

# An Investigation of Flow Theory in an Online Game

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## ABSTRACT

Flow Theory posits that motivation is highest when individuals experience above average challenges and perform at above average skill. I use data from a short, repetitive online game to test this hypothesis and to explore the role of Flow Theory in motivation and game play. I also explore the relationship between Flow Theory and demand for commitment. For each player, the Flow-Theory channel in which they are most likely to continue playing the game is identified, and players are categorized into types accordingly. Control, Boredom and Relaxation types are most common. Flow types are among the least common, making up 12.6% of players. Flow types have the lowest skill level, but challenge themselves the most, and are most likely to make use of self-control devices available within the game. Control types play most frequently and over a longer period of weeks. Apathy types are high skill but seek out low challenges and are least likely to make use of self-control devices. Flow and control types are more likely to play during the workday. Relaxation, boredom and apathy types are more likely to play during workday evenings. I conclude that the principle hypothesis of Flow Theory does not explain my findings, but other aspects of Flow Theory are relevant to an understanding of motivation and self-control.

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*JEL Codes:* D01, D91

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\*Data available upon request.

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## 1 Introduction

The psychology of motivation in computer gaming has gained interest in at least three areas of research. The first is the field of cyber addiction (Young, 2017), including pathological online gaming (Kuss, 2013). According to Griffiths (2005), components of gaming addiction include the use of the activity to alter mood, and withdrawal after cessation of the activity, both of which can be thought of as related to motivation. The second field is gamification, defined as the use of game-design elements in non-gaming contexts (Deterding *et al.*, 2011). A well-designed game is understood to generate intrinsic motivation, which gamification designers attempt to harness for behavior-change purposes or to increase engagement in targeted activities. The third field is Flow Theory, also known as the study of optimal challenge, which has been studied in the context of game playing (Cowley *et al.*, 2008; Su *et al.*, 2016). According to Flow Theory, the psychological state of flow arises when skill and challenge are matched, and both above average for the individual. Components of flow include “intense and focused concentration . . . loss of reflective self-consciousness . . . a sense that time has passed faster than normal . . . experience of the activity as rewarding, such that often the end goal is just an excuse for the process” (Nakamura and Csikszentmihalyi, 2014). These components of flow suggest overlaps with both the cyberaddiction and gamification literatures, each of which involves aspects of motivation that are parts of Flow Theory. Thus, it seems natural to further the investigation of Flow Theory in computer gaming.

The relevance of this investigation to Economics is multi-faceted. First, there is the sheer volume of game play in the population. In 2019, 163 million adults in the U.S. played some form of computer game (ESA, 2020). The average player spent 6.75 h/week playing, with approximately 7% playing upwards of 20 h/week (Limelight Networks, 2020). Thus, in aggregate, U.S. adults spent approximately 57 billion h playing over the course of the year. At the median hourly wage of \$19.33, this is 1.1 trillion dollars’ worth of time, which is approximately 5% of GDP. Given these numbers, understanding how and why individuals play is inherently economically important. In addition, to the extent that Flow is understood to be a source of intrinsic motivation (Bakker and van Woerkom, 2017), an investigation of Flow theory in a context in which intrinsic motivation is likely to be an important driver of behavior contributes to the extensive literature in behavioral economics on how intrinsic motivation generates behaviors that cannot be explained by standard economic models.<sup>1</sup>

However, there is also concern about the possibility that some game players may play in ways that are suboptimal for them. “Binge playing” is common: 14% of U.S. gamers played at least one session of at least 10 h. That number is 21.4% for gamers between 18 and 25 years of age (Limelight Networks,

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<sup>1</sup>See, for example, Gneezy *et al.* (2011).

2020). Acland and Chow (2018) found that approximately 15% of players of one casual game appeared to play more than they themselves wanted to, as evidenced by their willingness to use voluntary commitment devices to play shorter sessions, leading to significant reductions in session length and frequency. This number probably understates the number of players who play excessively, relative to their own preferences, because it only includes those who are sufficiently aware of their self-control problems to use commitment devices, so-called “sophisticates” (O’Donoghue and Rabin, 1999). Among the 15% who used commitment devices, play time per week decreased by 26 min. If we treat this as excess time caused by self-control problems, accept 15% as a lower bound on the number of players who play excessively, and assume that the numbers would be the same for players of other games, the total excess time among U.S. adults over the year would be 560 million h, worth almost 11 billion dollars. In light of the fact that the hourly wage is understood to be a lower bound on the value of time,<sup>2</sup> this suggests a considerable welfare loss. Because my data includes usage of voluntary self-control devices, I am able to make observations about the relationship between the psychology of motivation and demand for commitment and thus contribute to the literature on self-control in behavioral economics.<sup>3</sup> Further, given that 26% of adult players report playing primarily during breaks at work, excess game playing could have a considerable impact on productivity. Furthermore, to the extent that we can think of excessive play as representing a misallocation of time, we might suppose that it reduces subjective wellbeing. Thus, a better understanding of motivation and self-control contributes to labor economics, the economics of happiness, and public health.

In brief, Flow Theory postulates that the relationship between an individual’s current skill level at whatever activity they are engaged in – relative to their average skill in that activity – and the challenge the individual is currently facing – relative to the average challenge they face in the activity – affects the individual’s psychological state, and how motivated they are to continue the activity. A simple diagram captures the essence of the theory, presented in Figure 1, taken from Massimini and Carli (1988). Relative skill is on the horizontal axis, relative challenge on the vertical. The psychological state induced by any given combination of the two is determined by which of the eight zones that combination lies in. Each zone corresponds to what is referred to as a “channel,” defined by the psychological state induced by being within the relevant zone. If relative skill is comparable to relative challenge, and both are above average, the theory predicts the individual will be in the psychological state of flow. If the match is comparable but both are below average, apathy will ensue. And so on through the rest of the eight channels.

<sup>2</sup>Because it is the value of the marginal, or least valuable hour of either labor or leisure time.

<sup>3</sup>See, for example, Bryan *et al.* (2010).

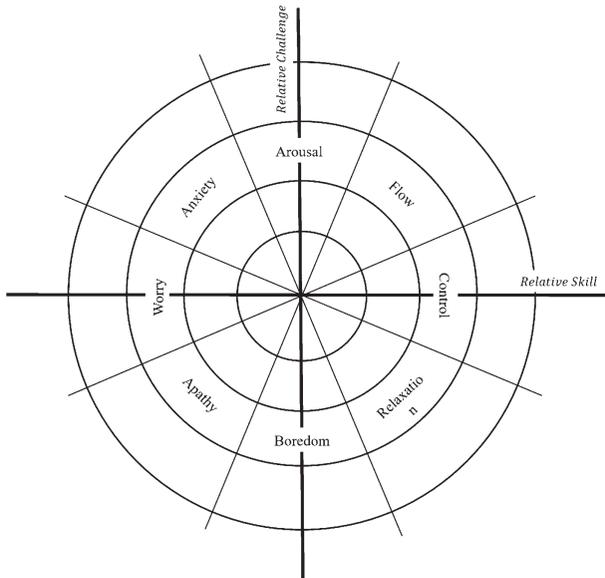


Figure 1: The Eight Channels of Flow Theory.

Based largely on evidence from interviews, the initial belief was that individuals would be most motivated in the flow channel, in particular because one of the characteristics of flow is intrinsic motivation (Nakamura and Csikszentmihalyi, 2014). Based on subsequent observation, however (increasingly using the experience sampling method), it appears that different types of people are most motivated in different channels. Thus, for example, LeFevre (1988) found that among workers in five large corporations in the U.S., approximately 40% were most motivated when in the flow channel, while another 40% were most motivated when in the apathy channel (The same study found that flow experiences were more likely to occur at work, while apathy experiences were more likely to occur during leisure hours). In a similar study, Csikszentmihalyi and Nakamura (1989) found that, among U.S. high-school students, those in a program for high-achieving math students were most motivated in the flow channel, while more “normal” students were most motivated by the experience of relaxation, which arises when skill is above average and challenge is below average. Most of the literature on Flow Theory has focused on the flow channel, and how it contributes to intrinsic motivation (Bakker and van Woerkom, 2017), but if the above empirical findings hold, then intrinsic motivation will come from different states for different types of people, making the full set of Flow Theory channels particularly important to understand.

In the context of online gaming, a primary question is whether there are different motivational types among players, and if so, whether there are observable differences among them, both with respect to individual characteristics, and with respect to how they play. One hypothesis would be that flow types will challenge themselves more than other types, in the search for flow. To the extent that flow involves intrinsic motivation, which has been associated with motivation to play games in the gamification literature, we might also hypothesize that flow types will play the game more than others.

In addition, because of a unique feature of the game I study, I will be able to explore differences in self-control and demand for commitment among types, which is to say, whether types differ in the extent to which they experience loss of self-control over how long or how frequently they play, and in how likely they are to take advantage of devices designed to improve self-control, a question that may contribute to the understanding of gaming addiction. A natural hypothesis would be that flow types, because the experience of flow causes them to lose track of time and become, in some sense, disconnected from other aspects of their life, will exhibit the greatest level of loss of control, and thus have the highest demand for self-control devices.

To explore these hypotheses, I make use of data from a short, repetitive multiplayer online word-guessing game.<sup>4</sup> The game is free, so concerns about the role of cost on gameplay do not arise. Players login to a central server and select one of two games,  $4 \times 4$  or  $5 \times 5$ , with all players in each game playing against one another simultaneously. The number of players in a game may be anywhere from the low two digits to the low three digits. Each game is 3 min long. At the beginning of each game, a gameboard is generated randomly by the server, consisting of a grid of either 16 ( $4 \times 4$ ) or 25 ( $5 \times 5$ ) randomly selected letters, and presented to all players. Players identify as many words as possible, consisting only of contiguous letters. Words earn points according to their length. Each game is followed by a 45 s break, during which players see the gameboard, a list of all possible words, the total number of points possible in the game, their own score, and the ranked list of all players, by score, with their own rank prominently displayed. The total possible number of words and points in a game vary widely, so that a player's score tells them little about their performance. The percentage of words or points the player found is not displayed, and would take up a considerable portion of the 45-s break to compute. Thus, it seems reasonable to conjecture that what players think of as success or failure is not their score, but their rank among players.

The game includes two devices designed to allow players to control how long they play, so-called "self-control" or "commitment" devices. The "*ex-ante*" device is a dialog box that appears when players login to the game, allowing

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<sup>4</sup>The game can be found at [www.wordsplay.net](http://www.wordsplay.net). However, it is no longer being updated for compatibility with newer browsers, and thus may not be accessible to all readers.

them to limit the number of games they can play. The “in-game” device is a button that appears between games, that allows players to play only one more game. Both devices cause players to be blocked from playing the game for 1 h. Players who choose to use the devices typically do not log back into the game immediately after the block ends.

## 2 Data and Methodology

The initial dataset consists of player/game observations. Each observation includes the player’s identifier, the timestamp of the beginning of the game, the player’s timezone, the total score possible in the game, and the player’s score and rank in the game. Play sessions for each player are defined as any period of continuous play that is separated from the next period by at least 30 min. Alternative definitions do not change the results qualitatively. The initial dataset contains all games and all players from October 12, 2007 to June 4, 2014. The total number of players is 20,187, and the total number of player/game observations is 41,923,774.

For each player, the following variables were constructed: “lifespan,” the number of weeks between the first and last dates the player was observed in the data; “gps,” the average number of games per session over the lifespan; “spw,” the average number of sessions per week over the lifespan. Next, the following variables were constructed: “percent-weeks,” the percentage of all weeks in the player’s lifespan in which they played at least one session; “life-skill,” “life-challenge,” and “life-rank,” the player’s average skill, challenge, and rank over the player’s lifespan (skill and challenge are defined below); “gps-diff,” and “spw-diff,” the differences between average games per session and sessions per week, respectively, between the first and last ten weeks of the player’s lifespan. Life-challenge warrants some clarification. For any given game in a session, players cannot control the challenge level of the game. However, by choosing to play when the game is more or less challenging, they can influence the average challenge level of the games they play over the course of their lifespan. It is in this sense that we can think of players as choosing the challenge level of the game.

The variable “last” was computed as a binary variable equal to one if the game was the player’s last game in a session, and zero otherwise. A categorical variable, “period,” was computed as the time of day and/or day of week the game occurred at, with values of “workday” for games between 8 am and 5 pm on a weekday, “worknight” for games between 5 pm the day before a weekday to 8 am the subsequent day (in other words, the evenings of Sunday through Thursday), and “weekend” for games between 5pm on Friday and 5 pm on Sunday. The variables “percent workday,” “percent worknight,” and “percent weekend,” were computed as the percentages of all games played during work days, work nights, and weekends, respectively, over the player’s lifespan.

Finally, two variables were defined based on each player's use of the two self-control devices that were included in the game. A dummy variable called "user" indicates whether a player used at least one of the devices at least twice<sup>5</sup> over their lifespan. A categorical variable called "usertype" indicates which device the player used most frequently.

Identifying motivational types according to the eight channels of Flow Theory depicted in Figure 1 requires that each player/game record be placed in the relevant zone on the diagram, according to the relative skill of the player at the time of the game and the relative challenge level of the game for the player. In other words, two variables need to be constructed, "relative skill" and "relative challenge," the axes of Figure 1. These variables were constructed as follows.

### 2.1 Relative Skill

First the variable, "skill," was computed for each player/game observation as the proportion of possible points in the game that the player earned. "Skill" thus ranges from zero to one. This measure could have been computed by the player during the break between games, but it seems unlikely that many players did so, given that their attention was drawn to the ranking of players and the words that could have been found. The average skill level at the time of the game, "avskill" is computed as the average of the player's skill in all games in the player's three prior sessions and their three subsequent sessions. Relative skill is the difference between skill and average skill, and ranges from negative one to one.

### 2.2 Relative Challenge

The variable "challenge" was computed as the average across players in the game, of avskill at the time of the game. Thus, like skill, it ranges from zero to one. It can be thought of as something like how good the competition is, which in turn can be thought of as how hard it is to achieve any given rank in the game. "Avchallenge" was computed as the average challenge level of all the games a player played in their lifetime. A rolling average was not used, as in the case of average skill, because of the fact that challenge might vary systematically by time of day (evening *vs.* working hours) or day of week (weekend *vs.* weekday), and that a player might temporarily change from one time of day or day of week to another temporarily, but would probably not shift their perception of challenge quickly. Since there is no secular trend in the challenge of games over time, for an individual or for players as a whole, it seems likely that players would judge the challenge of a specific game against

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<sup>5</sup>To exclude those who used a device only once out of curiosity.

the average of the typical challenge level of games they played over the course of their lifespan.

Next, a categorical variable called “zone” was computed for each player/game observation indicating which motivational channel (i.e., zone on the Flow diagram), the observation was located in, as follows. First, for each player/game observation, the angle of the ray from the origin passing through the point on the diagram determined by the relative skill and challenge of the observation was computed, with zero being the angle of the positive portion of the horizontal axis. Thus, for example, if the relative skill and challenge of an observation was (0.25, 0.25), the angle would be 45. Channels were determined by the angles of the rays that demarcate them on the diagram, and the zone variable was determined as the zone in which the angle of each player/game placed it. Thus, since the Flow channel extends from  $22.5^\circ$  to  $67.5^\circ$ , the zone variable for the observation above would be Flow.

Players were assigned to motivational types based on how likely they were to keep playing after a game located in any given zone. For example, if a player was most likely to keep playing when their most recent game was located in the Flow zone, they would be classified as a Flow type. The idea behind this classification is that continuing to play is an indicator of motivation, so that if a player is most likely to keep playing when their game play places them in the Flow zone, I conclude that they are more motivated by being in Flow than by being in any of the other channels. Under the assumption that the relative challenge level of the game, and the player’s relative skill level, are relatively constant during any given session, this classification scheme can be thought of, roughly, as how motivated the player is during a session, given the zone they are typically in during that session.

Motivational types were determined as follows. For each player independently, the “last” variable was regressed on a set of zone dummies, with no constant and no omitted category, using a linear-probability model, and including a 4<sup>th</sup>-order polynomial of how long the player had been playing. The coefficient on any given zone dummy indicates the probability that the player will stop playing if their most recent game places them in that zone. Thus, for example, if the coefficient on the Flow dummy is 0.1, it means that there is a 10% chance that the player will stop playing if their most recent game was in the Flow zone. The zone with the lowest coefficient was identified as the player’s motivational type, in the sense that it was the zone in which the player was most likely to continue playing. This channel was captured in a variable called “type.”

Players were retained in the dataset if the maximum  $p$ -value of a one-sided test of the difference between the lowest coefficient and the other seven coefficients was no greater than 0.25. In other words, for retained players, there is at least a 75% chance that they have been categorized into the correct type. This threshold was chosen to optimize the trade-off between the number

Table 1: Summary Statistics.

Variable	Mean	25 <sup>th</sup> pctl	95 <sup>th</sup> pctl
lifespan	220.0	137.3	344.1
percent weeks	0.686	0.470	0.997
gps	6.695	4.439	12.582
spw	8.435	4.490	18.337
life-skill	0.281	0.192	0.506
life-challenge	0.290	0.203	0.404
life-rank	0.443	0.273	0.826
gps-diff	4.527	0.993	19.796
spw-diff	5.916	-1.440	24.803
skill-diff	0.196	0.107	0.560
challenge-diff	0.196	0.176	0.454
rank-diff	0.276	0.102	0.846
percent workday	0.331	0.180	0.762
percent worknight	0.298	0.179	0.608
percent weekend	0.262	0.217	0.407

of players retained and the accuracy of categorization. In addition, to restrict the analysis to those who became significantly engaged in the game, players were only retained if they played more than 100 sessions in total. The total number of retained players in the final dataset was 754. All results are derived from this dataset, in which each observation is a player. The reason the number of players retained is so low is that in order to achieve a maximum  $p$ -value of 0.25 for a given player, it was necessary for there to be an adequate amount of data for that player. As a result, retained players are largely those who played a large number of games over their lifespan. This seems appropriate for the study, given that the goal is to investigate the motivation and behavior of regular players of the game, rather than those who might have been inadequately interested in the game to stay with it, or play it frequently enough, to accumulate the necessary number of games to be retained.

Table 1 provides summary statistics for all of the above variables.

To check the robustness of my results, I have conducted all of the analysis on two alternative samples. The first is one in which the threshold  $p$ -value was 0.1, and the second was one in which there was no threshold. In the first sample, the sample size goes down to 197 and in the second it goes up to 6,216. With very few exceptions in each case, mentioned in the results section, the results are qualitatively the same in the sense that all statistically significant results are either still significant, fall within the original 95% confidence interval, or, in a few cases, are marginally outside the original confidence interval but in the

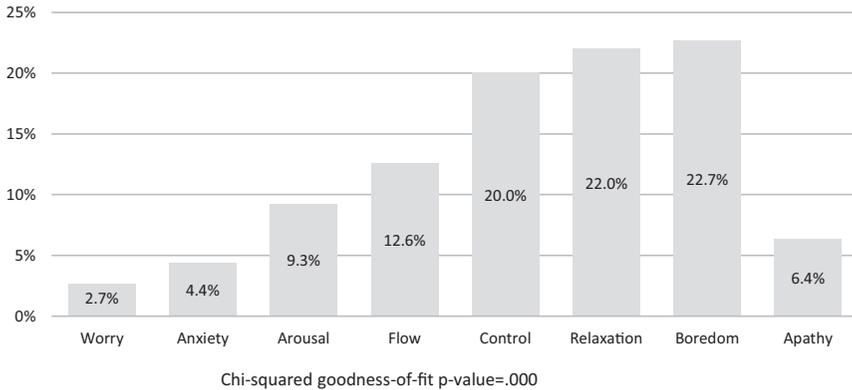


Figure 2: Distribution of Motivation Types.

same direction. In the more restricted sample, the results on when flow types play are reversed, and in the less restricted sample, the results on use of control devices by apathy types are reversed. I comment on these inconsistencies in footnotes below. Given that there are 73 statistically significant between-types comparisons in the main results, this many inconsistent results seems not unreasonable.

### 3 Results

The distribution of motivation types appears in Figure 2. The differences among types are statistically significant ( $p < 0.000$ ), using a Chi-squared goodness-of-fit test. The three most common types are boredom (22.7%), relaxation (22.0%) and control (20.0%). In terms of attracting players, it appears that the game appeals most strongly to those who seek out average to low levels of challenge, who we might think of as being motivated by the experience of what might be called “easy wins,” or games in which the challenge level is frequently low, relative to skill thus making it relatively easy to rank reasonably high. The next most frequent types are flow (12.6%), arousal (9.3%) and apathy (6.4%), respectively. Worry (2.7%) and anxiety (4.4%) are the least common, suggesting that the game is particularly unappealing to those who are most motivated by what might be thought of as more negative psychological experiences. Because they are under-represented among players, worry and anxiety types will be left out of all subsequent results.

Next I explore differences in how much different types play the game. Figure 3 show games per session (gps) and sessions per week (spw), by motivational type. There are no statistically significant differences in the length of

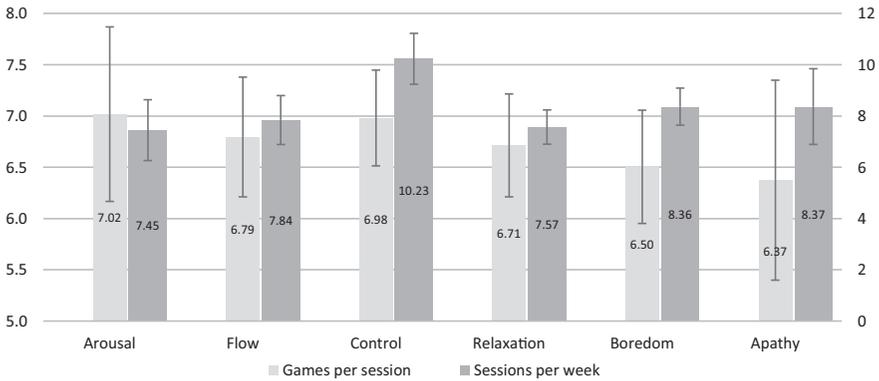


Figure 3: Games per Session and Sessions per Week by Motivation Type.

sessions, but control types stand out as playing substantially more frequently than other types, 10.23 sessions per week on average compared to 8.37 for the next highest type, apathy. The difference is statistically significant at the 5% level relative to all types. Control types play, on average, approximately 22% more frequently than boredom and apathy types, and approximately 35% more than flow, relaxation and arousal types.

Turning to the longer time frame, Figure 4 presents the lifespan, in weeks, and the percentage of weeks during the lifespan in which players played at least one session, by motivation type. Again, control types stand out. At 243.3 weeks, control-types’ average lifespan is 19.6 weeks longer than the next longest type, again, apathy. Relative to other types, control types have approximately 15% longer lifespans. The difference is statistically significant at the 5% level relative to arousal, flow, relaxation, and boredom, but not statistically significant relative to apathy. Meanwhile, control types are more likely to play during any given week than all other types except apathy. The difference ranges between 12.6 percentage points, for arousal, and 6.6 for flow. The differences are statistically significant at the 5% level for arousal, flow, relaxation, and boredom. The difference between control and apathy is, as with lifespan, not statistically significant.

Turning to the evolution of game-play, Figure 5 presents the results for *gps-diff* and *spw-diff*, the change in *gps* and *spw* between the first and last ten weeks of the lifespan. The columns show the *decrease* in length and frequency of game sessions, in percentage terms. Almost all types play shorter and less frequent sessions over the lifespan, perhaps predictable given that, unlike many online games, the game does not vary or become more interesting over time. Arousal, Flow and Control types reduce the length of their sessions by less than Relaxation, Boredom and Apathy at the 5% level. Flow, the notable exception, does not reduce how long they play over the course of their lifespan.

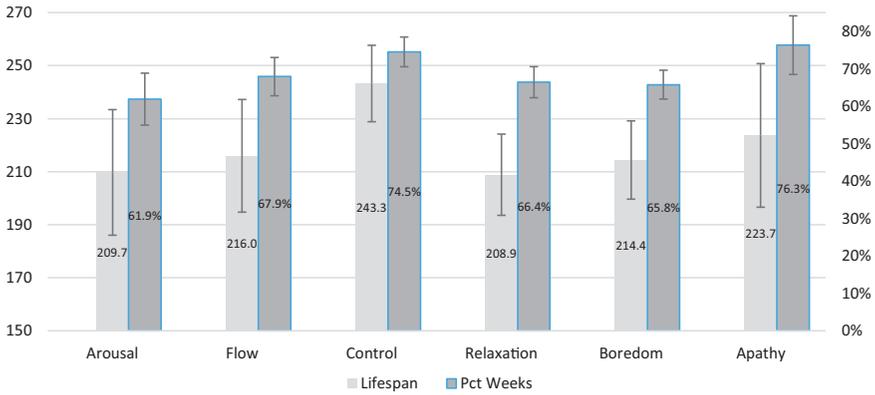


Figure 4: Lifespan and Percentage of Weeks Played by Motivation Type.

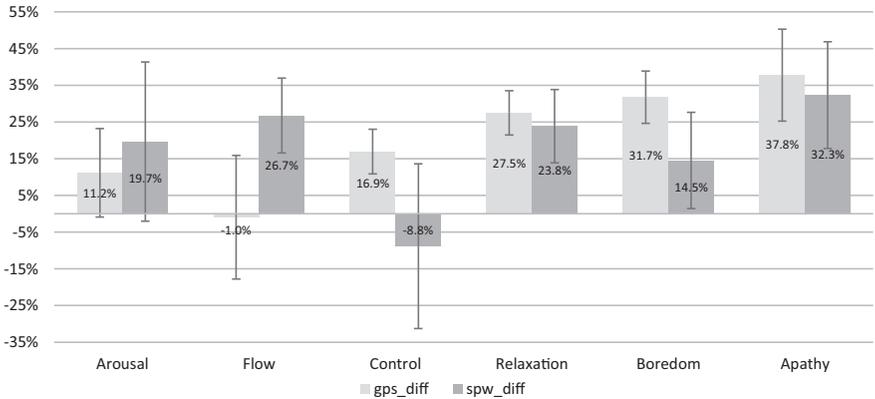


Figure 5: Percent Decrease in Games per Session and Sessions per Week by Motivation Type.

Meanwhile, control types are the only players to increase how frequently they play, significant against all other types at the 10% level or lower.

Motivational types also differ in their skill at the game, the level of challenge they typically take on, and the rank they achieve in the game. Figure 6 presents these results. The two sets of columns represent the lifetime average skill and challenge by type. The bars represent the lifetime average rank, measured on the second axis.

The figure reveals a clear pattern. Arousal and flow types are typically not very good at the game – earning, on average, 25.1% and 27.6% of the possible points respectively. However, they choose to take on challenges beyond their skill level, in both cases playing against other players who outperform them

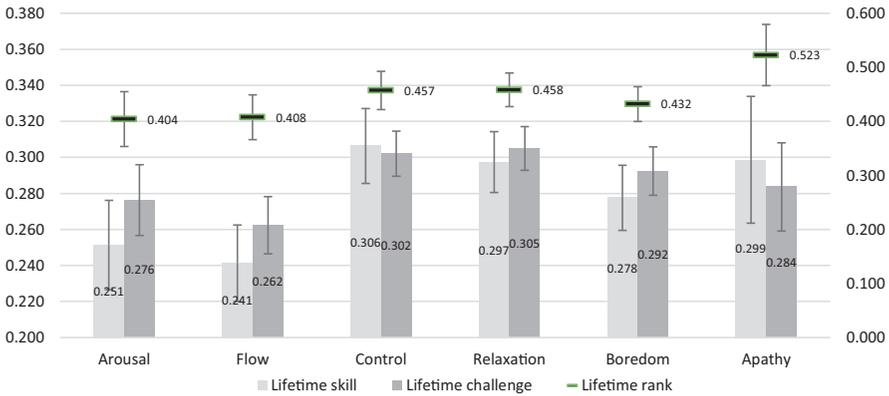


Figure 6: Lifetime Average Skill, Challenge and Rank.

by approximately two percentage points. For both of these reasons, they rank low in the game. For apathy types the opposite is true. They are typically quite good at the game, earning 29.9% of the possible points, but choose to play primarily when the game does not challenge them, playing against players approximately one and a half percentage points less successful, and, presumably for both reasons, they typically rank high. Control, relaxation and boredom types are typically relatively high skill, choose games that roughly match their skill level, and achieve a medium rank on average. The difference in skill between arousal and flow types and all other types is significant at the 5% level in all cases, except arousal versus boredom, which is significant at the 10% level. Differences among the other types are not statistically significant except control versus boredom, which is significant at the 5% level. The differences in challenge are less distinct. Arousal is below control and relaxation at the 5% level, and flow is below control, relaxation and boredom at the 5% level. None of the other comparisons is statistically significant. With respect to rank, arousal and flow types rank significantly below control, relaxation and apathy types, in some cases at the 5% level, and others the 10% level. Apathy is significantly above all the other types, at the 5% level, except for control, where the difference is significant at the 10% level.

Next I look at when the different motivational types typically play the game. Figure 7 presents the average percentage of games played during workdays, work nights, and weekends. Qualitatively, arousal, flow and control types appear to play a larger percentage of their games during the workday than during work nights, with the difference being greatest for control types.<sup>6</sup> Meanwhile, apathy types appear to play more during work nights, and relaxation and boredom

<sup>6</sup>In the more restrictive robustness sample, the result for flow types is reversed.

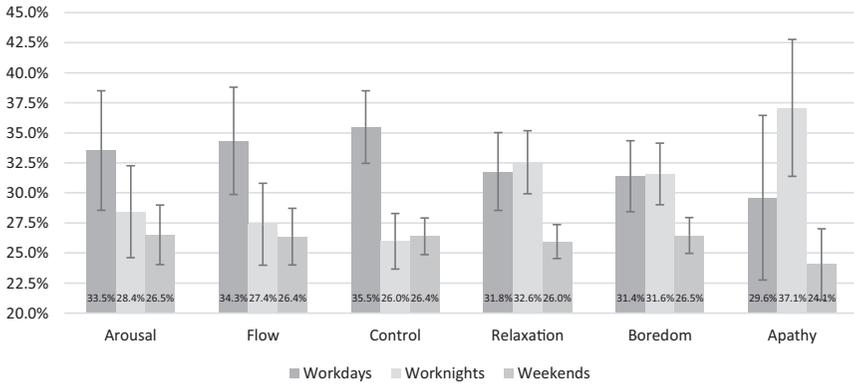


Figure 7: Percentage of Games Played During Work Days, Work Nights, and Weekends, by Motivation Type.

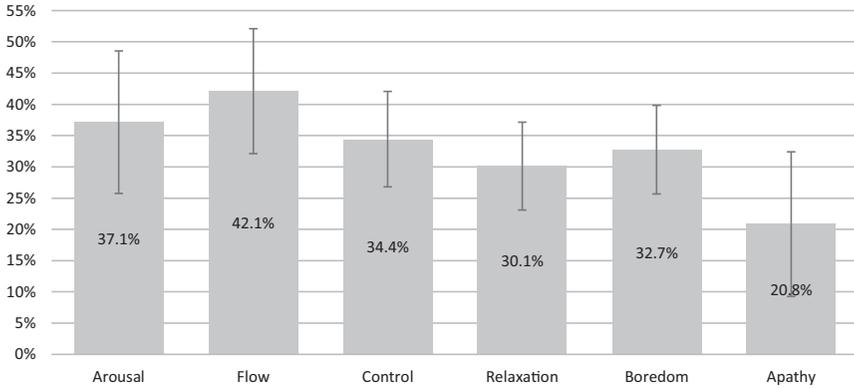


Figure 8: Percentage of Players Who Use Self-Control Devices by Motivation Type.

types play approximately equal percentages of games on workdays and work nights. There are no striking differences in the percentage of games played on weekends. There is a paucity of statistical significance in these results. The differences in workday play between control types and relaxation and boredom types are significant at the 10% level. None of the other differences in workday play are significant. The differences in week-night play between arousal, flow, and control types, on the one hand, and relaxation, boredom, and apathy types, on the other, are significant at the 5% level, except for arousal versus relaxation, significant at the 10% level, and arousal versus boredom, not significant.

Finally, I explore how likely the different motivational types are to make use of the self-control devices built into the game. Figure 8 presents these results.

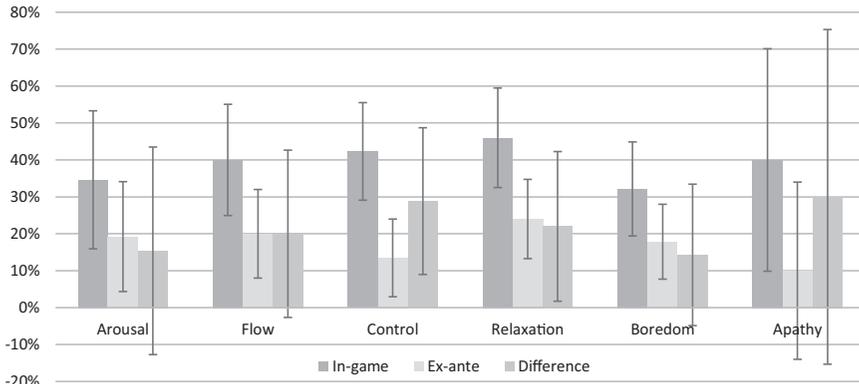


Figure 9: Preference for In-Game versus *ex-ante* Devices by Motivation Type.

Flow types are the most likely to make use of one or both of the devices, with 42.1% being device users, though the comparison with other types is only statistically significant (at the 10% level) with respect to relaxation and apathy. Apathy types, at 20.8% users, are the least likely to use the devices, by a considerable margin.<sup>7</sup> The comparison with other types is significant with respect to arousal and flow at the 5% level, and control and boredom at the 10% level.

I can also observe which device players are more likely to use. Figure 9 presents the percentage of players of different motivational types, among users, who use the in-game device more frequently than the *ex-ante* device, and those for whom the preference is reversed.<sup>8</sup> The third set of columns for each type represents the difference between the two. All types are more likely to use the in-game device more of the time than the *ex-ante* devices (which might not be surprising given that the in-game device allows for flexibility), but the difference is only statistically significant for control and relaxation (at the 5% level) and flow (at the 10% level). Flow and relaxation types are approximately twenty percentage points more likely to use the *ex-ante* device more than the *ex-ante* device, and control types are almost thirty percentage points more likely. One possibility is that the states in which these types are most likely to play the game are more pleasant than the others, so they are more likely to want to give themselves the flexibility to play longer if they do achieve the pleasant state they are most motivated by.

<sup>7</sup>In the less restrictive robustness sample, this result does not hold.

<sup>8</sup>These numbers do not add up to 100% because there are also players who use the two devices with precisely the same frequency.

## 4 Discussion

I begin by discussing how well my findings fit with prior findings in the Flow Theory literature. With respect to flow types, the most notable result is that, despite being relatively unskilled at the game, they seek out other players who are, on average, more skilled than themselves, presumably in order to challenge themselves so that they can experience the state of flow. In terms of motivation, they do not play longer or more frequently than other types, but, unlike other types, the length of time they play per session does not go down over the course of their lifespans. Interestingly, flow types are the most likely to make use of the self-control devices built into the game. Though the statistical significance of this result is not high, we might consider it suggestive, and it might be expected if the state of flow, by causing a loss of self-consciousness and temporal awareness, resulted in less ability to self-regulate, and thus a greater need for assistance in controlling the length of game play. If so, then Flow Theory may need to be added to the understanding in behavioral economics of the psychology of self-control.

Perhaps more notable than flow types in this game are control types, those who are most motivated when they face average challenge level but are performing well, and thus, we might think, experiencing a sense of being “in control” of the game, ranking high, but because of mastery, not because they choose easy challenges. Control types play the game dramatically more frequently than all other types, and are the only type to play more frequently over the course of their lifespan. They are also more likely to play in any given week, and continue to play the game over a longer period of weeks. In some sense, although they are not significantly more highly represented than all other types among players of the game, it seems that the game is best suited to their motivational type. This may be because the game lends itself to the experience of control. The challenge level of the game does not vary very much from one session to the next, making it easy to choose to play when the challenge level is near average. But if individual skill varies more over any given time period, it may be relatively common to have the experience of control, making the game particularly compelling for those who are most motivated by control.

Interestingly, both flow and control types appear to be more likely to play during the workday than other types, though here too the level of statistical significance is not high. This result is in keeping with the finding that many people experience flow most frequently in the work environment (LeFevre, 1988). If the same is true for control, we might expect those who are most motivated by flow and control to seek out, presumably during work breaks, a recreational activity that allows them to experience flow or control during the time of day when they are already experiencing, and motivated by, those psychological states. Meanwhile, relaxation, boredom, and apathy types are

all more likely to play during the evening than flow and control types, again, fitting with prior findings that these less energized states are more likely to arise during leisure hours (LeFevre, 1988). It may be that for relaxation, boredom, and apathy types, the game is a way to “unwind” or “space out.” Alternatively, it is possible that individuals are motivated by different states at different times of day, so that those who choose, for some other reason, to play during work hours find themselves motivated by states that are likely to arise during the workday, and vice versa for those who choose to play on work nights.

A related result is that players who are most motivated by arousal, flow and control decrease the length of time they play by less than those who are most motivated by relaxation, boredom and apathy. If we think of the first set of states as being more “high energy” and the latter set more “low energy” then we might conclude that the game is more successful as a way to achieve high-energy states, causing those types most motivated by these states to remain motivated longer than those most motivated by low-energy states. Thus, although the game appears to provide a leisure activity for low-energy types that works for them during the hours of the day when they seek out such activities, it seems to be more successful at doing so for the more high-energy types.

Finally, apathy types warrant some attention. They have relatively high skill, but are the only type to choose challenges below their skill level, and as a result rank high. Nonetheless, they do not appear to be motivated by, or seeking out, the experience of “easy wins.” Instead, perhaps, they simply have a preference for what we might consider to be the lowest energy psychological states. They are the most likely to play during work nights, and are the only group to play more during work nights than work days, which might suggest that for them, the game provides an experience comparable to passive activities such as watching television. Meanwhile, although they do not play longer sessions, or more frequently, or over a longer lifespan, they are the most likely to play during any given week, which we might think of as a measure of regularity of play. They are also the least likely to make use of the self-control devices. The picture these results paint is of a motivational type that seeks out low-energy states during a low-energy time of day, without any desire to limit how long they play, and on a highly regular basis.

## **5 Conclusion**

Using high-frequency, objective data from a repetitive, multiplayer online game, I categorize players according to the Flow Theory channel in which they are most likely to continue playing the game, which I take to be an indicator of their motivational “type.” Ignoring worry and anxiety types, as they are underrepresented in the data, I find a number of interesting comparisons among the types. Flow types challenge themselves more than others, presumably to

achieve flow, and, perhaps as a result, are most likely to become “lost” in the game, leading them to make use of the available self-control devices more than other types. Control types play more frequently and with greater regularity than all other types, and over a longer period of weeks than almost all. In some sense, the game seems to be best suited to them. Perhaps as a result, they are the only type to play more frequently over the course of their lifespan. Apathy types are relatively high skill, but seek out challenges below their skill level, and thus rank highest among the types. They play overwhelmingly during work nights, and with greater regularity than other types, making use of the self-control devices less than other types. Finally, there is a pattern of distinctions between the set of what might be called “high-energy” types (arousal, flow, and control) and “low-energy” types (relaxation, boredom, and apathy). High-energy types are more likely to play during the workday, and less likely to taper off in how long they play. The reverse is true for low-energy types.

These results contribute to the understanding of the motivational typology developed within Flow Theory. To a considerable extent, they fit what we might expect on the basis of prior findings. Some of the results may be particular to the specific game under study. It is possible that it is more successful at generating high-energy states than low-energy states, while the reverse might be true for other games. Alternatively, given that flow types are not highly represented among players, we might imagine that the game is not well suited to the generation of the flow state, as it does not provide adequate opportunity to challenge oneself. Data on a range of different types of games might shed light on these issues.

Understanding motivation in game play *per se* is economically important, given the number of hours played, and in particular the number of excess hours that players may be playing. In addition, my results contribute to the literatures on intrinsic motivation, and on the psychology of self-control. But there are other economically relevant implications of my work. In particular, if it is possible to use similar methodology to identify types in the work place, and evaluate their work characteristics, there could be valuable application in hiring and management practices. The same could be true in the domain of education.

The question could be asked, why apply Flow Theory in particular to the understanding of motivation in gaming, or any other activity for that matter. There are multiple theories of motivation, and it is hard to make the case that one is more relevant than another in any given context. However, the fact that Flow Theory has been adopted by investigators in the field of Self-Determination Theory (the primary field in which intrinsic motivation is studied), combined with the fact that intrinsic motivation is understood to explain motivation to play games, and engage in other activities, particularly in the work place (Deterring *et al.*, 2011), suggests that the motivational types defined by Flow Theory may be particularly relevant to the current study. Testing one motivational theory against another, however, is beyond the scope of this study.

One challenge to my study, and Flow Theory in general, is that the division of skill/challenge space into eight channels, demarcated by a set of regularly spaced diagonal lines, may be arbitrary, or at best inaccurate, and the psychological characterization of those channels may be incorrect. Prior studies have generated evidence to support the existence, primarily, of Flow, Relaxation, and Apathy types, as noted above. Determining whether the other types are correctly characterized in terms of their psychology, and whether the demarcation boundaries are in the right places, would require substantially more research. In theory I could shed light on the question of where the boundaries between types lie, using machine learning to identify clusters of players on the basis of where in skill/challenge space they are most likely to continue playing. There are two problems with this. The first is that I would need vastly more data per player to place them on the diagram with enough precision to identify clusters. The second is that I would have no way of characterizing the psychology of the different clusters, as I have no information about players' psychological states or traits. Given my goal of at least attempting to link behavior to psychology, the best approach seemed to be to take the existing demarcations and characterizations as given. As explained below, I would like to be able to go beyond this in future research.

A major limitation of the study is that I do not have any data on the actual psychological state of players while they are playing, or any information about what they were doing prior to playing the game, what they subsequently do, or how they are most highly motivated during other times of the day or while engaged in other kinds of activities. In future research, I would like to be able to implement an experience sampling methodology among a random sample of players. The hope would be to establish more conclusively whether the psychological states attributed to the eight channels of Flow Theory actually arise in players when their relative skill and challenge place them in those channels. The approach would also allow me to explore the states of mind that cause players to begin playing the game, as well as how their state changes as a result of playing the game. Also, I would be able to measure subjective well-being in different psychological states and compare the effect of the game on wellbeing across the different types. Finally, I would hope to gain insight into the psychology of self-control, including whether access to self-control devices affects psychological state or subjective well-being.

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