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Spring 2024

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Recommended Citation
Fant, Emerson, "Cognitive Indicators of Performance in League of Legends Players" (2024). Williams Honors College, Honors Research Projects. 1796.
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Cognitive Indicators of Performance in League of Legends Players

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Honors Research Project 2024
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Abstract

Gaming has taken over as the dominant leisure activity in the lives of many children and adults. The COVID-19 pandemic saw an already growing trend of teen’s recreational screen time use rise to almost 9 hours per day (Common Sense Media, 2022). As a category, the term “video games” covers a gigantic range of recreational cognitive tasks. When sitting down to play games, some people are seeking a relaxing and comforting experience with minimal challenge. Others are seeking a stressful, all-consuming, competitive, and at times overwhelming experience. Given the amount of time we spend playing games, we ought to seek a better understanding of them and how they affect our brains. A fair amount of research into this area has been done, but there is a striking lack of specificity in the literature about the specific relationships between individual cognitive traits and individual games.
Background

A growing body of research shows that gamers have an advantage over non-gamers with regards to working memory. A large cross-sectional study measuring the working memory of gamers and non-gamers found “positive associations between the time spent playing video games and visuospatial WM and n-back performance” (Waris et al., 2019). One shortcoming of this study, though, is that the participants’ gaming habits were broken down into poorly-defined genres. One such genre (“Action”) contained the games Mortal Kombat, Super Mario Galaxy, NHL Hockey, and League of Legends. Anyone familiar with each title could tell you that these games have so little in common that looking for any effects specific to this “genre” of game would be a hopeless endeavor. Indeed, the authors admit this limitation: “the division into game genres was likely not optimal” (Waris et al., 2019). To overcome this, games could be studied individually and then grouped into a genre based on the cognitive tasks required. However, the positive correlation observed in the study between gaming hours and working memory is promising.

Research has also shown that kids who game have higher creativity scores than non-gamers on the Torrance Tests of Creative Thinking (Jackson et al., 2012). The study tested a diverse group of 491 twelve-year-olds using the figural version of the TCTT. The sample included students from various ethnic groups and both sexes with different gaming preferences, and found that time spent playing video games explained a significant amount of the variance in TCTT scores. The more time a student spent gaming, the higher their score, regardless of all other variables.

A refreshingly specific study found that training participants using a first-person shooter called Halo: Combat Evolved produced a significant enhancement in visuospatial performance
at p<.01 (Sanchez, 2011). The study’s experimental group played Halo, while the control group played a word game which did not engage visuospatial circuits. After training, the participants read a complex text on plate tectonics and were asked to generate an essay explaining why Mt. St. Helens erupted. Mt. St. Helens was not explicitly mentioned in the plate tectonics text, so participants had to apply the concepts they learned to explain the phenomenon. Their essays were scored by identifying the five causes for the eruption. The experimental group significantly outperformed the control group regardless of video gaming habits and how fun they found their assigned game.

With games taking up an increasing portion of our daily cognitive activities, sketching out the relationship between games and our cognition is a crucial step to furthering psychological progress. If Halo can improve understanding of complex scientific topics by training a region of the brain, or if spending more time playing games could increase creativity or working memory, then it stands to reason that thorough investigation of the cognitive mechanisms at play in popular games will prove valuable.

**Introduction**

The game I am interested in studying is the most popular competitive game in the world, League of Legends. League of Legends is a prime target for research for multiple reasons. For one, the size of the game has generated some infrastructure, analysis, and an ecosystem within which we can work. The game also includes an Elo-style rating system. This style of system measures every player’s ability to win by assigning them a rating number which increases after wins and decreases after losses. Players with a higher rating are more skilled. This will be helpful because we suspect that players who are highly skilled at winning games will also score highly on certain cognitive measures related to in-game performance. Additionally, the game’s Application Programming Interface (API) is publicly accessible, fueling a plethora of data-tracking and analysis websites (such as DeepLoL, op.gg, and u.gg) which will provide us with
ample data. Every player in the world has a publicly visible profile on these sites which is automatically updated with every game they play, making these sites reliable sources to measure how skilled a player is currently, how skilled they were at any point in the past, how much time they spend playing, and how long they have been playing competitively.

Game Structure
League of Legends is one of the most complex competitive games ever designed. In this section, I will provide a broad overview of the structure of the game so that it may be discussed in more accurate terms later on. League is played using two teams of five players. Players play as their selected champion, using that champion’s unique set of skills and abilities to contribute toward victory. Teams of equal average rating are created, then they take turns picking and banning from the roster of 168 champions until both teams have 5 champions. This means that there are almost 4 quadrillion final outcomes from each draft; as such, it is rare for even the most experienced players to ever play the same draft twice.

During the match, every player controls the champion they selected during the draft. Typical team compositions assign one player to each lane, one player in the jungle, and one support player who helps as needed. A map of the playing field is provided below. Champions start at level 1 and become stronger as they progress to level 18 by securing income in the form of experience and gold. Experience and gold can be earned by “farming” (spending time to defeat for income) neutral enemies in the jungle or by defeating the enemy minions that march down each lane. These neutral enemies and minions are not at all threatening by themselves, but they cost time to farm. The core of League’s gameplay is maximizing income for your team and denying income from your opponents. At every moment of the match, a player must decide where their time is best spent. The game ends when one team’s nexus is destroyed. The nexus is a structure at the center of each team’s base, which is defended by four rows of turrets. The
outermost turrets are the weakest, and are worth the least gold. As you progress toward the enemy base, turrets become more valuable and more difficult to take.

The team with greater income will be a higher level, and will be stronger than their opponents, allowing them greater control of the game. This system of generating a permanent advantage has been compared to chess, where the winning player often has more pieces and better-developed pieces than the losing player, and therefore has greater control over the game. A better comparison might be made in terms of traditional sports: it would be as if every time a team scored they got a bit taller, faster, and stronger. When one team is a higher level they are said to be “playing from ahead”, and when they are a lower level they are said to be “playing from behind”. At high levels of play, even a small advantage in the early game can snowball into a crushing victory.
Goals and Objectives

The primary goal of this project will be to analyze a variety of hypothesized performance indicators with the intention of mapping out the cognitive traits and skills which contribute to successfully playing League of Legends. Each indicator will be measured and compared to participants’ ranks. The hypothesized performance indicators for League of Legends are as follows:

- **Internal vs external locus of control**
  - We suspect that highly ranked players will score as having a predominantly internal locus of control. In any five versus five environment, a player should
expect to only influence 10% of the outcome, relative to a one versus one setting where a player has 50% control. In League of Legends, the quality of play of the other nine players is an important determining factor in the outcome of the match. However, it is not effective to focus on such external factors. Strong players commonly refer to a “1v9” mindset, rather than a “5v5” mindset, emphasizing the importance of their own contributions to each match. Though it is not meant literally, the thought is that you can find a way to win even if your team tries to lose the match.

- If there is any causal link between performance and locus of control, we will not know which way it goes. It seems equally plausible that either an internal locus of control could help a player improve, or that a player who has been rewarded for developing their talent would then develop an internal locus of control. It would be surprising to see highly ranked players have an external locus of control.

  - Locus of control will be measured using Rotter’s Locus of Control scale (Appendix A).

- **Intrinsic vs extrinsic motivation**
  
  - With regards to motivation, several studies have found that intrinsic motivation has several long term benefits which are not present in people who are primarily motivated extrinsically. A study of Japanese nurses at long-term care facilities found that intrinsic motivation predicted high levels of job satisfaction and low turnover rates (Zeng et al., 2022). It was found that even when intrinsic motivation was equally effective at incentivizing academic performance, intrinsically motivated students reported lower stress (Baker, 2004). In line with these previous findings, we expect that players who are intrinsically motivated may perform better. One possible mechanism for this could be enhanced
creativity. We know that creative performance is boosted by positive mood states (Zenasni & Lubart 2002, To et al., 2012), and players who are more intrinsically motivated may have better moods because of lower stress or higher satisfaction, and therefore superior creative solutions to in-game problems.

Motivation will be measured using a modified version of the Sport Motivation Scale (Appendix B). Items will be adjusted to replace verbiage relevant to only traditional sports.

- **Frustration tolerance vs intolerance**

  In League of Legends, playing from behind can be a deeply frustrating experience. Not only are your options severely limited if you are weaker than your opponent, but you are likely to suffer repeated negative emotions as you and your team fall farther and farther behind. Before you lose, you must lose at least 6 of your structures and several neutral objectives, all of which should be experienced negatively. Additionally, the in-game chat and communications systems are more often used to direct flame, insults, and abuse toward teammates when a team is losing. We expect there to be individual differences in players’ ability to tolerate these situations, and that players with higher frustration tolerance will be able to come back and win more games after being in a losing position, thus resulting in them being a higher rank.

  However, as important as frustration tolerance may be when playing from behind, we may fail to notice an effect. When a team is in a losing position, they are still likely to lose no matter how well they play. This tendency further increases at higher levels of play. More skilled players are less likely to make costly mistakes from a winning position. If frustration tolerance helps players come back from losing positions, but skilled opponents more reliably win from winning positions, then skilled
players may see very little benefit from having high frustration tolerance. These features of the game may decrease the effect size such that we make a type II error.

- Frustration tolerance will be measured using the Mirror Tracing Frustration Test and the Frustration Discomfort Scale (Appendix C). The Mirror Tracing Frustration Test asks participants to spend time doing a frustrating task (tracing an asymmetrical object using a mirror) with minimal benefit. The longer a participant stays engaged in the task, the better they are said to tolerate frustration. We expect that the Mirror Tracing test may be a stronger predictor of frustration tolerance than the Frustration Discomfort Scale, but since it will need to be administered in person it will not be available to participants who are only completing the online survey.

- **Generalized self efficacy**
  - We expect similar results from self efficacy as we do with locus of control. Players with a high sense of self efficacy may have an easier time reaching higher ranks, and/or highly ranked players may develop a strong sense of self efficacy as a result of having achieved a difficult long-term goal.
  - Generalized self efficacy will be measured using the Generalized Self Efficacy Scale (Appendix D).

- **Creativity**
  - Creativity is the proposed mechanism by which motivation affects performance in League. As noted above, with so many possible combinations of team compositions, every match will present even highly experienced players with new situations. Players with high creativity may do a better job generating solutions to these infinite new problems. It has already been demonstrated that playing video games in general increases creativity in children (Jackson et al., 2012), but it
remains to be seen if creativity is important in League of Legends and among other demographics.

○ This will be measured using the Torrance Tests of Creative Thinking (TCTT).

Methods

Participants will take the above tests in a battery. The GSE, Sport Motivation Scale, Frustration Discomfort Scale, and Locus of Control measures will be administered through the Qualtrics survey platform. Respondents will be asked to provide the names of their League of Legends account(s) along with the four surveys, so that their answers can be compared to their in-game performance. The TTCT and Mirror Test cannot be administered remotely, so they will be offered to a separate set of participants. These in-person participants will be recruited on the University of Akron campus and compensated modestly for their time. The in-person participants will also be asked to complete the same Qualtrics survey. The survey will be spread through several channels. I will ask professors to share the survey with their students. We also hope to share the survey through the University of Akron’s esports program, as well as through my connections with the online League of Legends community. Of course, participants will only be eligible for the study if they compete in League of Legends online play and are 18 years of age or older.

All data collection will be anonymous. There is no need to ask participants for any identifying personal information, so none will be collected. Still, the data will be password protected, accessible only by Emerson Fant and Dr. Kaut. Data will be imported to SPSS Statistics where it will be analyzed using correlation and multiple regression analysis to determine any significant relationships between individual performance indicators and participants’ ranks.

Anticipated Outcomes
I hope to establish a significant relationship between some of the performance indicators and actual in-game performance. I predict that internal locus of control, intrinsic motivation, frustration tolerance, high self efficacy, and high creativity will correlate with high performance in the game environment. I also predict that external locus of control, extrinsic motivation, frustration intolerance, and low creativity will correlate with low performance.

Once an indicator is established to be positively correlated with rank, there are several outcomes, including results which could fuel at least two exciting projects. The first would be an experimental design where a group is intentionally trained on said cognitive traits and compared to a control group to see if cognitive skills trained outside the game are transferable to the game. The second, and potentially even more interesting, would be an experimental design similar to the (Sanchez, 2011) study to see if the cognitive traits required to perform in-game can be trained by playing and then transferred to other areas.

There is already research to suggest that this is possible, as discussed above. To take research in this area further, we require a clearer picture of which games affect which cognitive abilities. Since gaming covers such a breadth of cognitive tasks, even different game modes within the same game may fail to produce similar results. The myriad potential applications of games as training tools are exciting, but such applications will need to stand on a solid framework of understanding which game and which game modes within those games actually train gamers’ brains.

If none of the performance indicators are found to correlate significantly with players’ success in the game, then that would also be an interesting result. Since League of Legends is an intense cognitive task with a clear performance output across a wide range of skill levels, we would anticipate that some measurable variables ought to be able to predict success. If significance is not established for any of the variables tested in this study, the next step would be to create a new set of hypothesized performance indicators and to test those. It may also be possible to establish a significant correlation in error. If, for example, the in-person sampling
used disproportionately recruits participants who are high on extrinsic motivation, then we could find a spurious correlation. There is a moderate risk of this happening, since there will be a small monetary incentive to participate, but a spurious correlation will not emerge unless the extrinsic motivation is also correlated with rank.
Appendix A

Rotter’s Locus of Control Scale

Respond to the following questions by selecting the statement that you agree with the most.

1a. Children get into trouble because their parents punish them too much.
1b. The trouble with most children nowadays is that their parents are too easy on them.

2a. Many of the unhappy things in people’s lives are partly due to bad luck.
2b. People’s misfortunes result from the mistakes they make.

3a. One of the major reasons why we have wars is because people don’t take enough interest in politics.
3b. There will always be wars, no matter how hard people try to prevent them.

4a. In the long run people get the respect they deserve in this world.
4b. Unfortunately, an individual’s worth often passes unrecognized no matter how hard they try.

5a. The idea that teachers are unfair to students is nonsense.
5b. Most students don’t realize the extent to which their grades are influenced by accidental happenings.

6a. Without the right breaks, one cannot be an effective leader.
6b. Capable people who fail to become leaders have not taken advantage of their opportunities.

7a. No matter how hard you try, some people just won’t like you.
7b. People who can’t get others to like them don’t understand how to get along with others.

8a. Heredity plays the major role in determining one’s personality.
8b. It is one’s experiences in life which determine what they’re like.

9a. I have often found that what is going to happen will happen.
9b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10a. In the case of the well prepared student, there is rarely if ever such a thing as an unfair test.
10b. Many times exam questions tend to be so unrelated to course work that studying is really useless.

11a. Becoming successful is a matter of hard work; luck has little or nothing to do with it.
11b. Getting a good job depends mainly on being in the right place at the right time.
12a. The average citizen can have an influence in government decisions.
12b. This world is run by the few people in power, and there is not much the little guy can do about it.

13a. When I make plans, I am almost certain that I can make them work.
13b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14a. There are certain people who are just no good.
14b. There is some good in everybody.

15a. In my case getting what I want has little or nothing to do with luck.
15b. Many times we might just as well decide what to do by flipping a coin.

16a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
16b. Getting people to do the right thing depends upon ability. Luck has little or nothing to do with it.

17a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.
17b. By taking an active part in political and social affairs the people can control world events.

18a. Most people don’t realize the extent to which their lives are controlled by accidental happenings.
18b. There really is no such thing as “luck”.

19a. One should always be willing to admit mistakes.
19b. It is usually best to cover up one’s mistakes.

20a. It is hard to know whether or not a person really likes you.
20b. How many friends you have depends on how nice a person you are.

21a. In the long run, the bad things that happen to us are balanced out by the good ones.
21b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22a. With enough effort, we can wipe out political corruption.
22b. It is difficult for people to have much control over the things politicians do in office.

23a. Sometimes I can’t understand how teachers arrive at the grades they give.
23b. There is a direct connection between how hard I study and the grades I get.

24a. A good leader expects people to decide for themselves what they should do.
24b. A good leader makes it clear to everybody what their jobs are.

25a. Many times I feel that I have little influence over the things that happen to me.
25b. It is impossible for me to believe that chance or luck plays an important role in my life.

26a. People are lonely because they don’t try to be friendly.
26b. There’s not much use in trying too hard to please people; if they like you, they like you.

27a. There is too much emphasis on athletics in high school.
27b. Team sports are an excellent way to build character.

28a. What happens to me is my own doing.
28b. Sometimes I feel that I don’t have enough control over the life my direction is taking.

29a. Most of the time I can’t understand why politicians behave the way they do.
29b. In the long run, the people are responsible for bad government on a local or national level.
Appendix B

Sport Motivation Scale

On a scale of one to seven, indicate the extent to which each of the following items corresponds to one of the reasons for which you are presently practicing your sport. Items have been adjusted as following: “doing x sport” has been replaced with “playing x game” and “in shape” has been replaced with “highly ranked”

1. For the pleasure I feel in living exciting experiences
2. For the pleasure it gives me to know more about the game that I practice
3. I used to have good reasons for playing the game, but now I am asking myself if I should continue doing it
4. For the pleasure of discovering new techniques or strategies
5. I don’t know anymore; I have the impression of being incapable of succeeding in this game
6. Because it allows me to be well regarded by people that I know
7. Because, in my opinion, it is one of the best ways to meet people
8. Because I feel a lot of personal satisfaction while mastering certain difficult aspects of the game
9. Because it is absolutely necessary to do sports if one wants to be in shape*
10. For the prestige of being highly ranked
11. Because it is one of the best ways I have chosen to develop other aspects of myself
12. For the pleasure I feel while improving some of my weak points
13. For the excitement I feel when I am really involved in the activity
14. Because I must play to feel good about myself
15. For the satisfaction I experience while I am perfecting my abilities
16. Because people around me think it is important to be highly ranked
17. Because it is a good way to learn lots of things which could be useful to me in other areas of my life
18. For the intense emotions I feel while playing
19. It is not clear to me anymore; I don’t really think my place is in this game
20. For the pleasure that I feel while executing certain difficult plays
21. Because I would feel bad if I was not taking time to do it
22. To show others how good I am at the game
23. For the pleasure that I feel while learning things that I have never tried before
24. Because it is one of the best ways to maintain good relationships with my friends
25. Because I like the feeling of being totally immersed in the activity
26. Because I must play regularly
27. For the pleasure of discovering new performance strategies
28. I often ask myself; I can’t seem to achieve the goals that I set for myself

*Item 9 will be omitted from the Qualtrics survey
Appendix C

Frustration Discomfort Scale

Respond to the following questions with a score of 1-5, with 1 being strongly disagree and 5 being strongly agree. A higher score indicates higher frustration intolerance, while a lower score indicates higher frustration tolerance.

1. I need the easiest way around a problem; I can't stand making a hard time of it.
2. I can't stand having to wait for things I would like now.
3. I must be free of disturbing feelings as quickly as possible; I can't bear if they continue.
4. I can't stand being prevented from achieving my full potential.
5. I can't stand doing tasks that seem too difficult.
6. I can't stand it if other people act against my wishes.
7. I can't bear to feel that I am losing my mind.
8. I can't bear the frustration of not achieving my goals.
9. I can't stand doing tasks when I'm not in the mood.
10. I can't bear it if other people stand in the way of what I want.
11. I can't bear to have certain thoughts
12. I can't tolerate lowering my standards even when it would be useful to do so.
13. I can't stand having to push myself at tasks.
14. I can't stand situations where I might feel upset.
15. I can't tolerate being taken for granted.
16. I can't bear to move on from work I'm not fully satisfied with.
17. I can't stand the hassle of having to do things right now.
18. I can't stand having to give in to other people's demands.
19. I can't bear disturbing feelings.
20. I can't stand feeling that I'm not on top of my work.
21. I can't stand doing things that involve a lot of hassle.
22. I can't stand having to change when others are at fault.
23. I can't get on with my life or be happy if things don't change.
24. I can't stand having to persist at unpleasant tasks.
25. I can't tolerate criticism, especially when I know I'm right.
26. I can't stand to lose control of my feelings.
27. I can't tolerate any lapse in my self-discipline.
28. I can't tolerate being overlooked.
29. I can't bear to have been treated unjustly.
30. I can't stand being left in the dark with no explanation.
31. I can't stand giving up immediate pleasures for the sake of a distant goal.
32. I can't tolerate being treated with disrespect.
33. I can't bear being deprived now of things I lacked in the past.
34. I can't tolerate other people's bad or stupid behavior.
Appendix D
General Self-Efficacy Scale (GSE)

Respond to the following questions with 1-4, with 1 being not true at all and 4 being exactly true. Scores range from 10-40, with a higher score indicating more self-efficacy.

1. I can always manage to solve difficult problems if I try hard enough
2. If someone opposes me, I can find the means and ways to get what I want.
3. It is easy for me to stick to my aims and accomplish my goals.
4. I am confident that I could deal efficiently with unexpected events.
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.
6. I can solve most problems if I invest the necessary effort.
7. I can remain calm when facing difficulties because I can rely on my coping abilities.
8. When I am confronted with a problem, I can usually find several solutions.
9. If I am in trouble, I can usually think of a solution.
10. I can usually handle whatever comes my way.
References


