# SOME COGNITIVE BIASES DURING GO-PLAYING

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“The mind has its illusions as the sense of sight; and in the same manner as feeling corrects the latter, reflection and calculation correct the former.” - Pierre Simon, Marquis de Laplace Rationality (Koehler & Harvey 2008, p.316)

ABSTRACT
One main topic in the psychology and behavioral economics literature from the past 50 years is concerned with heuristics and cognitive biases. As human beings, we have cognitive limitations which in diverse contexts and on a regular basis stop us from taking the best decisions. Heuristics, which are mental shortcuts, are generally useful when taking decisions, but oftentimes cognitive biases occur and they contribute to reaching less than optimal results.
Some of these cognitive biases are due to cognitive limitations, some are due to the fact that we give more importance than necessary to unimportant things (e.g., framing). These phenomena have been noticed in experiments which often consisted of situations which were supposed to reproduce day-to-day-life decisions (see, e.g., Schwartz 2003, pp.19–20). However, there is a significant chance that such phenomena could be encountered in many other situations that involve decisions making, including during games such as the Chinese game of Go.
Acknowledging the existence of biases when playing Go and using debiasing techniques might be useful in oder to reach a better understanding of the game and as a way of improvement of decision making during the game by pushing aside a part of our emotions and impulsiveness and concentrating more on the cognitive calculation-based processes.

## *1. Introduction*

It comes as a natural thing as a human being to try to understand better the things that one likes, be it science, be it games, be it anything else. However, very few people get to be experts in their fields and often passion is not the thing missing. What stops us all from being very good at what we are doing? Often it's our own mind and our own emotions which do that. Improvement in many fields will often require understanding our humanly limitations, letting go of what makes us more human (emotions, intuitions), and concentrating more on what makes computers amazing at their job: calculations, lack of interference of emotions.

There is a simple proverb from the game of Go which illustrates the strong role of emotions during Go playing: “**You are two stones stronger when watching a game**”. Emotional involvement in the game will make one weaker, while taking distance will likely make one (a bit) stronger. When watching someone else's game it's easy to detach oneself, whereas while playing one's own game it's almost impossible to leave aside one's emotions and feelings. However, trying the best to have a calm, detached attitude, combined with some mental “disconnecting” from the game during the game will make one play better (Golem 1998).

This paper is looking at the findings of the behavioral economics literature about heuristics and biases in order to try to understand a little bit better what mental processes might be to blame for *systematic* mistakes that Go players make. These mistakes can sometimes be explained by the same processes that take place in our minds when we make other *systematic* wrong decisions.

The structure of this paper is as follows: Part one is the introduction. Part two presents briefly the main theories of human decision-making from the last 70 years which suggest a shift from the previously common rational-agent models. Part three introduces the game of Go and research about biases and the game of Chess, only to have the background to further on introduce three particular biases and some examples of how they might be influencing Go players. The last part introduces the concept of debiasing in order to raise the question of how it could be useful in order to help Go players with their game-biases. Right at the end there is a short glossary with the used Go game terminology. It must be noted that the purpose of this paper is more to raise some questions about the possibility of using the latest advances in the field of decision making than to actually answer a particular question.

## *2) Behavioral economics: biases and heuristics*

The last approximatively 70 years have seen some shifts of paradigm when it comes to the assumptions regarding the standard behavior of decision maker. The earlier used rational-agent model, which said that a decision maker behaved by trying to maximize his utility in a given situation was initially replaced by the boundedly rational model of H. Simon. The rational-agent model had assumed that an agent will incorporate all the relevant pieces of information needed for the decision and will take into account all of the expectations about future opportunities and risks and will ultimately make a decision that perfectly incorporated the previous information. H. Simon's model claimed that decision-makers would be contented with *satisficing*, with simply obtaining a result that's good enough, but not necessarily the best. Later on, D. Kahneman and A. Tversky's work explored the systematic biases of the human mind: by having the rational-agent models as a null hypotheses, they demonstrated some of the systematic ways in which the beliefs and choices of individuals actually differ from the neoclassical norm (Thaler 1980; Thaler 1994; Thaler 1988; Kahneman 2003). The next paragraphs will look into detail at these changes of the paradigm.

### A. Herbert Simon's *Satisficing*

In the 1950s Herbert Simon introduced the concept of *satisficing*, his concept being “the first major challenge to the standard economic model of choice, which was revealed to be an abstract mathematical ideal that neglected to consider or incorporate the limited decision-making capacities of real human beings” (Abdukadirov 2016, p.18). Starting with his two of his articles[1] he attempted to point to the faults of the traditional mainstream economics model of the rational behavior of individuals by coming up with an alternative to the utility maximization theory. His proposed new theory is known under the name of *satisficing*. This new model of his, which he described as a theory that was at that point not (yet) rigorous and systematic enough, attempts taking a step away from the models of rational behavior from the field of neoclassical economics, and at the same time taking a step in the direction of the models of adaptive behavior from the field of psychology. Therefore, it can be said that he moves from the “global rationality of economic man” to defining a person as an individual “with a kind of rational behavior that is compatible with the access to information and the computational capacities that are actually possessed by organisms […], in the kinds of environments in which such organisms exist”. One of his critics to the traditional models is the fact that, unlike in predictions in those models, in reality it is not reasonable to assume that individuals are capable of assigning pay-offs to all outcomes, because that also implies that the individual is aware of everything and nothing unexpected can happen.

1 “A behavioral model of rational choice” (1955) and “Rational choice and the structure of the environment” (1956)

As already mentioned, individuals don't have unlimited computation capacity and they don't have unlimited time in order to make the necessary calculations. So there are situations in which (also maybe in order to save energy) it's enough to seek for a “good enough” option[2], and it's not necessary to look for the “best one”, which is what *satisficing* actually means. So, humans might often not be *optimizing*, but only *satisficing*, and that might be *good enough* (for them), given the limited time and the scarcity of resources (i.e. mental computation power) (Simon 1955; Abdukadirov 2016, p.18; Simon 1956).

### B. Kahneman and Tversky's 3 separate programs of research

As human beings we are able to do amazing things: we can speak multiple languages, we can recognize people we haven't seen in years, we can learn to pay attention at multiple things at the same time, we can drive cars, etc.. But there are certain things at which we are not as good, more precisely, there are things at which we *systematically and predictably* do wrong (Thaler & Sunstein 2008, p.19). The research of Kahneman and Tversky[3] and the three different research programs they have worked on are about these systematic and predictable human mistakes. The next paragraphs will present the main ideas of their three programs of research.

#### *a) Program 1: Heuristics and biases*[4]

When individuals need to make judgments in conditions of uncertainty, they “rely” often on heuristics. These heuristics simplify the work of individuals: instead of having to assess probabilities to events and predict values, individuals will use simpler operations of judgment. When used well, heuristics are very effective, because they make the judgment a lot faster and the results are often good (enough). But

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2 To explain such a situation, H. Simon refers to Chess positions in which one is clearly winning and therefore he might not need to do the exhaustive mental search for the very best move, but instead find a move that's good enough in order to win. I believe that situations that occur often enough in the game of Go might be useful for explaining this procedure in an easier way that H. Simon explains it in his article. Since we are not able to compute all possible options while playing Go, we have no choice but to rely on our and our opponent's limited calculation capacity, which is not necessarily something bad. During a game it often happens that you are ahead at points, which you realize by carefully counting your territory and your opponent's territory. There are situations in which you might be ahead by a small margin, there are situations in which you are ahead by a large margin. By taking into account the fact that the opponent can also play unexpected moves and you are not able to calculate all the possibilities, you have usually two choices in such a situation when, let's say, you are ahead: (a) you can play the move you think is the correct one, which still usually allows something unexpected to happen in the area where you still have *aji*, or (b) you play a move which is not the best one, but it protects your *aji*, and, in case you are winning by a lot, it is likely to secure your win; if you are not, you are taking a chance.

3 Michael Lewis' book “The Undoing Project - A Friendship That Changed Our Minds (2016)” is a great book that presents the unexpected friendship of the two researchers and their cooperation which brought the science world a big step ahead.

4 The program is based mostly on the following journal articles:

- Kahneman, Daniel; Slovic, Paul and Tversky, Amos, eds. *Judgment under uncertainty: Heuristics and biases*. New York: Cambridge University Press, 1982.
- Kahneman, Daniel and Tversky, Amos. *On the Psychology of Prediction.* Psychological Review, July 1973, 80(4), pp. 237-51.
- Tversky, Amos and Kahneman, Daniel. *Judgment under Uncertainty: Heuristics and Biases.* Science, September 1974, 185(4157), pp. 1124-31.

there are cases in which these heuristics don't work well and they lead to systematical and predictable errors of the judgment, to biases. And it's not only normal individuals who are prone to biases, but also experts and specialists. Three such heuristics are: representativeness, availability, and adjustment and anchoring (Tversky & Kahneman 1974). One of the reasons why representativeness is important, is because people predict by representativeness, which means that “they select or order outcomes by the degree to which the outcomes represent *the essential features of the evidence*”. This works in many situations (same as all heuristics), but in some cases it doesn't. The researchers reached this conclusion testing groups of students in more ways. In one of them, 114 graduate psychology students at three important American universities received a description of a boy called Tom W.[5] and then some additional information[6]. The subjects were asked to rank "how similar is Tom W. to the typical graduate student in each of the following nine fields of graduate specialization?"[7] When answering, the psychology graduate students made the following systematical and predictable mistakes:

- They took into account the projective personality tests, even though, given their field of study, they surely heard before that such tests are known to be invalid (therefore, all the characterization based on these tests should have been ignored, but they weren't);
- They believed that if the description of Tom W. was valid in high school, it should still be valid now during his studies, but that's not necessarily the case;
- Even if the personality of Tom W. really corresponded to the description, there are likely more students fitting that description in fields such as humanities and education compared to computer science, simply because there are so much more students in these other fields (*insensitivity to prior probability outcomes*) (Kahneman & Tversky 1973; Tversky & Kahneman 1974).

The studies of Kahneman and Tversky in this field have been highly influential and further studies have been made based on their findings. One such example is an experiment from 2006 conducted by Ariely et al., which was constructed the following way: students were presented different objects, each worth between 10 and 100 dollars. They were asked whether they would pay for the products a sum equal to the last two digits of their social security numbers. Even though those numbers clearly not influence in any way how much the products were worth, they did influence the responses of the students: i.e. students with the 20% lowest numbers (made out of the last two digits of their social security numbers) rated a bottle of 1998 Cotes du Rhone at an average of 8,64 dollars, while the 20% with the highest two digits rated it at an average of 27,91 dollars (Ariely et al. 2006). This clearly points to the anchoring effect observed also by Kahneman and Tversky.

5 “Tom W. is of high intelligence, although lacking in true creativity. He has a need for order and clarity, and for neat and tidy systems in which every detail finds its appropriate place. His writing is rather dull and mechanical, occasionally enlivened by somewhat corny puns and by Hashes of imagination of the sci-fi type. He has a strong drive for competence. He seems to have little feel and little sympathy for other people and does not enjoy interacting with others. Self-centered, he nonetheless has a deep moral sense.” - (Kahneman & Tversky 1973)

6 “The preceding personality sketch of Tom W. was written during Tom's senior year in high school by a psychologist, on the basis of projective tests. Tom W. is currently a graduate student. Please rank the following nine fields of graduate specialization in order of the likelihood that Tom W.. is now a graduate student in each of these fields.” - (Kahneman & Tversky 1973)

7 The specializations were: Business Administration, Computer Science, Engineering, Humanities and Education, Law, Library Science, Medicine, Physical and Life Sciences, Social Science, and Social Work.

*b) Program 2: Prospect theory (choice under risk)*[8]

Similar to the first program, the two researchers used different questions[9] to test their hypotheses. This program poses a criticism to the expected utility theory as the descriptive model of decision making under risk and it proposes instead a different theory, the prospect theory (Kahneman & Tversky 1979). Illustration 1 represents maybe the main three ideas of the prospect theory:
- It's based on “gains” and “losses” (unlike Bernoulli's original model often used in economics, which is based on *states of wealth* as “carriers of value”);
- The graph has two sides, to the left and to the right of the reference point; one represents gains, the other losses; the graph is S-shaped, which shows diminishing sensitivity for both gains and losses;
- The two curves, the one to the right of the reference point and the one to the left, are not symmetrical: they represent *loss aversion*: people respond stronger to a loss than to a corresponding win (usually a 2:1 rate when it comes to money gains and losses) (Kahneman 2011, pp.282–283).

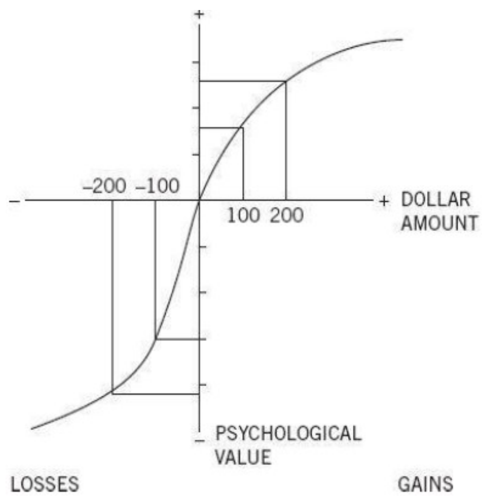


*Illustration 1: A value function*
(Kahneman 2011, p.283)

*c) Program 3: Framing effect*[10]

The third program is mostly about the implications of framing effects for rational-agent models. Even

8 The program is based mostly on the following journal articles:
• Kahneman, Daniel and Tversky, Amos. *Prospect Theory: An Analysis of Decisions Under Risk.* Econometrica, March 1979, 47(2), pp. 263-91
• Tversky, Amos and Kahneman, Daniel. *Advances in Prospect Theory: Cumulative Representation of Uncertainty*. Journal of Risk and Uncertainty, October 1992, 5(4), pp. 297-323
9 An example that appears in Kahneman's “Thinking, fast and slow”: “Problem 1: Which do you choose? Get $900 for sure OR 90% chance to get $1,000” and “Problem 2: Which do you choose? Lose $900 for sure OR 90% chance to lose $1,000” (Kahneman 2011, p.279). (I chose this example because the ones in the original article use numbers and probabilities that are not as easy to calculate).
10 The program is based mostly on the following journal articles:
• Tversky, Amos and Kahneman, Daniel. *The Framing of Decisions and the Psychology of Choice*. Science, January 1981, 211(4481), pp. 453-58.
• Tversky, Amos and Kahneman, Daniel. *Rational Choice and the Framing of Decisions*. Journal of Business, October 1986, 59(4), pp. S251-78.

though rationality has been defined in different ways, two of the axioms usually connected to it are consistency and coherence. Findings show that there are situations in which individuals systematically violate these two axioms: even though it shouldn't, the formulation of the problem affects the response of the respondent. The researchers used again short problems, and they checked whether the respondents gave the same answer to problems which basically said the same thing, but used different formulations[11]. And they didn't: depending on the formulations, the answers were different. The different answers were given to important questions involving the loss of human life and to less important questions involving money (Tversky & Kahneman 1981). Their findings confirmed the ideas of illustration 1. Additionally, Kahneman and Tversky also propose that when it comes to choices, there is a difference between the normative model and the descriptive model, and therefore they should be treated separately (Tversky et al. 1986).

Even though Kahneman and Tversky didn't use the two-system model (which explains the way our thoughts are formed) throughout their first researches, Kahneman later mentions in his book “Thinking, fast and slow” that there is a strong connection between the ideas of their research and the two-system model of the mind (Kahneman 2011, pp.281–282). On one hand, most of our thoughts and actions involve effortless thinking and are guided by System 1 (intuition). The cognitive operations associated with it are quick, associative, intuitive, heuristic, automatic, unreflective, driven by affect, undemanding on our limited cognitive resources. On the other hand, System 2 takes care of the analytic and effortful thoughts (reasoning). The cognitive operations associated with it are rule-based, reflective, and they require effortful thinking. The importance of this model comes from the fact that it digs deeper and it points out to some of the reasons why we make certain predictable and systematic mistakes. Our mind functions like this: if possible it would like to make no effort, so whenever it can, it will do just that (Stanovich & West 2000; Sherman et al. 2014). When playing Go or training it there are situations which put into use System 1 and situations that require the use of System 2. However, this depends on the aptitudes of the Go player and of his past experience: while an answer to a particular tsumego will come automatically to a 7dan player, it might require a lot of reflection from a weaker player.

Additionally, if we choose to just answer without reflecting before, our System 1 might give a wrong answer. When looking at illustration 2 and trying to answer the question who has a bigger territory, one might be inclined to say that white's territory is bigger (System 1 response). However, that's not the case. By choosing to count instead of just giving the intuitive answer (therefore using System 2), one will realize that the initial intuition is wrong and that, in fact, black's territory is larger: white has only 121 points on the board, while black has 136.

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11 “Problem 1 [N = 1521: Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the con- sequences of the programs are as follows: If Program A is adopted, 200 people will be saved. [72 percent] If Program B is adopted, there is 113 probability that 600 people will be saved, and 213 probability that no people will be saved. 128 percent] Which of the two programs would you favor?” vs. “Problem 2 [N = 1551: If Program C is adopted 400 people will die. [22 percent] If Program D is adopted there is 113 probability that nobody will die, and 213 probability that 600 people will die. [78 percent] Which of the two programs would you favor?” - (Tversky & Kahneman 1981). (in between parenthesis you can see the percentage of the respondents who gave each of the answers)

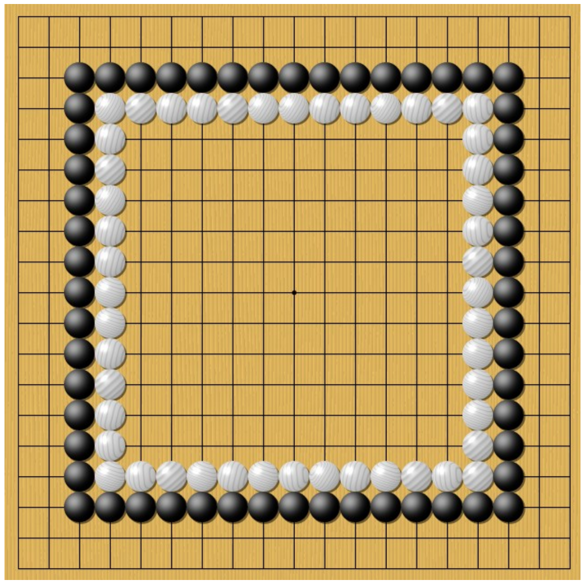

*Illustration 2: White's territory only looks bigger*
(Miura 1995, p.46; Golem 1998, p.69)

The previously mentioned phenomena can be exemplified easily with the help of tsumego.

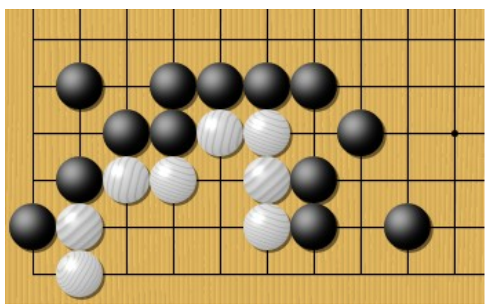

*Illustration 3: Black to kill white*

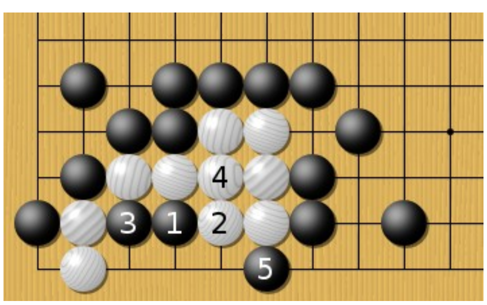


*Illustration 4: [Wrong variation] The wrong sequence that probably first comes to many people's mind*

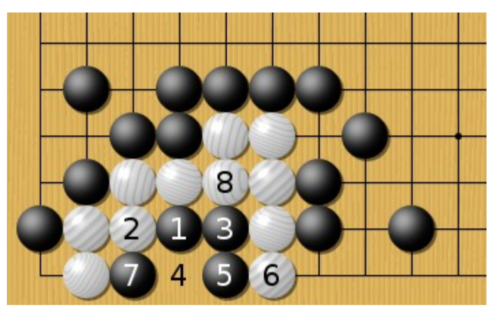


*Illustration 5: [why the previous move doesn't work] If white answers correctly, then the group lives*

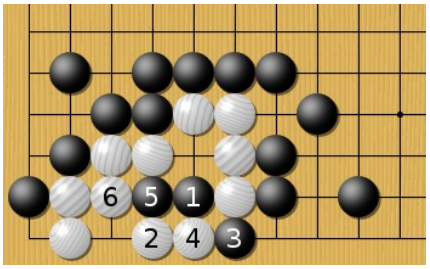

*Illustration 6: [Moves 1-6]*
*Black 1 is the correct move*

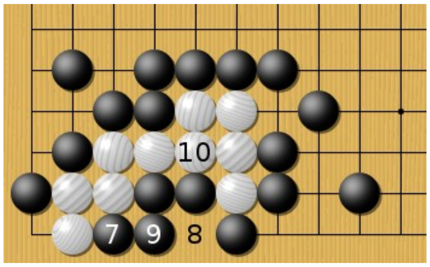

*Illustration 7: [Moves 7-11]*
*Move 11 is played at 8*

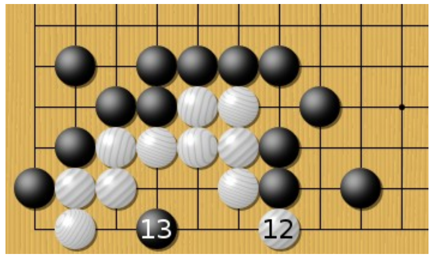

*Illustration 8: [Moves 12-13]*
*White dies after this sequence*

3) *Biases during Go-playing*

This part will briefly introduce the game of Go and mention a few fields in which research has been made in connection to Go. Then it will explain why it seems reasonable to look at Go in relation to cognitive biases by presenting briefly some research that's been done regarding the game of Chess. Then three biases: anchoring, availability, and the endowment effect will be introduced and they will be explained in the context of the game of Go.

Go is an old Chinese board game, with a high popularity in East Asia (Berlekamp & Wolfe 1994, p.2). Depending on the source, it's said to be between 2000 (Schmidt 1981) and 4000 years old (Koulen 1986). It's played on a 19*19 lines board using 180 white and 180 black stones and the goal of the game is to surround more territory than the opponent. When it comes to the category of games it belongs to, Go is a deterministic (there are no elements of chance) 2-player zero-summed board game with perfect information. This category of games includes games like Chess, Chinese chess, Dame, Go-moku, Shogi (Chan 1996). Go is also a discrete game (because the two players play alternatively, not simultaneously) and a finite game (after a finite number of moves, the game will produce a clear outcome) (Browne 2008).

Go has been known to be an interesting research domain for computer science and artificial intelligence, because it could facilitate the examination of areas such as planning, problem solving, pattern recognition, opponent modeling, tree search, learning, and knowledge bases. However, unlike the previously mentioned field which has been quite a popular research area (see, e.g., AlphaGo), what's less know is that Go could provide a good research domain for the field of cognitive psychology (Burmeister 2000; Berlekamp & Wolfe 1994). There have been studies that have shown the positive consequences of playing Go, such as the increase of patience and the increase of the capability of people of anticipating decisions of other people (Rieger & Wang 2016). Additionally, it's been shown that Go could help scientists with investigating memory, implicit learning, pattern recognition, perceptual learning, problem solving, and attention (Burmeister 2000). Given this background information, the possibility of connecting the field of decision making, including heuristics and biases, with Go comes quite naturally. It seems plausible to consider that the different types of deviations from the normative behavior that have been observed in the context of human behavior (Kahneman 2011) might be affecting the standard judgment of Go players during their games. If that's true, then such cognitive biases could lead to a worse result compared to the one which is not affected by this systematical interference. What's more, given the fact that Chess and Go belong to the same category of games (see previous paragraph), the fact that there have been scholars looking into biases in the context of games like Chess (e.g., see Cowley 2002, Bilalić et al. 2010) comes only as a further confirmation of the possibility to connect the two fields.

However, since according to my knowledge there haven't been any published papers about the cognitive processes that take place when taking a decision during a Go game, I will first look at what scholars have written about how decisions are made when, playing Chess. It seems that when playing Chess, because of their impossibility to compute too many moves, Chess players will usually consider 2-3 moves per position. What's interesting is that these moves that are considered are not random ones. The player will look at the position, then he will applicate some heuristics (e.g., examining first those moves that permit the opponent the fewest replies[12]) and come up with a small subset of the legal moves which the player will then take into consideration (Simon & Chase 1973). Additionally, it seems that experts in general (not only Chess experts) use a recognition-primed strategy when making a decision: they will "look" into the typical examples that their long-term memory has stored and they consequently make sense of the world that way (Phillips et al. 2008).

Why could looking into these biases be important and for whom?
On one hand, for Go players. By understanding that during their games their own mind is sometimes controlling them in a way that leads them to systematically taking worse decisions and by understanding some of these ways, they can improve their understanding of the game and take better decisions during the game. On the other hand, maybe there is a chance that by looking into biases in a very particular field, one could come on with something that hasn't been observed before, but, of course, there is a lot of work needed in order to get there. Since Kahneman and Tversky there haven't been any huge inoovation in their field of research, so maybe it's possible to try to look into completely new ways of gaining knowledge.

This part will look into three biases which I believe *systematically* affect Go players during their games and some examples will be given as to exemplify the consequences of these biases.

*a) Anchoring*

The fact that often "people make estimates by starting from an initial value that is adjusted to yield the final answer" is known under the name of *anchoring* (Tversky & Kahneman 1974). During Go games there is a tendency of Go players, particularly weaker ones, to automatically play in the area where the opponent last played, often right next to where they have played last. Instead of reassessing the situation after the new piece of information (i.e. the opponent's last move), the players sometimes take for granted that the opponent's last move is a hint that points out to the most important area on the board, and they get anchored by it. What's more, the opponent's last move also makes that particular area very salient. But often the best move on the board is not at all in the area where the opponent placed his last move. Each new move requires a new reassessment of the situation and finding the best move implies global thinking, not limiting oneself to a small area.

Such cases happen very often in handicap games, one such example being illustration 9 representing a 9-handicap game. White just played at 1 and it's black's turn. Instead of looking at the whole board, black will often play almost instantly move 2 from illustration 10, because he would be *anchored* by white's last move. However, that's the wrong way of playing. Finding the right move requires assessing the global situation. The right move can be seen in illustration 11.

12 Note that this examples works only for Chess players, not for Go players.

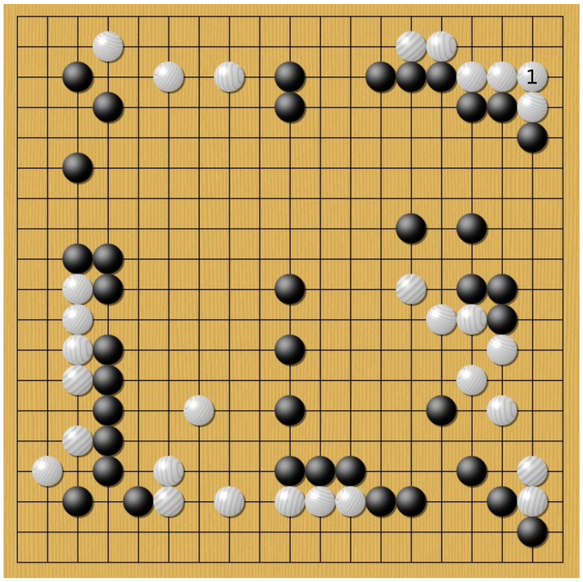

*Illustration 9: Black to play*

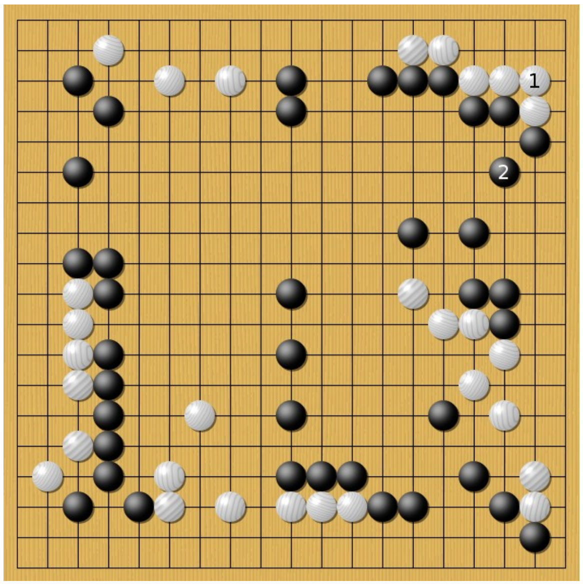

*Illustration 10: Usual [wrong] response by weaker players*

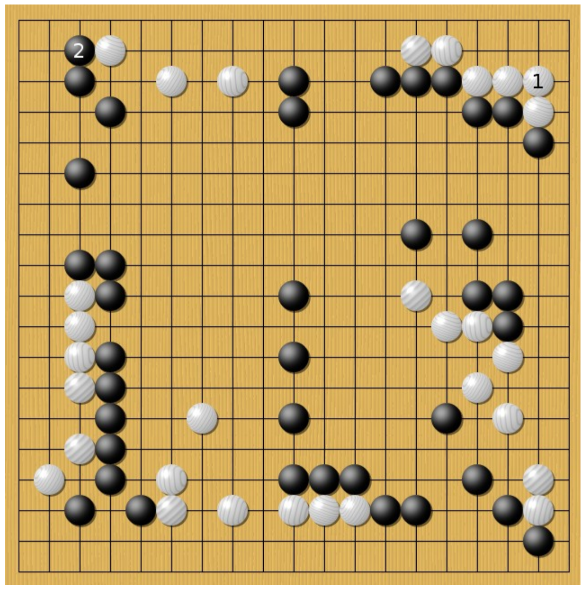

*Illustration 11: Correct response (the biggest move on the board)*

Yes, limiting oneself to that particular area where the opponent last played is energy and time efficient (i.e. calculating moves in a small area consumes is faster than evaluating a global situation) and the right answer is sometimes located within that area, but other times it simply isn't. Go is a game about the efficient allocation of resources. What's the minimum number of stones does black need to invest in order to gain 20 points of territory in the corner, on the side, and in the center? In the corner: 9, on the side: 13, in the center 18. However, things are more complicated than that. Even though building territory in the corner is more efficient than building it on the side or in the corner (see the following illustration), things are more complicated than that. Oftentimes you might win by (indirectly) building territory in the center.

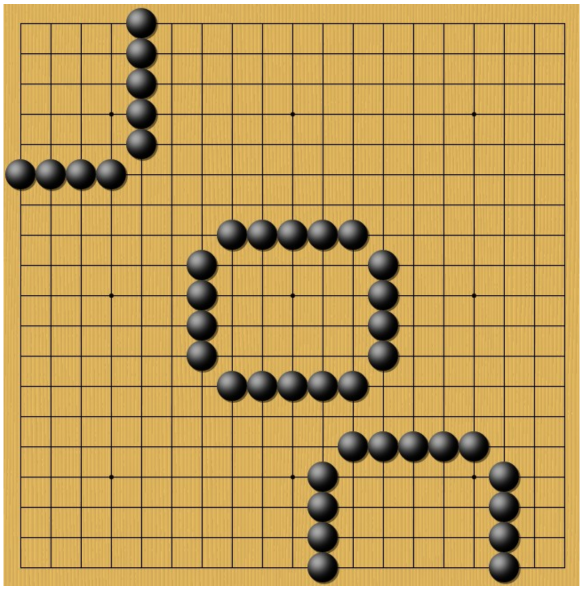

*Illustration 12: The most efficient way of surrounding 20 points in the corner, on the side, and in the center (own illustration)*

The next example comes in order to exemplify this tendency to give too much importance to the last move. When playing and you want to find out the best move in a certain position (e.g., during a commentary), one would often show the last exchanges when asking a player for advice about the right move. However, maybe it does make it more interesting to understand the flow of the moves, but in a sense it's useless and it shouldn't happen. The situation should be analyzed as a given. Previous information can at best not add any value to the situation and in worst case it can bias in the sense of anchoring the commentators and the players to focus on a particular area (where the last moves have been played) and not assessing the whole board situation. If the position is difficult, then maybe in a sense knowing how it got there would help understand the situation, but in a rational world it shouldn't be the case.

The Einstellung effect (when trying to solve a problem which consists of a familiar context, the idea that comes immediately to mind will stop one from looking at the possible alternatives) has been observed and written about in the context of the game of Chess. Looking with an eye-tracking device at master players while they were trying to solve a Chess problem showed that they are directing their attention towards the right places on the board which would help them find solutions to their problems. However, research has showed that in all kinds of contexts, once a person has formed an opinion on a topic, they will just not add the new information to their knowledge, they will be quite immune to it. As humans we are looking for evidence that confirms our world view, and we ignore evidence that does the opposite (Bilalić et al. 2010). Does this happen in the context of Go? I believe it does happen, for example in the context of josekis: for years it has been believed that some sequences lead to even results or favorable results for one of the players and that they ought to be played in a certain way. The situation was so extreme, that I even recall a professional player saying that back when he was an insei (studying at one of the Go schools in Asia in order to become a pro), if he had played certain moves, then his teachers would just start questioning why he was even there. This perception of certain positions got not become such an "innate" part of the players, that they wouldn't even consider playing some other moves. However, with the arrival of AI, some moves which in the old days would have been considered very bad are now suddenly good or at least playable. One such example can be seen in illustration 14. While in the before AlphaGo era invading at the 3*3 points so early was pretty much never seen in professional games because it wasn't considered good, nowadays it's a common move.

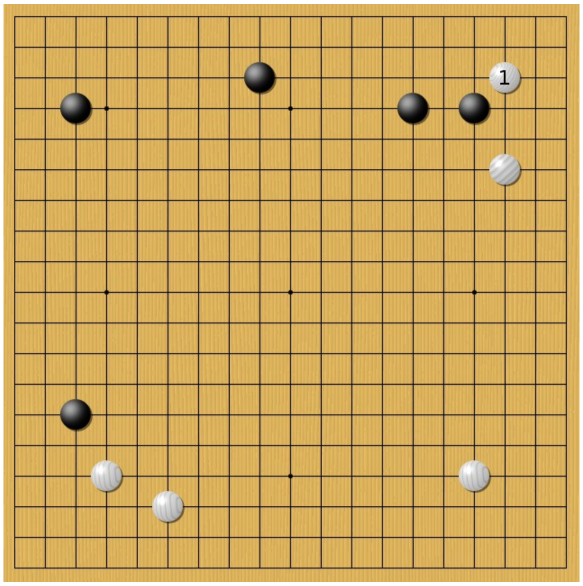


*Illustration 13: W: AlphaGo vs. B: AlphaGo [year 2016, game 3/3], source: http://www.alphago-games.com/*

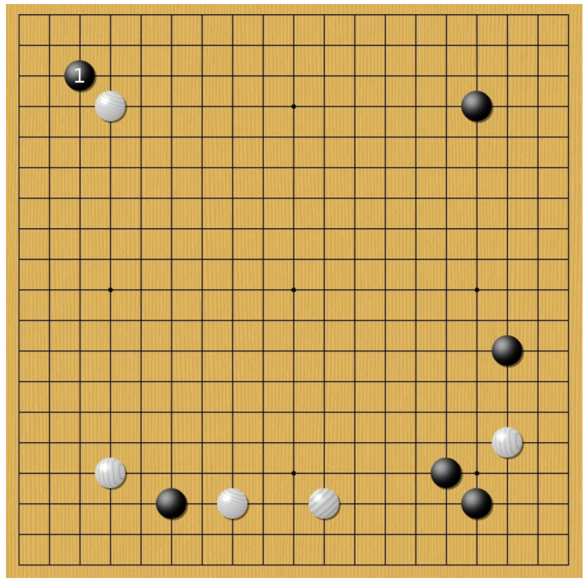


*Illustration 14: W: Tao Xinran [7p] vs. B: Tong Mengcheng [6p], Chinese Agon Cup [year 2018], source: http://gokifu.com/*

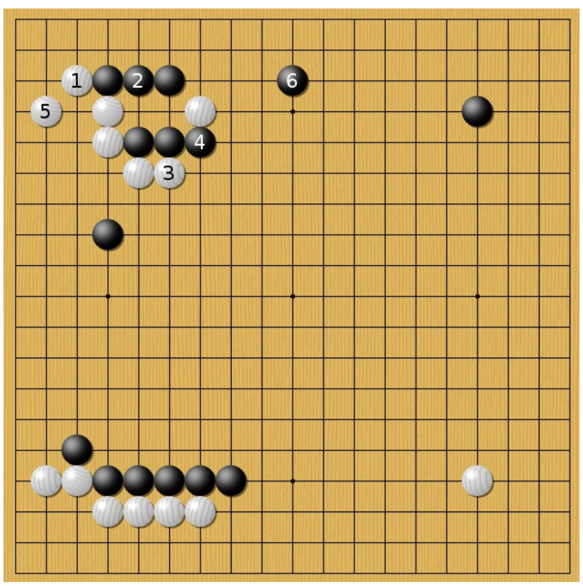


*Illustration 15: Classical joseki [own diagram]*

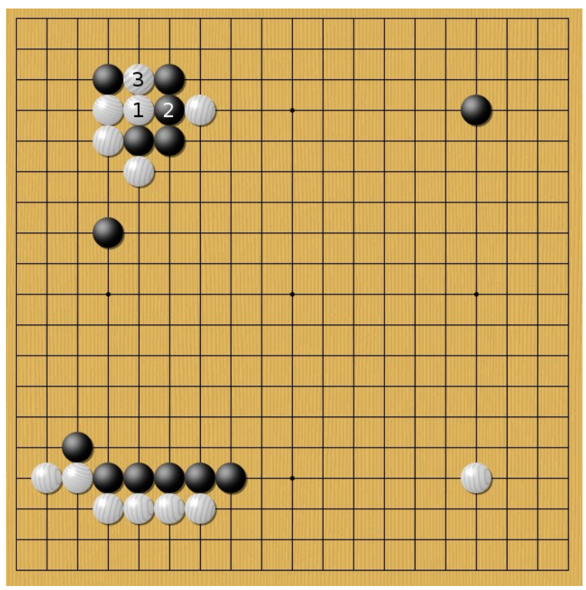


*Illustration 16: W: AlphaGo Master vs. B: Chen Yaoye [9p] [year 2017], source: http://www.alphago-games.com/*

When it comes to josekis still, the Einstellung effect can be seen also in connection to the play of weaker players, not only strong amateurs and professionals. Exactly as described by theory, when having to play a move, sometimes you feel straight away after your opponent's move a strong urge to ("gut feeling") play in a certain spot. And you start reading a few possible follow ups of the move and you might consider some other moves as well, but maybe you are actually not really considering the other possible moves. Maybe you are just superficially checking them out as a way of disconfirming the possibility that they are good moves in order to just (happily) play the initial move that one wanted to play (the "gut feeling" one). However, testing is needed to confirm this hypothesis.

*b) Availability*

Availability has been defined as "the ease with which relevant instances come to mind" (Tversky & Kahneman 1973). Go players sometimes play certain moves in certain situations because they have a vivid image of what happened during another game in a similar position, e.g., in one of her last games, player A didn't defend her moyo and her opponent entered it. Because her she didn't defend her potential future big territory properly, she lost the game. Because that memory is still very present in Player A's mind, during the next game when she will encounter a more or less similar position, she might be influenced by her past experience: This salient memory might make her protect her moyo way too early in the game, by increasing her sense of urgency for that particular move. Yes, in some cases it would be indeed the best to protect the moyo early on, but in some others it would not be.

*c) The endowment effect*

Experiments have shown that once we mentally label a certain object as being our, we value it more highly than before we regarded it as ours (Halpern 2015). It seems that when we can let go of the whole it's-mine-and-that-automatically-makes-it-better ideology, we might be better at reassessing the situation. This phenomena has been noticed in experiments where the average selling prices were typically more than twice as large as the average buying prices, e.g., (Kahneman et al. 1990; Dhar & Wertenbroch 2000). A typical study of the endowment effect consists of giving a good like a coffee mug to half of the participants. Then all the participants in the experiments meet in a market in which the experimenters offers to buy the good from the half of participants in the experiment who possesses them and tries to sell the good to the half who doesn't posses it (Johnson et al. 2007).

Going back to the situations encountered when playing Go, often the following thing happens on the board: instead of letting go of weak stones which present a liability for oneself, one might get attached to them and invest more and more stones to save the few initial ones, which makes the liability stronger and stronger. Why can't we just let go of it? It's for the same reason why we can't let go of failing businesses or failing romances: once something is our *child*, once we invested a lot of energy and effort and resources into something, it's indeed very hard to let go of it.

There is even a Go-proverb that speaks about this particular phenomena: "**Give up worthless stones**.". The author of the Go-proverbs book which included this one says the following: "This proverb warns against getting too attached to stones that have served their purpose or to stones that aren't very useful and have no easy way to live or escape. It is important to distinguish these from key stones, such as those separating two weak enemy groups [...]". The author shows with the following two diagrams, which present the mentioned phenomena (Golem 1998, p.114).

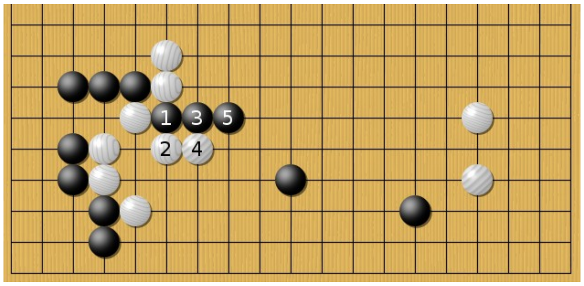


*Illustration 17: White is greedy and unreasonable*

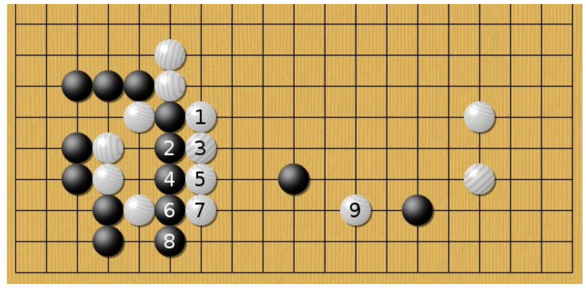


*Illustration 18: White makes a clever sacrifice*

(Golem 1998, p.114)

*4) Debiasing*

How to deal with the previously mentioned biases and with the many others that we have as human beings? Going back to the research done in the field of decision making, there have been scholars looking into this problem. The biases and heuristics approach suggests further on that decision making of individuals can be improved by eliminating biases (Phillips et al. 2008). But how to close the gap between the descriptive and the normative behavior? The two approaches that have been generally used are the following: altering the incentives that influence behavior (e.g., imposing taxes on soda in order to make people drink less soda) and altering the way in which information is presented for various choices (e.g., adding information about the calories intake on the fast-food menu, offering salad as the default side dish instead of French fries). However, these approaches have not always been effective. As a substitute to these, a group of scientists developed two computer games meant to “substantially reduce game players' susceptibility to cognitive bias”, namely, anchoring, representativeness, confirmation bias, etc. (Morewedge et al. 2015). However, all these findings don't seem at all applicable to the Go players at a first glance. Are they really not applicable? Are there maybe ways of debiasing Go players by creating programs that can effectively point out to these cognitive malfunctions of players and repair them? To what extent could Go problems training be used to do that and to what extent do Go teachers already intuitively use certain debiasing techniques, in case they do so? These are all questions that are yet to be answered.

**Mini glossary of technical terms from the game of Go**

Aji = The tactical potential of a position that is not immediately utilized. Aji is said to be good or bad.
Joseki = A corner pattern that is locally equal for both sides. However, a given joseki can be totally inappropriate to the whole-board situation and thus entail considerable loss.
Moyo = A large framework of potential territory[13].
Tsumego = Go problems which involve living with one's own group of stones or killing the opponent's group of stones.
Handicap-games = When playing against a weaker player it's normal to give him an advantage in order to make the game more even.

13 The definitions for the therms *aji, joseki,* and *moyo* were taken word by word from (Golem 1998).

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