Appendix I

Some Updates and Commentaries

By Peter Shotwell

Note: I haven't had the time to thoroughly keep up with research in the various fields which the main article covers, but a quick Internet survey in September 2007 revealed some interesting advances in the field of board game neurocognition.

Two books have also appeared. One seemed to confirm some of the proposals I had made in the main article about cultural differences and go playing and I speculate further about them. The other was an up-to-date survey of board game work in cognitive psychology.

Lastly, I review (all too briefly) the stunning new developments in computer go that were derived from discoveries in how humans think.

All in all, this appendix is by no means definitive and there may be much more out there—any help from readers would be greatly appreciated. I can be contacted through the American Go Association.

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TABLE OF CONTENTS

Carlo Methods of Computer Go

I. *The Geography of Thought: How Asian and Westerners Think Differently. . . and Why* by Dr. Richard Nisbett (The Free Press 2003)

The Geography of Thought echoes thoughts that I suggested in the main cognition article about culturally-related reasons for go being popular in the East and chess in the West.

Publishers Weekly suggested that 'if Nisbett's explanation turns out to be generally accepted, it means a big victory for memes in their struggle with genes.' In their review, they commented that:

This book may mark the beginning of a new front in the science wars. Nisbett, an eminent psychologist and co-author of a seminal Psychological Review paper on how people talk about their decision making, reports on some of his latest work in cultural psychology. He contends that 'human cognition is not everywhere the same'—that those brought up in Western and East Asian cultures think differently from one another in scientifically measurable ways. Such a contention pits his work squarely against evolutionary psychology (as articulated by Steven Pinker and others) and cognitive science, which assume all appreciable human characteristics are 'hard wired.'

Initial chapters lay out the traditional differences between Aristotle and Confucius, and the social practices that produced (and have grown out of) these differing 'homeostatic approaches' to the world: Westerners tend to inculcate individualism and choice (40 breakfast cereals at the supermarket), while East Asians are oriented toward group relations and obligations ('the tall poppy is cut down' remains a popular Chinese aphorism). Next, Nisbett presents his actual experiments and data, many of which measure reaction times in recalling previously shown objects. They seem to show East Asians (a term Nisbett uses as a catch-all for Chinese, Koreans, Japanese and others) measurably more holistic in their perceptions (taking in whole scenes rather than a few stand-out objects). Westerners, or those brought up in Northern European and Anglo-Saxon-descended cultures, have a 'tunnel-vision perceptual style' that focuses much more on identifying what's prominent in certain scenes and remembering it. Writing dispassionately yet with engagement, Nisbett explains the differences as 'an inevitable consequence of using different tools to understand the world.'

In an NPR interview available at www.npr.org/templates/story/story.php?storyId=1180660, Nisbett spoke:

Well, let me start by saying how I got into the business of looking at the difference. I had a very brilliant Chinese student a number of years back . . . . . who told me one day that he and I were different. I thought the world was a line and he thought the world was a circle and I did a bit of a double-take on that and he began to tell me what has turned out to be the story of our research essentially. He said that Westerners are analytic. They tend to think about an object. They zero in their perception on a particular object—could be a person—and think about its attributes and try to categorize the object on the basis of its attributes and to think of the rules that apply to the behavior of the object with a view toward controlling it. And among the rules that people use—Westerners use to think about things are the formal rules of logic.

In contrast, East Asians have a holistic way of thinking. They pay attention to a much broader field than Westerners do. They pay attention to the situation that a person is in. They pay attention to the context that a physical object is in and they're much more concerned with relationships among objects and relationships among people than Westerners, are and they don't have such explicit rules for the behavior of objects and people. And they don't expect to have such control over them as Westerners do. And among the rules they don't have are the rules of logic. At least they use the rules of logic to think about everyday life events less than Westerners do. . . . .

. . . . . [W]e show people movies of underwater scenes and there's always a particularly salient object, usually a fish, and we define salience by the fact that one of these fish is larger, brighter and faster-moving than the others. And we show these scenes for 20 seconds and then we ask people what it is they have seen. And Westerners, the first thing they say is, `Well'—and then they zero in on a central object. They say, `I saw what looked like a trout swimming off to the left. It maybe had some pink speckles on its belly.' East Asians are much more likely to start out by saying, `I saw what looked like a stream; there were rocks on the bottom and some plants.' So they start out with a context.

Altogether, our Japanese subjects, in one experiment that we ran, remembered 60 percent more detail about the environment or the background than the American subjects that we tested did. And they

actually saw 100 percent more, twice as many, relationships involving inanimate objects as the Americans did. It's as if, if it wasn't moving, it wasn't really there for the Americans. . . .

A listener emailed in a question about go. She asked:

`Go . . . . . is an ancient strategy board game highly regarded in several East Asian societies. The rules and pieces are simpler than chess, but playing the game becomes much more complex. It could be said to reflect the holistic nature of East Asian thought. If Dr. Nisbett is familiar with the game of Go, I'd be very interested to hear his opinions.'

Prof. NISBETT: I'm not really familiar with it, but your opinion is certainly shared. There's actually a PhD dissertation on that very topic saying that essentially chess is linear. When you think of the rules that each piece must follow, different rules for different pieces, in contrast to the much looser structure and more holistic structure of Go. So you're certainly in good company when you have that belief.

This PhD dissertation could be Dr. Earnest Brown's at http://www.slateandshell.com/ErnestBrownDissertation1.asp. (He has a second article on Buddhism and go at www.usgo.org/bobhighlibrary). Also, I had a brief email exchange with Dr. Nisbett in which he independently confirmed his thoughts on NPR about go.

The Wikipedia article on the 'Tall Poppy Syndrome,'—the aphorism mentioned in the *Publishers Weekly's* second paragraph—casts an interesting twist to this discussion by showing how it means something quite different in the West.

Tall poppy syndrome (TPS) is a pejorative used in Australia, Canada and New Zealand to describe what is seen as a leveling social attitude. Someone is said to be suffering from tall poppy syndrome when his or her assumption of a higher economic, social or political position attracts criticism, being perceived as presumptuous, attention seeking or without merit.

The term originates from accounts in Aristotle's Politics *(Book 5, Chapter 10) and Livy's* History of Rome *(Book I). Aristotle wrote: 'Periander advised Thrasybulus by cutting the tops of the tallest ears of corn, meaning that he must always put out of the way the citizens who overtop the rest.' . . .*

The [Eastern] proverb, 'The nail that sticks out gets hammered down' is particularly well known, although this proverbial phrase applies more to conforming to social conventions than to high achievement and the accumulation of wealth. . . .

Thus, we can add another dimension to the differences between East and West, along with some of the other items discussed in the main article of this appendix that Dr. Nisbett didn't cover—the context of the more visually-oriented linguistic systems of Japan, China and Korea, and the differences of their grammatical structures. Some thoughts on 'Philosophical Religiousness,' still another dimension of difference, are explored in the next section.

II. Are Eastern and Western Differences Reflected in Cloning Studies, the Jungian 'Cultural Unconscious,' and in Go vs. Chess?

'Whatever an environment breeds you to love, you love it.'

The rapper Snoopdog discussing convicted football quarterback Michael Vick and dogfighting in Black ghettoes on the Larry King TV show

In 1962, the Jungian psychoanalyst Dr. Joseph Henderson introduced the idea of a 'cultural unconscious.' He suggested that it 'topographically' existed between the 'personal' and 'collective' 'unconscious.'

. . . it is built up through many exposures to cultural canons of taste, of moral choices, of social custom, and of religious symbolism. And it is built on influences from the family life in which an important part of these canons have been passed on from previous generations. Accordingly much of what has been called 'personal unconscious' is not personal at all but that part of the collective culture pattern transmitted through our environment.

Although Henderson's idea was not mentioned, a possible example of the differences between the Eastern and Western 'cultural unconscious' seems to have been described in an article on the international reaction to cloning by John Tierney in the Nov. 20, 2007 *New York Times*:

Are Scientists Playing God? It Depends on Your Religion

Now that biologists in Oregon have reported using cloning to produce a monkey embryo and extract stem cells, it looks more plausible than before that a human embryo will be cloned and that, some day, a cloned human will be born. But not necessarily on this side of the Pacific.

American and European researchers have made most of the progress so far in biotechnology. Yet they still face one very large obstacle—God, as defined by some Western religions. . . .

. . . In South Korea, when Hwang Woo Suk reported creating human embryonic stem cells through cloning, he did not apologize for offending religious taboos. He [and his defenders] justified cloning by citing his Buddhist belief in recycling life through reincarnation.

'. . . Asian religions worry less than Western religions that biotechnology is about "playing God,"' says Cynthia Fox, the author of Cell of Cells*, a book about the global race among stem-cell researchers. 'Therapeutic cloning in particular jibes well with the Buddhist and Hindu ideas of reincarnation.' . . .*

*You can see this East-West divide in maps drawn up by Lee M. Silver, a molecular biologist at Princeton. . . . 'Most people in Hindu and Buddhist countries,' Dr. Silver says, 'have a root tradition in which there is no single creator God. Instead, there may be no gods or many gods, and there is no [linear] master plan for the universe. Instead, spirits are eternal and individual virtue—*karma*—determines what happens to your spirit in your next life With some exceptions, this view generally allows the acceptance of both embryo research to support life and genetically modified crops.'*

. . . By contrast, in the Judeo-Christian tradition, God is the master creator who gives out new souls to each individual human being . . .'

Dr. Henderson was the last person to have taken personal training from the master and he recently died at age 104. His obituary in the *New York Times* provided a framework for some speculative thoughts that I've had about the differences between chess and go that extend beyond what Dr. Nisbett and I have previously written about:

. . . Dr. Henderson became widely known for a notion related to Jung's idea of a collective unconscious: that of a cultural unconsciousness, in which people's inherited impulses may be automatically filtered through their culture, sometimes to appear in remarkably varying forms. An example would be the channeling of aggression, in which the impulse might take the form of team sports, dance or warfare.

Would this ‘channeling of aggression’ account for some differences between chess and go that, to my knowledge, haven’t been discussed before? Can it be said that these differences occur along cultural lines that resemble those that seem to have been defined in the cloning debates?

What follows is by no means a ‘final’ opinion and is largely meant to only stimulate further discussion and research in the anthropology of games.

Thinking along philosophical and religious lines, can we ruminate about how the role of the king in chess is a rather ‘monotheistic’ concept? If he is killed, the game is suddenly over and his ‘kingdom’ and the ‘lives’ of all those associated with him are at an end. Thus, for the next chess game, a whole new hierarchy ruled by a new king must arise—‘The King is dead, long live the King! Or, if you prefer, ‘The Second Coming is at Hand!’ (Note that a stalemate produces the same result by curiously conforming to the original meaning of the Persian *shah mat*—that the King is ‘helpless’).

‘Resurrecting’ the entire kingdom with its leader (and their ‘individualized’ and hierarchical souls), in the full sense of the word—‘the act of rising from the dead or returning to life’—seems diametrically opposed to the ‘pluralism’ of playing with identical go pieces, whose deaths do not affect the fates of their fellows. Both the stones who have died in go and those who managed to survive until they ‘passed away’ at the game’s end seem to arise as ‘re-incarnations’ in a new game, as they are anonymously picked out from the ‘World Pool’ of the ‘Available” Souls’ in the go bowls to begin life anew—but not as the same ‘person.’ (Since the number of go stones in the bowls are more or less fixed, this would be in the sense of the traditional view of reincarnation that would not take into account the idea of population increase and the consequent need for new souls. Nor would it take into account the ‘*karma*’ of the individual stone/souls. Nevertheless, the general idea of reincarnation seems to be there).

But then why is chess so popular in China, Japan, Korea and other East Asian nations such as Vietnam and Thailand, if it isn’t part of the Eastern ‘cultural unconscious?’ And what about India?

Despite the loose arguments of David Li’s *The Genealogy of Chess* that a Chinese general invented chess, and other far-fetched ideas that the game evolved from *liubo*, unlike the Chinese home-grown game of go that spread to Japan and Korea, chess was almost certainly imported into

the East (or formed on the way, as postulated by some). Either way, the game remained unchanged as it was in Muslim Persia and earlier, if it came from India. Despite the probably erroneous theories of Joseph Needham that can be seen in his article at http://history.chess.free.fr/library.htm—that chess was originally a divinatory game of astral and other 'symbols' propelled by magnets that only later morphed into a contest—chess is fairly obviously a 'war' game whose nomenclature and layout are simply that of two feudal armies fighting each other. Although the 'king' was called the 'shah' in Persia and the 'raja' in India, these were simple, ancient concepts of army leaders. For example, in the old Muslim Persian version the openings were usually called *tabbiyya*—the 'battle array.'

Thus, in Chinese *xiangqi*, the leader is a 'general' or 'marshal' who lives in a 'palace' that he cannot leave with his two 'advisors.' Running through the game is a river that is generally thought of as the border between the ancient kingdoms of Chu and Han of the Warring States period. (Calling it the 'Milky Way' just seems to be a weak attempt to make the game into a celestial contest by dividing the sky into two halves. Along the same line of thought is the popular folktale that there are no 'emperors' (or 'kings') in Chinese chess because the fact that one of them dies would dangerously draw imperial dissatisfaction).

The rest of the army consists of horses, chariots, cannons (or catapults), elephants (or ministers), and soldiers. Cannons can shoot over the river, but elephants cannot cross it. The character for *xiang* means 'elephant' and is sometimes conjectured that this means that the game came from India where elephants were used in war, but it also means 'symbol' or 'image,' perhaps to distinguish it from games like go where there are no images (or more correctly, characters) involved.

In Korean *jianggi*, which was probably imported from China, one side is named 'Cho' and the other is called 'Han,' and its pieces are also named after elements of armies who are commanded by two generals.

In Japanese *shogi*, the leaders of the two armies are called the 'royal' and the 'jeweled' generals and a military-styled system of promotion of pieces. By the mid- to late-16th century, the 'drunken elephant'—in effect, a 'crown prince' after promotion that also had to be captured along with the royal general—had been eliminated and by the early 17th century and the beginning of the Edo period, the use of prisoners 'dropping' into the game had been introduced. Perhaps this practice came from the changes in civil warfare whereby instead of

execution, captured soldiers could switch sides—thus gaining a ‘new life’ perhaps in the spirit of ‘reincarnation’ (coming down from the sky?) See http://history.chess.free.fr/shogivar.htm for details on how many variations of shogi developed through the centuries that were essentially all war games.

In other words, these Eastern versions of the original types of chess are not two abstract ‘kingdoms’ who oppose each other and symbolize much more than common battles as in the West.

After being imported by the Crusaders or through the Moors in Spain, Western chess was played by Muslim rules using mere lumps for pieces because the Koran forbade images of living creatures. Games were slow and many of them lasted for days. But by 1202 AD, some rule changes in Germany began to modify the shape of the game.

Various chess-related Wikipedia articles illustrate the way the Western game evolved, seemingly in response to a changing social milieu that did not occur in the East.

An attempt was made to make the pieces more interesting, each rank's pawn being given the name of a commoner's occupation, from left to right

- *City guard (in front of a knight, as they trained city guards in real life)*
- *Worker/Farmer (in front of a castle, for which they worked)*
- *Blacksmith (in front of a knight, as they care for the horses)*
- *Weaver/Clerk (in front of the bishop, for whom they wove or clericked)*
- *Merchant/Moneychanger (before the king)*
- *Doctor (the queen's pawn)*
- *Innkeeper (bishop)*
- *Gambler and other "lowlifes" (in the left-most rank, that direction being literally sinister.)*

The most famous example of this is the second book ever printed in English, [in the 15th century] The Game and Playe of the Chess*, which indeed was seen as much as a political commentary on society as a*

chess book, and was printed second by William Caxton because it was, like the Bible, among the most popular books of its day. New alterations, made after 1475 CE, led to further evolution of the game: the queen—a powerful new piece—was introduced, leading to additional value being attached to the previously minor tactic of pawn promotion.

For various reasons—the historical effects of some powerful queens and/or the rise of the Cult of Mary, and/or the rise of the middle classes, a 'Wonder Woman' was now on the board to stay, adding the possibility of matricide to the already implicit themes of patricide, fratricide, and regicide. And, if we look at the new relationship of unequal power as a powerful queen's guardianship of a weak, immature son while the father/king was off at war, a perhaps significant Oedipal dimension was also added that seemed to reflect some of the realities of the time.

The war elephant of the [Indian game] chaturanga also evolved into the bishop, giving the piece more range. This rise of 'unwarlike' figures and a departure from the pure military symbolism prevalent in India and Persia may have bought these pieces closer to the court and ordinary household. Furthermore, checkmate became easier and games could now be won using a smaller number of moves.

The ability to move two spaces, and the resulting ability to have an *en passant* capture was another important change that literally and figuratively 'speeded up' the game.

Our knowledge of early chess is from stories, many of French origin, where the game plays a supporting role: Huon de Bordeaux playing the king's daughter to save his head and have one night with her, Garin de Montglane playing Charlemagne for similar stakes, and Floire et Blanchefleur tricking a Saracen prison guard. . . .

Scachs d'amor *(Catalan for 'Chess of Love'), whose complete title is* Hobra intitulada scachs d'amor feta per don franci de Castelvi e Narcis vinyoles e mossen fenollar *is the name of a poem written by Francesc de*

Castellví, Bernat Fenollar, and Narcís de Vinyoles, published in Valencia, Spain towards the end of the 15th century.

The poem is conceived as a chess game in which the opponents are Franci de Castellvi, as White (in modern chess), (Mars Març*, Love Amor and red pieces in the play), and Narcis Vinyoles, playing Black (Venus, the Glory* Gloria*, and green pieces). They debate about love, and Bernat Fenollar comments and establishes the rules. . . .*

The poem uses the game as an allegory for love. Its structure is based upon sixty-four stanzas (the same number as for the chessboard squares), nine verses each. The stanzas are grouped three after three: The first stanza in the group represents the White move, the second one the Black's move, and the third one a comment on the rules by the arbiter. The three stanzas in the beginning are an introduction and the last one is checkmate.

Supposedly, the game played is the first one documented with the modern rules of chess. . . .

Cafés came into vogue in Paris in the mid-17th century and by the mid-18th century 'chess was played in nearly every café.' The Régence was established as a rendezvous for the literati of the day. Voltaire, the two Rousseaus, Franklin, and Philidor, are but a few of the men of note who constantly frequented the Régence in early times.' To these we can add Robespierre and Napoleon; Deschapelles, La Bourdonnais, and Saint-Amant. They all played chess at La Régence.

Spread by café society writers into the general culture, we can see the modern results in books by Nabokov and movies like *The Seventh Seal*, along with the cultural hoopla generated by Bobby Fischer's Cold War victories over the Russians, and the angst over Gary Kasparov's loss to Big Blue. It is hard to deny that the game means something more than just a war game in the West, and that it occupies a culturally different *niche* than *shogi, jianggi* or *xiangqi* do in the East.

In fact, in terms of literature, history, religion, strategy and philosophy, chess occupies the same 'topographical position' in the 'cultural unconscious'—or 'consciousness,' for that matter—that go does in the East. Take, for example, the millions of non-player televisions that were turned on to watch the victories of Nei Wei Ping or Jiang Zhujiu in the Super Go triumphs over the Japanese.

Looking back in history, another indication of the deepness of the influence of go upon the Chinese Mind is the profound association

between go and poetry, which first flourished during the Tang dynasty which began in 618 AD. For example, almost a thousand years later, in the 17th century, after the sad fall of the Chinese Ming dynasty to the Manchu Qing, Wu Weiye could sadly wrote:

In leisure, my window facing pines
I study old wei qi *manuals*
National experts were not altogether lacking in those year.
Do you know that the south wind was not strong?
The gouged-out eyes on Xu Gate see the troops entering Wu

(The gouged out eyes are those of a former hero, but they also refer to the eyes of a dead go group; the troops, of course, are foreigners. For more information, see *The Art of Black and White in Chinese Poetry* by Chen Zu-yan, and for a sample of the affinity of go with Buddhism, see *Go: The Study of Buddhist Ideals* by Earnest Brown, all at www.usgo.org/bobhighlibrary.)

The same reverence for the game is also apparent in the arts—depictions of go playing as one of the Four Accomplishments appear all through Chinese art, as well as sages and Immortals playing in sylvan settings, etc. A look at the extensive *ukiyo-e* go art of Japan can be seen at www.kiseido.com.

As for stories, there are many popular ones about chess in the East, (and because of the use of the word *yi*, it is unknown if some are about go or chess), but they are on lesser, more mundane themes than many that involve go in the East or chess in the West.

For example, Eastern chess does not involve the universal forces of *yin* and *yang* like dramatic representation of the black and white symbolism of go; no Eastern chess player plays the Devil for his life; and there are no 'Rotten Axe' stories in which Immortals play a game for 100 years, let alone play at all, unless one includes the buffoon-like characters in the Tangerine Story. The paean to a 'symbolic game' that Needham used, which was allegedly written by King Wu of the Zhou dynasty, is not about chess, and the only other significant story is the supernatural, subterranean chess pieces in a Tang dynasty folk tale. (For translations, see Dennis Leventhal's article at http://history.chess.free.fr/library.htm).

In other words, there is no connection in chess with the founding of Chinese civilization by Huang Di or Yao, no psychologically twisting stories as the tragedy of Yao's son, Dan Zhu, or inclusion in the classics

such as *The Romance of the Three Kingdoms* or *The Plum in the Golden Vase.*

Finally, there is the observation that none of the Eastern chess players who play the Western-style game (aside from a few women in a generally non-competitive field) have become top-level players, nor have any Westerners won any tournaments in go.

However, it is important to note that this argument for differences between Eastern and Western 'collective unconscious' as reflected in go and chess cannot include Southern China, or its relationship through ancient and modern migrations to Thailand and Vietnam. In that broad South Asian swath, go is hardly played at all and chess is truly the national board game. One can then wonder about Nisbett's results—did they include Southern Chinese, even though it is an entirely different culture than that of the North, as anyone will attest to who has sat up at night listening to the clack-clack of *mah jong* pieces in Macao, or followed the avid street games of chess in Singapore or Bangkok played by immigrant Chinese and natives alike.

As witnessed by the immigration of laborers and merchants in the recent Chinese Diaspora, perhaps it is a more individualistic nature that attracts the Southern Chinese to these war-like games? After all, when they arrived, it is they who have set up networks of businesses and, in the case of the West, have adapted most splendidly to Western ways. And what about India, the birthplace of chess, where no go is played, but whose Hindu belief systems showed up in the clone studies? Is that 'East' or 'West'? And how about the 'individualistic' Hinayana Buddhism of Thailand as opposed to the Mahayana type of most of Asia—is that a factor in their thinking and perceptions? Nisbett's results certainly point to some interesting differences, but it would seem that they might need some clarification and more research!

I am grateful for Alex Trotter's and John Fairbairn's considerable inputs on this article. However, all mistakes are mine.

III. *Moves in Mind: The Psychology of Board Games*
by
Fernand Gobet, Alex de Voogt and Jean Retschitzki
(Psychology Press 2004)

Some of Fernand Gobet's work was reviewed in the main article and since then, he and two colleagues have written a comprehensive review of recent work in the fields of cognitive psychology, artificial intelligence, cross-cultural psychology, education and neuroscience. Go was only one of the games covered and they found, of course, that the field has been dominated by chess studies, which have left many puzzles to unravel in future research.

For example, in Chapter Nine ('Individual Differences and Neuropsychology of Talent'), they conclude:

This chapter has raised more questions than it has provided answers. While the role of intelligence for board games can at least be addressed with empirical data, little is known about the role of emotions and motivations. This is clearly a domain in which active research should be pursued. Similarly, there is little robust evidence from neuroscience research, and, given the novelty of the techniques used, the need for replication is apparent. Theoretical links were sometimes made between neuroscience and the chunking theory, which has dominated the previous chapters of this book. . . . . but these links should be seen as highly tentative at the moment. Connecting neuroscience with cognitive theories such as the chunking or template theories is likely to be an active domain of research in the near future.

The topics discussed in this chapter [also] raise intricate methodological questions. For example, how can the direction of causality between expertise in board games and intelligence be ascertained? What is the best way of measuring brain activation differentiating search and pattern-recognition behavior? Obviously, this is not the only place in this book where methodological issues are raised. . . . .

Hans P. Op de Beeck of the Massachusetts Institute of Technology's Department of Brain and Cognitive Psychology commented on *Moves in Mind* in *Acta Psychologica*; Vol. 119(2); (Jun 2005); 231-233.

This and many other psychology articles are available online from subscribing institutions at www.apa.org/psycinfoa.

I believe the authors did a good job given the current state of the field. They review a broad spectrum of topics, and they provide the reader with a coherent framework. As such, the book seems like an absolute must-have for all researchers who have a particular interest in psychological research on board games. . . . . There are a few basic papers in the field that have an undeniable value for all psychologists. However, this is not true for the large majority of the references in this book. Furthermore, I have the feeling that the research of other board games mostly fails to generate results that tell us more about the human mind than we already knew from chess research. . . . .

IV. Recent Studies on the Use of MRI to Study High-level Cognition in Go and Chess, the Effects of Aging in Go Players, and Neural Substrates in the Judgment Processing of Amateur and Professional Players

Since I last edited the main essay in 2002, three interesting articles appeared in the field of neurocognition. I do not have the time to other than note them and hope this will lead interested readers to investigate further.

An interesting one is the first neurocognitive study of the differences between chess and go players. The MRI studies were done on chess by Michael Atherton, Jiancheng Zhuang and others at the University of Minnesota, and, with the cooperation of the University, on go by Xiangchuan Chen, Daren Zhang and others in China. They studied six chess and six go players of reasonable amateur strength. These were listed as I-*kyu* to 1-*dan* in the case of go, although it was not mentioned whether the Chinese or Western ranking system was used. As for the chess players, presumably they had no ranking so their level of skill was probably not great.

The full texts, and related articles can be viewed in .pdf format by typing the exact titles into Google.

'A Functional MRI Study of High-level Cognition. I. The Game of Chess' *Cognitive Brain Research* Vol. 16(1) (Mar 2003): 32-37

Abstract: *Chess is a game that involves many aspects of high level cognition and requires sophisticated problem solving skills. However, there is little understanding of the neural basis of chess cognition. This study employed functional magnetic resonance imaging (fMRI) to identify cortical areas that are active during the analysis of chess positions compared with a spatial task with matched visual stimuli. Bilateral activation was revealed in the superior frontal lobes, the parietal lobes, and occipital lobes. Some small areas of activation were observed unilaterally in the left hemisphere. The left hemisphere showed more activation than the right. Results are discussed in relation to a similar brain imaging study on the game Go.*

‘A Functional MRI Study of High-level Cognition II. The Game of Go’ (In the same issue of *Cognitive Brain Research*)

GO is a board game thought to be different from chess in many aspects, most significantly in that GO emphasizes global strategy more than local battle, a property very difficult for computer programs to emulate. To investigate the neural basis of GO, functional magnetic resonance imaging (fMRI) was used to measure brain activities of subjects engaged in playing GO. Enhanced activations were observed in many cortical areas, such as dorsal prefrontal, parietal, occipital, posterior temporal, and primary somatosensory and motor areas. Quantitative analysis indicated a modest degree of stronger activation in right parietal area than in left. This type of right hemisphere lateralization differs from the modest left hemisphere lateralization observed during chess playing.

The chess players were presented with a blank board (to give a base line reading), then asked to solve some problems. Then they were presented with random positions and asked to name pieces marked by stars in order to isolate the activities involved in actual playing.

The go players also got a random board and were asked to search for intersections marked by low contrast as a general visual search task to differentiate that from a real board position, in which they were asked to find the best move for Black in 30 seconds.

To briefly summarize the results, with one exception, neither go nor chess players showed lateralization in their thinking, which may dispel the idea that go is more ‘spatial’ and ‘visual’ and hence a more ‘right-brained’ activity.

However, the one difference was that the speech areas of the right hemispheres of the go players were more active. The researchers suggested that perhaps this was because go players more often name their strategic concepts. (Japanese work in this field was noted in the main article). The Chinese team also added that go computer programs do not take account of these functions carried out by the right parietal area.

I might add that the terms of go are much more spatially-oriented than those of chess, so perhaps in this novel way, the folklore about the use of left- and right-hemispheres might be right!

Surprising to them, also, was their finding that neither chess or go players use a frontal area called ‘g,’ which British researcher John

Duncan has called the area of intelligence, and which is used to solve IQ problems. Are chess and go ‘no brainers’ as an article in *Nature* (Dec. 12, 2002) suggested? They cautioned that this may be because of the non-competitive aspects of the study or because not much mental work was needed (or used) to perform the tasks. (As I discussed in the main article, these are common, and common-sense difficulties with all studies like this).

Also quoted was comments made in *Nature* by psychology expert John Gabrieli of Stanford University in California, ‘Most of the stuff we think of as smart is based on experience.’ Another thought they had was that, because R.J. Sternberg thinks there are three kinds of intelligence—analytical, creative and practical—the latter two may be more involved in playing board games. They concluded by expressing a desire to test professional go players.

* * * * *

Given my age and those of many of my friends, one earlier and interesting article is a report on aging and expertise. Masunage Hiromi from the UCLA Rossier School of Education wrote in *Psychology andAging*; Vol. 16(2); Jun 2001; pp. 293-311.

In a sample of 263 male Go players at 48 levels of expertise and ranging from 18 to 78 years of age, it was found that factors of expertise deductive reasoning (EDR) and expertise working memory (EWM) were independent of factors of fluid reasoning (Gf) and short-term working memory (STWM) that, along with cognitive speed (Gs), have been found to characterize decline of intelligence in adulthood. The main effects of analyses of cross-sectional age differences indicated age-related decline in EDR and EWM as well as in Gf, STWM, and Gs. However, interaction and partialing analyses indicated that decline in EDR and EWM decreased to no decline with increase in level of expertise. The results thus suggest that with increase in factors known to raise the level of expertise—particularly, intensive, well-designed practice there may be no age-related decline in the intelligence that is measured in the abilities of expertise.

* * * * *

A more recent study is ‘Neural Substrates in Judgment Process While Playing Go: A Comparison of Amateurs With Professionals’ by Japanese researchers Y. Ouchi, T. Kanno and others in *Cognitive Brain Research*; Vol. 23(2-3); (May 2005); pp. 164-170.

Lightly edited, their abstract reads:

*A professional go player shows incomparable ability in judgment during go games. Positron emission tomography (PET) was used to investigate the neural substrates of professional go players’ judgment process. Eight professional go players and six amateur players were instructed to think over silently in the opening-stage game (*fuseki*, territorial planning) problems and the life-or-death [end-game] problems presented on the monitor in front of them for 60 s of H-sub-2¹-sup-5O PET scans and to state the answer afterwards.*

We found that in the territorial planning problems the parietal activation was equally observed in both groups with the additional prefrontal activation in the amateur group, and in the [end-game] decision problems the precuneus and cerebellum were activated in professionals while the premotor and parietooccipital cortices (visuospatial processing region) were extensively activated in amateurs. The comparison of the two groups showed stronger activations in the precuneus and cerebellum in the professionals in contrast to the premotor activation in amateurs during [end-game] judgment. In addition, the cerebellum was remarkably activated in the higher-ranking professional players. These findings suggested the cerebellum and precuneus play important roles in processing of accurate judgment by visual imagery and non-motor learning memory processes in professional go players.

V. From Human Temporal Difference Learning to the New Monte Carlo Methods of Computer Go

Recently, there have been stunning developments in computer play that is based on earlier work in human temporal difference learning. What follows does not pretend to be comprehensive, and I don't pretend to be an expert, although Rémi Coulom, developer of Crazy Stone, the world's strongest computer go program, graciously looked this article over and made some comments. However, all mistakes are mine, so please read this only as a portal into what has turned out to be a better method than the classical hand coding that has dominated computer go programming for so long.

Back in 1994, an article appeared in *Advances in Neural Information Processing*: 'Temporal Difference Learning of Position Evaluation in the Game of Go' by N.N. Schraudolph, P. Dayan and T.J. Sejnowski of the Computational Neurobiology Laboratory of The Salk Institute for Biological Studies in San Diego. Their abstract read:

The game of Go has a high branching factor that defeats the tree search approach used in computer chess, and long-range spatiotemporal interactions that make position evaluation extremely difficult. Development of conventional Go programs is hampered by their knowledge-intensive nature. We demonstrate a viable alternative by training networks to evaluate Go positions via temporal difference (TD) learning.

Our approach is based on network architectures that reflect the spatial organization of both input and reinforcement signals on the Go board, and training protocols that provide exposure to competent (though unlabelled) play. These techniques yield far better performance than undifferentiated networks trained by self play alone. A network with less than 500 weights learned within 3,000 games of 9x9 Go a position evaluation function that enables a primitive one-ply search to defeat a commercial Go program at a low playing level.

Coming up to 2007, the Wikipedia article on Temporal Difference Learning discussed the situation. (The Monte Carlo method will be discussed after this).

Temporal difference learning is a prediction method. It has been mostly used for solving the reinforcement learning problem. TD learning is a combination of Monte Carlo ideas and dynamic programming (DP) ideas. TD resembles a Monte Carlo method because it learns by sampling the environment according to some policy. TD is related to dynamic programming techniques because it approximates its current estimate based on previously learned estimates (a process known as bootstrapping). The TD learning algorithm is related to the Temporal difference model of animal learning.

The TD algorithm has also received attention in the field of Neuroscience. Researchers discovered that the firing rate of dopamine neurons in the ventral tegmental area (VTA) and substantia nigra (SNc) appear to mimic the error function in the algorithm. The error function reports back the difference between the estimated reward at any given state or time step and the actual reward received. The larger the error function the larger the difference between the expected and actual reward. When this is paired with a stimulus that accurately reflects a future reward the error can be used to associate the stimulus with the future reward.

Dopamine cells appear to behave in a similar manner. In one experiment measurements of dopamine cells were made while training a monkey to associate a stimulus with the reward of juice. Initially the dopamine cells increased firing rates when exposed to the juice, indicating a difference in expected and actual rewards. Over time this increase in firing back propagated to the earliest reliable stimulus for the reward. Once the monkey was fully trained the dopamine cells stopped firing. This mimics closely how the error function in TD is used for reinforcement learning.

The relationship between the model and potential neurological function has produced research attempting to use TD to explain many aspects of behavioral research. It has also been used to study conditions such as schizophrenia or the consequences of pharmacological manipulations of dopamine on learning.

The ‘Computer Go’ article in Wikipedia explains that:

One major alternative to using hand-coded knowledge and searches is the use of Monte-Carlo methods. This is done by generating a list of potential moves, and for each move playing out thousands of

games at random on the resulting board. The move which leads to the best set of random games for the current player is chosen as the best move. The advantage of this technique is that it requires very little domain knowledge or expert input, the tradeoff being increased memory and processor requirements. However, because the moves used for evaluation are generated at random it is possible that a move which would be excellent except for one specific opponent response would be mistakenly evaluated as a good move. The result of this are programs which are strong in an overall strategic sense, but are weak tactically. This problem can be mitigated by adding some domain knowledge in the move generation and a greater level of search depth on top of the random [evaluation]. Some programs which use Monte-Carlo techniques are MoGo, CrazyStone.

In 2006, a new search technique, upper confidence bounds applied to trees (UCT), was developed and applied to many 9x9 Monte-Carlo Go programs with excellent results. UCT uses the results of the play outs collected so far to guide the search along the more successful lines of play, while still allowing alternative lines to be explored. . . .

In 2007, Rémi Coulom developed a new method of generating candidate moves for the UCT algorithm based upon machine analysis of ELO scores/past games. As a result of these changes, CrazyStone has shown an improvement of roughly 600 ELO points on the CGOS server. . . . [As of December 2007, the rankings given in the rest of the article are outdated—Crazy Stone, which won the December 2007 UEC championship with a perfect record was a 2-kyu on KGS.]

Further information about UCT can be found at http://senseis.xmp.net/?UCT and at Rémi Coulom's website, http://remi.coulom.free.fr/Amsterdam2007.

Late in 2006, Coulom explained his methods to *Wired* magazine:

Wired News: What makes programming go so much tougher than chess?

Remí Coulom: In Go, you don't capture pieces, and so it's very difficult to say that black is ahead or white is ahead just by looking at the board. In order to survive, a group of stones needs to surround two 'eyes'—empty areas that can't be invaded by the opponent.

On a 19-by-19(-line) board, you'll have plenty of stones whose life or death status is undecided, and this is extremely difficult to analyze statically. This is different from the situation with chess or (checkers), where you can look at the board and say, 'I have one more pawn than you.'

WN: What are 'Monte Carlo' methods and how do they apply to Go?

Coulom: Monte Carlo methods are named after a quarter of Monaco that's famous for its casinos. In the case of Go, the basic idea goes like this: To evaluate a potential move, you simulate thousands of random games. And if black tends to win more often than white, then you know that move is favorable to black.

WN: With 250 moves in a typical game, that must take a lot of computational power.

Coulom: The version of Crazy Stone in the Torino Olympiad [in 2006] ran on a four-CPU machine—two dual-core AMD Opterons at 2.2 GHz—and did about 50,000 random games per second. Unlike traditional algorithms, the Monte Carlo approach is extremely easy to parallelize, so it can take advantage of the multi-core architecture of the new generation of processors.

WN: Crazy Stone was not the first program to use Monte Carlo methods, but it was successful enough that it started a trend among Go programmers. What was your innovation?

Coulom: Because you can't sample every possible random game, the Monte Carlo algorithm can easily fail to find the best moves. For instance, if most of the random games resulting from a certain move are losses, but one is a guaranteed win, the basic algorithm would take the average of those games and still evaluate it as a bad position.

Crazy Stone is clever enough to avoid this problem. When it notices that one sequence of moves looks better than the others, it tends to play it more often in the random games.

WN: Why have people like Nick Wedd, the moderator of the monthly KGS tournaments, complained that watching games played by Monte Carlo programs can be boring?

*Coulom: Monte Carlo **programs** maximize the probability of winning, not the margin that they win by. When they're very far ahead of the opponent, then they'll always play a safe move, which might look boring compared to more aggressive alternatives. It may be boring to watch, but it's more efficient in winning games.*

WN: I've heard that a lot of the top Go programs are written by top Go players. What's your experience with the game?

Coulom: Before I started to write my first Go program, I decided I was going to play well enough to beat the other programs out there. But I don't think being a strong player is important to write a strong program. When I was still programming chess, this was obvious: my program was immensely stronger than me.

Some of the programs out there do use these set sequences of play, called joseki*, but I avoid hard-coding this knowledge. I see some programs blunder because they blindly apply a hard-coded pattern.*

At the 2007 European Congress, Martin Meuller, one of the leading developers and commentators on computer go, gave a lecture summing up the current state of the art of computers that play go. His website is http://www.cs.ualberta.ca/~mmueller/cgo/villach2007.html

From the report in the July 23, 2007 *American Go Association E-journal*:

Last year, Guo Juan 5P played a series against Crazy Stone on a 7x7 board in which the program always won or got a jigo *when playing white against the pro; this year MoGo scored 9 wins and 5 losses against Guo Juan on a 9x9 board. 'Monte Carlo programs play many strange moves,' conceded Mueller, 'but they're very good at winning. All without a single line of programming.' Such programs run as many as 100,000 simulations—or 1 million moves per second—for each move in a 9x9 game.*

When asked about these figures, Coulom kindly responded in an email: 'A playout for 9x9 is about 100 moves. . . . The fastest MC program I know does indeed do 100,000 simulations per second (that is Libego, by

Lukasz Lew). But that means 10 million moves per second. 1 simulation = about 100 moves. 10,000 simulations per second is typical (when running on one core).'

'Why does it work so well?' Mueller asked. 'There's no theoretical explanation, although we have excellent empirical results.' In other words, a broadly grinning Mueller said, 'We don't really know.' Although Mueller said that many researchers now think it's 'just a matter of time before there's a professional-level go-playing program,' he thinks it may be farther off. 'My own feeling is that we need one or two more good ideas, but where they'll come from I don't know.'

For an ongoing, day-to-day, bird's eye view of where these new ideas might come from, you can subscribe to the computer go discussion list at http://hosting.midvalleyhosting.com/mailman/listinfo/computer-go