the best move, the number of different positions examined during the analysis, the number of different first moves proposed, and so on; altogether, there were about twenty variables. The huge surprise was that for most of these variables, there was no difference between masters and weaker players. In particular, strong players did not calculate significantly deeper than weaker players (the average maximal depth was 6.8 half-moves for the grandmasters, compared to 6.6 half-moves for the candidate masters, and 5.5 half-moves for the weaker players). Even for variables that differed between levels of skill, the absolute differences were minimal, and could hardly be used to explain the huge variation in the quality of moves chosen. Finally, it was clear that most subjects were very selective: from the 30 or so possible moves that White could play in the given position, they mostly investigated three or four of them.

Most of the book, however, was devoted to a qualitative analysis of the structure of the decision processes in relation to Otto Selz's theory of problem solving. A first result of the protocols was that subjects investigated the same continuation several times, either immediately, or after having directed their attention to a different variation. This process, which de Groot named *progressive deepening*, seems to operate both due to limitations in human processing capacities, and because it allows newly discovered information to be integrated with previous variations.[5] Progressive deepening is also a result of the cyclic organisation of chess players' thought, which may be characterised as a sequence of observation-test-evaluation phases. As larger cycles may include smaller cycles as means of dealing with sub-problems, a player's thought may be described as complex hierarchies of problems and sub-problems. De Groot argued that progressive deepening, as evidenced in chess, characterises most complex, goal-directed thought and choice processes, scientific activity included.

De Groot proposed also that a player's thinking process may be divided into four main phases: orientation, exploration, investigation, and proof. In the *orientation* phase, players collect relevant information and try to form a first (tentative) judgment of the position. During the *exploration* phase, sample variations are analysed, and, typically, the number of critical moves or plans is reduced to two. The two candidate moves are analysed in great detail during the *investigation* phase, which is characterised by a more in-depth search than during the exploration phase. Players strive to validate their favourite move (or plan). Note that most of the argumentation used by chess players consists of convincing themselves that one of the two variations is better than the other. Finally, the *proof* phase is used to recapitulate the information obtained in the analysis and to check the correctness of the argumentation.

[4]Nowadays, a tape recorder or a video recorder makes the experimenter's task easier.

[5]Incidentally, this finding throws doubts on Kotov's training method (in *Think like a grandmaster*, 1971), in which he instructs players, among other things, to visit each branch of the search tree only once.

De Groot described also several *chess methods* used by players to reach their solution. These methods include strategic and tactical plans, ideas, and goals. Note that while they differentiate well between strong and weak players, all these methods are tied to the domain of chess. The higher-level *thought and choice methods*, which organise the structure of the protocol, did not differ between players of various skills.

In summary, masters choose better moves not because they search more deeply or visit more nodes in the tree search, but because (1) they select better lines for further investigation, (2) they evaluate the final positions within a variation better, and (3) they apply better *chess* methods to solve the problem at hand. All these findings point not to a difference in carrying out the search, but to a difference in knowledge, and also in perception (Masters are normally able to zoom in rapidly during the exploration phase to the critical elements of the position).

In order to test this hypothesis, de Groot carried out a simple experiment which was to yield spectacular results. Paradoxically, only 12 pages buried in the chapter on chess talent are devoted to this experiment, which has since been applied to other domains and is now often referred to as "de Groot's recall experiment." Positions were shown for a short amount of time (from 2 to 15 seconds), and subjects then had to reconstruct the position as accurately as possible. As noted before, the results were stunning: Grandmasters were able to reproduce correctly almost the entire position, whilst weaker players could retain only a few pieces. A more qualitative result was that masters were able to understand the gist of the position very rapidly – even with a presentation time below five seconds.

2.2 More about chess players' perception[6]

After an interlude of about 20 years, de Groot again took up the question of chess players' memory and perception. This topic was the thesis theme of Riekent Jongman, a student of his. Besides replicating some of the 1946 book data, Jongman had two goals in mind. First, he wanted to know how remarkable was the performance of chess masters. Second, he wanted to pin down more precisely the question of chess perception: what do chess players really see during the 5 second exposure of a position?

Answering the question of masters' performance is tantamount to establishing how much information is contained in a chess position. If the quantity of information, expressed in bits, or number of possible binary choices, is huge, then the performance of masters is truly amazing. In contrast, if the masters are able to see the position in such a way that it is coded economically, taking advantage of the redundancy in the position, then the quantity of information is of more manageable size and the masters' performance is not so surprising. An example of redundancy is offered by the English language, which has a redundancy of about 75%. For instance, the probability of an "n" following the letters "tio" is very high in English.

Using various experimental techniques, de Groot and Jongman found that chess positions are very redundant for chess masters (75%, as for English). Therefore, masters do not need a huge processing capacity to recall a chess position. Chess redundancy allows them to code the position efficiently. Instead of seeing 26 disconnected pieces on 64 independent squares, masters "see" a Panov attack of the Caro-Kann defence. It is, then, not a big deal for them to reconstruct the position afterwards.

An interesting mixture of two apparently incompatible methodologies was used by de Groot in his studies of chess players' eye movements. In this experiment, eye movements were recorded during the 5 second presentation of a chess position. After their attempt to reconstruct the position, subjects were asked to retrospect on what they had seen during the exposure time. Results show that, while not perfect, masters' retrospective descriptions agreed with where the eyes had looked. These descriptions also offer information on where masters directed their attention; this information would not be gained only through the eye fixations and the latency times, and allows one to integrate the quantitative data into a consistent "story". Comments also shed a useful light on what masters do when they are confronted with "weird" positions, positions they cannot categorise rapidly.

The analysis of eye movements showed clear differences between novices and masters: the latter's fixations are faster and smoother. In addition, masters zero in rapidly on the important squares. They literally *see* a different position. Interestingly, masters use simple visual cues to direct their eye movements to critical squares. For

[6]The topic of this section is dealt with in detail in *Perception and Memory in Chess* (de Groot & Gobet, 1996) .

example, a white Pawn that has entered Black's territory is a conspicuous visual property of a position, but is also almost always a valid cue to the chess meaning of the position.

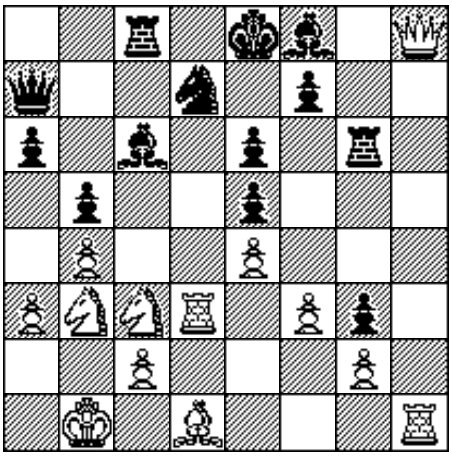

Diagram 1 depicts a middle-game position; in Figure 1 we see the eye movements of a master (Figure 1a) and a Novice (Figure 1b) (presentation time of the position = 5 seconds). Note that the master performs more fixations and that he covers more squares than the Novice. Note also that the master rapidly directed his attention to the white Kingside, characterised by the presence of an advanced and conspicuous black Pawn.

Diagram 1: A complex middle-game position.

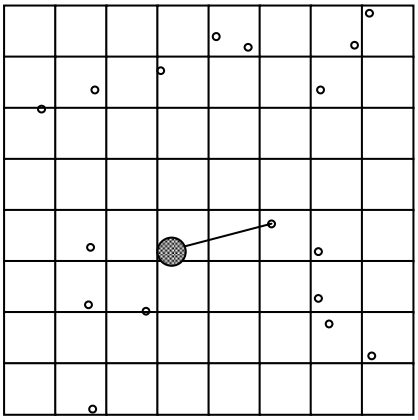

Figure 1a: Eye fixations of a master.

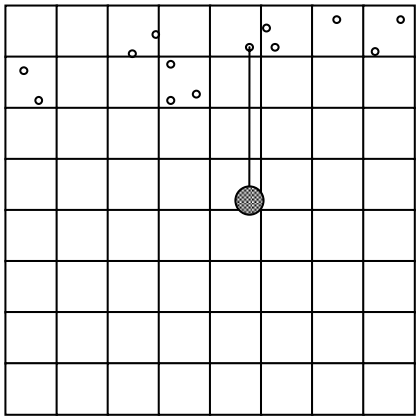

Figure 1b: Eye fixations of a novice.

Figure 1: Examples of eye fixations for a master (left) and for a novice (right). The large grey circle indicates the first fixation.

2.3 A non-standard approach

De Groot's approach to psychology is complex. It is a subtle mixture of "hard" techniques, mathematical and statistical – do not forget that he was a professor of methodology for over 20 years – and of "softer" approaches, such as interpretative analysis of verbal protocols. In this case, the psychologist tries to understand the subjects' behaviour at several levels, some of which are not accessible through sheer quantitative techniques. His work on chess, starting with his thesis, offers a good example of the concomitant application of these two approaches.

A brief glimpse at the history of psychology may be useful to situate de Groot's approach. At the turn of the century, Germany was the world centre of psychology. An important school was *introspectionism*, whose main sources of data were verbal protocols collected by subjects highly trained at inspecting their own mental states. Note that most tasks used by introspectionists were exceedingly simple (for example the pressing of a button when hearing a tone), and the yield of information had little to do with more complex processes of thought and decision making. This "atomism", however, was overcome step by step, mainly in Oswald Külpe's Würzburg group, from which later Otto Selz's Denkpsychologie ("Psychology of Thought") emerged. Selz's main research tool was systematic introspection in an experimental setting. The work of Selz inspired de Groot in his treatment of chess thought. De Groot met Selz in person as late as 1938, when Selz landed in Amsterdam as a refugee from Nazi-Germany.

In the United States, the early twenties saw a violent reaction to these schools with the Behaviourism movement. One of its tenets was that anything that could not be observed or measured had no place in scientific psychology. Exit then introspection. Some of the favourite domains of study of Denkpsychologie, such as problem solving, almost completely disappeared from the American universities, where emphasis was given to research on learning and to the study of very simple tasks (such as the memory for nonsense syllables or the learning by rats in mazes) that were amenable to clear-cut experimental manipulations. It was not until the late fifties that a counter-revolution was launched by the so-called cognitive psychology movement, which emphasised that non-observable concepts may also be stated scientifically (think, for example, of the concept of gravity in physics) and deplored the lack of relevance of most work done by behaviourists. This brand of cognitive psychology still dominates psychology nowadays.

The approach taken by de Groot in his thesis and his later work on chess is a typical example of Selzian Denkpsychologie. At the theoretical level, the claim is that the thought process may be seen as a chain of mental operations carried out by the subject. Each operation occurs as a consequence both of the problem at hand and of the results of the previous operation. According to Selz, thinking is made possible not by the recognition of previously learnt associations, but by the application of solving methods that may be applied to different types of problems. At the empirical level, verbal protocols are used to support or invalidate the theory. In addition to such a Selzian methodology, de Groot has used, already in his thesis, quantitative data analysis to corroborate his theoretical claims. It is in this mixture of two approaches – at first sight incompatible – where the originality of his work resides.

Criticisms have been levelled against introspectionism and protocol analysis, focusing mainly on the subjectivity and rationalisation present in such data. To these, de Groot replied that a psychology discipline that does not ask subjects about what they (think they) are doing misses something very important, as they are the best experts of their own mental life. In his opinion, data gathered from protocols can be used as any other data to test theories. Many "hard science" theories in psychology – behaviouristic theories first – would not pass this test: they are too much at variance with what the subject reports to have done. Nowadays, the "official" cognitive psychology has accepted the use of concurrent protocols, but not of retrospective protocols, nor introspection.

A rapid perusal of the more recent literature on chess psychology (see Gobet, 1998; Gobet, de Voogt, & Restchizki, 2004) shows that experimenters are interested mainly in quantitative results (e.g., percentage of pieces correctly replaced, number of errors in a recall task; number of moves analysed, depth of search in a problem solving task), but that very few of them bother to ask subjects to comment on their own performance and to describe, for example, the strategies they use. In addition, most researchers have accepted the theoretical proposal of Chase and Simon (1973) that masters perceive chess positions not as a *Gestalt* but as "chunks of pieces". From this perspective, the success of *Thought and Choice in Chess* is somewhat paradoxical. Current psychology has retained from this study mainly the quantitative results, results that de Groot used only to *illustrate* his theory of thinking. Interestingly, none of the researchers of chess psychology gave much credit to de Groot's painstaking description of chess players' thinking. It is true that *Thought and Choice in Chess* was written in a tradition which in America had been wiped out by Behaviourism, in Europe slowly faded during the second quarter of the century, and has since fallen into oblivion. In the later phases of his life, De Groot pointedly reminded us that scientific psychology has much to gain by employing some of the "soft" techniques advocated by the *Denkpsychologie* approach.

History may prove de Groot correct after all. In the last two decades, there has been a renewal of interest in more qualitative ways of analysing chess data. There has been a revival of interest, too, in "higher descriptions" and of "global descriptions" of positions, besides the more detailed descriptions at the chunk level. Obviously, this is the level you get when you ask experts to speak about their field of expertise. And this is the level of analysis de Groot emphasised in *Thought and Choice in Chess.*

3. Acknowledgements

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5. SelectedGames

Gereben (Hungary) - De Groot, Munich 1936, Ragozin Defence
1 d4 d5 2 Nf3 Nf6 3 c4 e6 4 Bg5 Bb4+ 5 Nc3 dxc4 6 e4 c5 7 e5 cxd4 8 Qa4+ Nc6 9 0-0-0 Bd7 10 Ne4 Be7 11 exf6 gxf6 12 Bh4 Nb4 13 Qxb4! Bxb4 14 Nxf6+ Kf8 15 Rxd4! Qa5 16 Nxd7+ Ke8 17 Nf6+ Kf8 18 Ne5 h5 19 Ned7+ Kg7 20 Bxc4 Rhc8 21 Kb1 Bc3!! 22 Re4 Bxb2! 23 Kxb2 Qd2+ 24 Kb1 b5 25 Bb3 Qd3+ 26 Ka1 Qc3+ ½ -½

De Groot - O'Kelly (Belgium), Beverwijk 1946, Ruy Lopez
1 e4 e5 2 Nf3 Nc6 3 Bb5 Nf6 4 0-0 Bc5 5 Nxe5 Nxe5 6 d4 c6 7 dxe5 Nxe4 8 Bd3 d5 9 Qf3!? Qh4 10 g3 Ng5? 11 Qd1! Nh3+ 12 Kg2 Qe7 13 f4 h5 14 Nc3 g5 15 f5 g4 16 Qe2 Bd7 17 Na4 Bb6 18 b4! 0-0-0 19 Nxb6+ axb6 20 a4 Rhe8 21 a5 bxa5 22 Bb2 d4! 23 Rxa5 Qxb4? 24 Ra8+ Kc7 25 Ba3! c5 26 Bxb4 Rxa8 27 e6 Bc6+ 28 Be4 cxb4 29 Bxc6 bxc6 1-0

J.T. Barendregt – A.D. de Groot, blindfold game, Amsterdam 1971, King's Indian, Sämisch
1 d4 Nf6 2 c4 g6 3 Nc3 Bg7 4 e4 d6 5 f3 0-0 6 Be3 e5 7 Nge2 Nc6 8 d5 Na5 9 Nc1 c5 10 Qd2 Nh5 11 Bd3 f5 12 exf5? 12 Nxc4! 13 Bxc4 Qh4+ 14 Bf2 Qxc4 15 fxg6 Nf4! 16 gxh7+ Kh8 17 Be3 Bf5 18 Bxf4 exf4 19 N1e2 Rae8 20 0-0 Re3! 21 Rac1? Rfe8 22 Rf2 Bd3 23 b3 Qb4 24 a3 Qxb3 25 h4 Qxa3 26 Ne4 Bxe2 27 Rxe2 Rxe2 28 Qxf4 Qb2 0-1

Adriaan de Groot – Herbert A. Simon, over the Board Game, 1981, Sicilian Defence
1 e4 c5 2 f4 Nc6 3 Nf3 e6 4 Nc3 Nge7 5 e5 Ng6 6 g3 d6 7 exd6 Bxd6 8 Bg2 0-0 9 0-0 Qc7 10 d3 b6 11 Nb5 Qd7 12 Ng5 Bb7? 13 Qh5 h6 14 Nxf7? Rxf7 15 Qxg6 Ne7 16 Qxf7+ Kxf7 17 Nxd6+ Qxd6 18 Bxb7 Rd8 19 Be4 Qd4+?! 20 Kg2 c4 21 c3 Qc5 22 d4 Qd6 23 a4 Nd5 24 Bd2 Nf6 25 Bf3 a6 26 Rae1 g6 27 Re5 Nd7 28 Bg4!? Qc6+ 29 Bf3 Qxa4 30 Re2 Nf8 31 f5! gxf5 32 Bxh6 Qd7 33 d5! exd5 34 Bg4 Kg6 35 Bxf5+ Qxf5 36 Rxf5 1-0