Why Are Games Fun:
A Psychological and Neuroscientific Analysis

Objectives and Question

What aspects of a game makes a game “fun” and how does our brains interpret kind of fun?

The main goal of this short project is to analyze why games are fun on multiple levels. We want to analyze how our brains processes critical thinking, creativity, and analysis, particularly which parts of our brains are responsible for certain actions. Additionally, we would like to analyze the structure of the games, taking into consideration the game tree of possible win positions and draw positions for known games (mostly taken from the interesting group from Fall 2018). Lastly, we would like to take into consideration the larger picture of what makes games so engaging on a composition and inherent level. A combination of 12 different elements amalgamate together to make games the most engaging and fun pastime.

How do our brains respond to creativity, critical thinking, and strategic analyses?

The brain is the most complicated and most intricate structure known to mankind. The various parts work in an interconnected fashion to create sophisticated thoughts and well developed information. It works as an information processor, gathering numerous neuron inputs and precisely consolidating all the information into a single concise output. In analyzing games and how our minds interpret different games we must consider the ways our brain processes creativity, critical thinking, and strategic analyses.

Executive functions are considered the highest cognitive processes any human can possess. These are specific skill sets that go beyond what a computer can do – rational thinking, problem solving, critical analysis. These higher order neural networks are most developed during adolescence, with teachers and educators being at the forefront of promoting the activation of these networks. Throughout these crucial years, older adult figures like teachers may pave the way for adolescents so that they can develop the necessary skillsets to strategically navigate the world outside of obtaining knowledge from brute force memorization.

Unfortunately, many school systems have maintained this "factory model of education." As technology advanced with computerization and automation, the education model remained the same, catering to the factory systems that used to exist in the industrial revolution era.

The prefrontal cortex is the home to critical thinking. It is home to emotional responses, in-depth thinking, and controlled behavior. Compared to other animals, humans have the largest prefrontal cortex percentage in respect to total brain size: roughly around 20%. Because humans utilize the prefrontal cortex at a level much higher than other animals, it is one of the last parts of the brain to mature. This maturation process is due to various neuroplasticity functions to develop. Two main processes occur during this maturation phase: synaptic pruning of

unnecessary undeveloped cells and on the other hand, strengthening the synaptic connections that the neural circuits utilize most.

During this maturation process, one of the most important aspects that must be employed is the idea of strengthening executive neural functions and their respective neural networks. The incorporation of brute memorization into the existing stable networks of long-term memory occurs mainly when students start to recognize relationships that form with the prior knowledge stored in those networks. With critical thinking and strategic analysis, it creates an environment for the brain to develop such neural networks that result in greater connectivity between neurons that fire together, a process known as Hebbian learning, coined by psychologist Donald Hebb. Hebbian learning is the idea that when neurons fire together, they wire together. Since a person's mental capacity is not limited to the total number of neurons that are in one's brain, it is dependent on the number of synaptic connections these neurons have with one another. It is through this process of critical thinking and strategic analyses where such connections are greatly created, developed and reinforced.

Just like any physical exercise, the brain is also a muscle. Thus, mental exercise is essential for the brain to thrive, both maintaining healthy current cells and responsible for generating new brain cells that replace cells that die because of wear or apoptosis. Activities that require thought, more specifically, activities that require critical thought, help the brain to create these utmost important connections between neurons.

What games are interesting?

This section is take mostly from the Fall 2018 group who studied the interestingness of games.

Game Analysis:

Othello

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	0	0
12	0	1	0	0	1
11	4	0	0	0	4
10	8	16	0	0	24
9	58	8	0	0	66
8	44	172	0	0	216
7	646	88	12	0	746
6	292	1520	92	0	1904
5	3224	658	232	0	4114
4	1522	6422	412	0	8356
3	9266	2380	914	0	12560
2	3626	10148	1222	0	14996
1	9846	2418	1370	0	13634
0	1620	3793	755	0	6168
Totals	30156	27624	5009	0	62789

Total Positions Visited: 62789

Win Ratio: 30156 / 62789 → 48.027521% win rate
Draw Ratio: 0 / 62789 → 0% draw rate

Pong Hau Ki

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	44	44
1	8	0	0	0	8
0	0	4	0	0	4
Totals	8	4	0	44	56

Draws = 44

Fringe1 Nodes = 4
Average Win/Draw Child Ratio = 2.000000
Avg No. Winning Children = 2.000000

Win Ratio: 8 / 56 → 14.285714 % win rate

Draw Ratio: 44 / 56 → 78.571429% draw rate

Shift Tac Toe

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	2344	2344
20	0	4	0	0	4
19	36	0	0	0	36
18	0	64	0	0	64
17	120	0	0	0	120
16	0	132	0	0	132
15	190	0	0	0	190
14	0	250	0	0	250
13	338	0	0	0	338
12	0	526	0	0	526
11	606	8	0	0	614
10	16	1022	0	0	1038
9	1400	12	0	0	1412
8	32	1766	0	0	1798
7	1962	32	0	0	1994
6	32	2684	0	0	2716
5	2450	32	0	0	2482
4	24	3538	0	0	3562
3	3440	36	0	0	3476
2	12	7414	0	0	7426
1	34976	36	0	0	35012
0	11914	31338	0	0	43252
Totals	57548	48894	0	2344	108786

Draws = 2344

Fringe1 Nodes = 2344
Average Win/Draw Child Ratio = 41.835270
Avg No. Winning Children = 55.256824

Win Ratio: 57548 / 108786 → 52.900189% win rate

Draw Ratio: 2344 / 108786 → 2.154689% draw rate

Quick Chess

Remoteness	Win	Lose	Tie	Draw	Total
Inf	0	0	0	2344	2344
20	0	4	0	0	4
19	36	0	0	0	36
18	0	64	0	0	64
17	120	0	0	0	120
16	0	132	0	0	132
15	190	0	0	0	190
14	0	250	0	0	250
13	338	0	0	0	338
12	0	526	0	0	526
11	606	8	0	0	614
10	16	1022	0	0	1038
9	1400	12	0	0	1412
8	32	1766	0	0	1798
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Draws = 2344

Fringe1 Nodes = 2344
Average Win/Draw Child Ratio = 41.835270
Avg No. Winning Children = 55.256824

Win Ratio: 708437 / 1258148 → 56.307922% win rate

Draw Ratio: 19564 / 1258148 → 1.554984% draw rate

The Fall 2018 “fun-ness” group did an analysis with what people thought was most fun. Here is their conclusion:

“Shift-Tac-Toe was ranked the most fun game, with an average fun score of 4.5 out of 5. In contrast, the lowest ranked was Pong Hau Ki, with an average score of 2 out of 5.

Interestingly, neither of these games were ranked as the most difficult. Othello took the title there, with a ranking of 3.8 out of 5, compared to Pong Hau Ki’s 2.5 out of 5 and Shift-Tac-Toes’ 3.1. Othello also won in the player’s ability to see strategy before the last two moves, with one player saying they knew who would win with 5 moves still left.

Players were asked to verbally describe what they found fun about the games. Shift-Tac-Toe was most frequently described with words like ‘new,’ ‘unpredictable,’ ‘requires thought.’ In contrast, Pong Hai Ki was most commonly described as ‘boring,’ ‘repetitive,’ and that it had ‘few options.’ Othello was verbally described as ‘difficult,’ with ‘many options.’

The ranking of Shift-Tac-Toe as the most fun goes against our original hypothesis. We predicted that a higher number of draws would lead to less fun and greater dissatisfaction in the players. Shift-Tac-Toe, at an approximately 2.15% draw rate, has higher chance of draws than Othello, with 0% of draws. However, Pong Hau Ki’s ranking as the least fun concurs with our hypothesis.”

There are many different factors that create what makes a game fun. Fun, in of itself is a subjective term – different people have different perspectives what they perceive fun to be. However, there is usually a consensus on a few key aspects tend to make games fun on a psychological level.

Games have a motivational factor, usually in the form of a conclusive result. The higher the win rate percentage is means that a person is more likely to win, and thus, because of this definitive conclusion, such a game with a higher win rate percentage be more engaging. It is human nature to have a desire to have a winner / loser outcome – it results in more competitive action to finally come to this conclusive conclusion. Thus, games with an outcome where the win rate is higher leads to more engagement. Additionally, the more likely the game would end in a draw means that there would be no final outcome of who was the winner / loser / tied players. Based on this knowledge, games with a high win percentage should trigger the player to find it more fun due to its likelihood to win. This is also inverse to the draw rates of each game. If the draw rate is higher, the likelihood of coming into a conclusion of a winner/loser is much lower, thus resulting in an inconclusive result. Games like Shift Tac Toe and Quick Chess have the highest win rates, with both having win rates above 50%, 52.900189% and 56.307922% respectively. Their draw rates are also on the lower end of the scale: 2.154689% and 1.554984%. On the contrary, Pong Hau Ki has the lowest win rate at a mere should have the least 14.285714 % but despite this low win rate, it interestingly also has a low draw ratio of 1.554984%.

Outcome rates are just one component of what makes games fun. Another interesting factor that makes games fun is human perception. Human perception of a value move is may not in reality create a valuable move in the actual game itself. Take for example the misère version of Dots and Boxes. The goal in that game is to have the least number of boxes by the end of the game. During the game, one might think that their strategy is to always have the least number of boxes as the game continues one. However, when playing this game, we noticed that to win at the end, we need to take majority minus one boxes first. It is not until after taking almost half of the total boxes where we see our strategy work;

the last move forces the opponent to take the removing majority plus one boxes, forcing them to lose. This was a very interesting analysis. Human perception might have thought that the winner must maintain winning point value throughout the game. However, this was not the case when playing the game. In fact, if the player had maintained their human perception of the game throughout the entire game, the player would have lost despite believing that they were winning throughout the game. These circumstances always strike us as different and interesting as our perception of what may seem as the "logical" and "sensible" thing to do may not result in the actual correct move to make.

The list of what makes games fun is inherently infinite, but there are few traits of games that make a game not fun.

A game where the final outcome of the game is determined by the very first move is one that is considered not fun. A game determined by the first move is a game where assuming both players play perfectly, there is no ability for the opponent to turn the game around at any point of the game. This takes away the challenging critical thinking aspect of the game, a key aspect in what makes a game fun. A game with no comeback actions places the players in their prospective potions from the start, not allowing for a possible win if the player starts off with the wrong move. Regardless of how complex the rest of the game gets, it does not affect the outcome if the first move is the only move that matters.

Games who have nonexistent additions to complexity are not deemed more fun than its skeleton version of the game. For example, the game 10 to 1 game is not any less fun that 100000 to 1 – the general idea of taking the opposite of your opponent remains the same for both versions of the game. Just because there is an additional 99990 moves, the complexity of the game does not make the game more fun.

The idea of fun is fundamentally a subjective idea – it ultimately depends on who is evaluating what they consider as fun. However, there are few key aspects that almost always contribute to a game's fun rating that almost all players will agree upon.

10 Reasons Why Games are Engaging

FUN: the great motivator.

Fun and learning results in the will to learn, increasing intrinsic motivation and prompting the desire for recurrence of the experience. The definition instantly possesses this major duality. On one hand, fun means amusement, but on the other hand, it could also represent ridicule. Because of this dichotomy, it is necessary to take in the context of the environment present in. Fun can mean both enjoyment / pleasure and amusement / ridicule, a positive representation and a more negative representation respectively. According to Mark Prensky's book, "Digital Game-Based Learning," he states that "this dichotomy [...] lies at the root of resistance by business people and educators to new learning approaches based on any connection to fun." We see fun utilized in many learning environments. It appears that fun plays an important role in the learning process mainly in that it can promote relaxation and motivation. These two qualities allow the brain to enjoy itself, functioning more efficiently.

PLAY: the universal teacher.

While fun is a simple duality in describing a state of being, play is a much more complex phenomenon relating play to both anthropological and sociological aspects. Learning through play is the optimal generic learning environment, creating experimentation a relaxed method. Chris Crawford, a noted game designer states that "children are expected to play because we recognize (perhaps unconsciously) the fundamental utility of games as an educational tool." Alison Gopnick, a psychology professor at UC Berkeley, has studied how many children initially have a fascination with learning play, an idea that teaches children through ideas of play.

However, despite play rarely being associated to work, the notion of creating play in a work environment can completely affect one's attitude towards work. As a result, incorporating playful games in a working environment often optimizes involvement and gives pleasure.

SIX STRUCTURAL FACTORS OF A GAME

Games are inherently a subset of play and fun. Like the dichotomy that fun inherently possesses, play also has a wide variety of positive and negative meanings. However, what all games have is the idea of structure: rules, contest, rivalry, and struggle. Besides these two qualities of fun and play, games are also composed of six key structural elements. These six structural design factors are the main components of what makes games engaging.

1. Rules Create Stability

Rules are what differentiate organized play from chaotic play. It is this idea of structure that creates organization within players. Such rules impose limits, forcing players to take specific restricted paths to reach certain goals, creating fairness and excitement. Rules set limits on what is okay and what is not okay. One of the key reasons that games are so fun is because this set of rules creates a sense of structure that everyone playing must abide to. This idea of "fairness" is inherently ingrained in human nature – elementary school kids seems to always know when someone is not playing by the rules, yelling "That's not fair" or "They're cheating!" As one gets older, rules become increasingly important, leading to players often manipulating the rules and bending them to surround the game to one's own advantage. The game in of itself would not exist if it were not for the rules that surround it, creating stability and structure and ultimately fairness for all the players that play.

2. Goals = Motivation

In a game, achieving the end objective is often what motivates you. As humans, we are all generally goal-oriented as a species in its entirety. No sense of goal creates a lack of motivation, thus resulting an unwillingness to play, breaking our original idea that games are inherently a subsect of fun and play. As a result, goals push us to achieve and to win.

3. Outcomes and Feedback

Bringing back to the initial idea of win / lose /draw/ tie rates, these values are the outcome that result at the end of the game, giving you feedback bout how you measure your progress against the goals. Because humans are competitive by nature, winning and losing also has a strong emotional and ego-gratification implications, once again contributing to the attraction of games. Additionally, feedback is where learning takes place. Like the concept of reinforcement learning often utilized by many artificial intelligence programs, where a program learns from feedback of positive or negative failure, humans are exhibit this reinforcement learning algorithm through the idea of feedback from the game. Thus, humans are constantly learning how the game works, how to succeed, and the game's underlying model.

4. The Three C's: Conflict, Competition, Challenge

These three C's is what creates adrenaline and creativity when playing a game. Since competition is an innate character as our basic nature as human beings, people tend to gravitate towards games that ted to be competitive. This idea of competition also sparks creativity and critical thinking regardless of what the end goal might be. Although there may be some games that are not competitive in nature, all games involve conflict or challenge even if solving such conflict / challenge is via teamwork and cooperation. This idea

of the three C's greatly contributes to the players' emotions while playing the game.

5. INTERACTION

Interaction comes in two parts: the interactions between the player and the game itself (feedback) and the inherent social aspect of games. It is this social idea of games that encourages social groups to form – you play games WITH people. These social interactions promote creativity and ultimately, cultivating an amicable environment between players. Despite the industry's general focus on single player games that play against the machine CPU, there is indeed a shift to make games multiplayer. Although there are an increasing number of computer / online games, these games still bring people together in social interaction not necessarily in a physical sense, but rather it provides a platform for conversation to occur. Games encourage social interactions, contributing to the structure of the games and why they are fun.

6. REPRESENTATION

Games always represent something, regardless of how small or big, abstract or concrete, direct or indirect. Representation is the idea that they are about something. As vague as it may seem, games have created a more detailed in representation, in both story and narrative, both aspects becoming more grand throughout the years. Many game developers utilize eye-catching intriguing features to represent games, adding to the game's appealing aspect and ultimately adding to a game's interestingness, creating a more fun environment for the game itself.

The Concept of FLOW

Games cultivate this intense idea of FLOW – intense concentration – as most people would describe it. It is this flow-ous state where previously difficult tasks become enormously easier, creating a sense of extreme pleasure. In this flow state, the challenges presented perfectly mesh with your own capability to solve them, thus generating this dopaminergic sense of pleasure. However, the greatest challenge is maintaining this state of flux that is present in flow. Despite this challenge, many games try to create this state of flow for the player, generating pleasure, and ultimately making them fun.

Problem Solving Sparks CREATIVITY

Creativity is one of the greatest ways to expand thinking. Through critical thinking, games provide an outlet for players to think outside of the norms, sparking creativity and thinking "outside of the box." During prefrontal cortex development in adolescent ages, this idea of creatively and critically thinking is even more so important as it is during this time where the foundation for the most essential of prefrontal cortex development is laid. Because of the immense opportunities for creativity and critical thinking, games have been incorporated in many educational platforms to promote the idea of learning through fun.