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Tetris and Flow

Gabie Gagnon

Adam Montgomery

Carnegie Mellon University

**Introduction**

Often people find themselves caught up in tasks that effortlessly consume their time. People report feeling as if they are “in the zone” and able to fixate on something for hours, often being able to demonstrate incredible performance at the task at hand. Being “in the zone,” obsession, effortlessly being consumed with a task, all of these describe flow. Flow is a mental state where someone is able to perform an activity with full immersion, energization, and enjoyment of every level of the task at hand (Czikszentmihalyi, 1990). This kind of actualization is very often seen in expert musicians, professional athletes, spiritual development most often seen in Eastern religions, and in video games.

Flow, a kind of absolute focus and enjoyment, is a main reason people report continuing to play video games. Video games are such an easy means of stimulating flow because of their ability to stimulate an intrinsic motivation, where skill and challenge are balanced and a player is at optimal arousal (McGonigal). Video games have progressed into much more than simple ways to pass time, there are rich pictures, videos, dialogue, etc. which vary across genre and intention of the game. We theorize that it is flow which is a motivation for why people desire to play more video games, which begs a natural question: “is flow in games related to higher enjoyment?”

Most folks’ initial answer as to why games are “fun” is that they present the player with a win condition (McGonigal, 2011). What this implies is that the fun of games comes from seeking some kind of reward: that games have conditioned us to seek this “win”. On the contrary, though, some of the most popular games in existence are, in fact, impossible to win. One such game is Tetris—it has been proven at the dissertation­level that, mathematically, the only winning strategy for Tetris is infinite play. This implies that you cannot beat Tetris (Brzustowski, 1992). Yet at the same time, Tetris is one of the most popular games in the world. Linking this back to flow one can see that the concept is in fact in play when it comes to the idea of infinite Tetris: as one’s game of Tetris continues, the speed of the falling blocks increases, slowly raising the difficulty level for the player. It is hypothesized that this invokes flow—the player is constantly working at the top of their ability in order to continue playing the game, increasing ad infinitum.

The literature on flow begins with its originator, Mihaly Czikszentmihalyi, and his book on the experimental studies he conducted, entitled Flow: The Psychology of Optimal Experience (1990). Within this study, Czikszentmihalyi and his team of experimenters used a questionnaire to gauge the level of enjoyment with which people engaged in activities—from chess to rock climbing to composing music. From this extensive study, Czikszentmihalyi concluded that the lower enjoyment of low­risk activities and higher enjoyment of high­risk activities stems from “flow”, or the ability to work at the top of one’s capabilities for an extended period of time. The question we are seeking to answer, then, is whether this principle of flow applies to video games, and whether removing the flow­effect from a game reduces enjoyment.

The hypothesis for this study is that when flow is removed from a game of Tetris, the player’s enjoyment of the game will decrease, dependent on their reported skill level with the game. We further predict those with low skill level will enjoy less challenging versions of Tetris more than players with a high reported skill level.

We argue the justification for our hypothesis supported by the current literature on flow. In a study conducted by O’Keefe and Linnenbrink­Garcia (2014), they contend that the participants who were given tasks which they report as more enjoyable and personally valuable were able to solve the most problems out of their participant pool, and conversely their participants who solved fewer problems responded with the tasks being either less enjoyable or personally valuable. Our experiment is investigating the engagement the participants reported and their anecdotal reports that they were “in the zone” suggest that their interest and enjoyment increased their performance on the tasks (O’Keefe and Linnenbrink­Garcia).

Critically important is the ability to initiate flow in the experiment. The use of Tetris improves our chances of initiating flow in our participants, but Czikszentmihalyi argues that flow is formulaic, where the right challenge must be linked with the same skill level. This suggests that use ofTetris is optimal.

**Method**

*Participants*

Ten undergraduates from Carnegie Mellon University participated in this experiment. Participants were not be compensated for their participation.

*Apparatus and Stimuli*

The stimuli were presented on a computer screen (one of two designated “experimental” computers). The Tetris game and the surveys for measuring enjoyment were controlled by the integrated keyboard or attached keyboard (in the respective use of a participant's own computer or a designated computer). Critical to this experiment is the Tetris game, which was used under fair use for this experiment, following the traditional rules of the game, save some modifications for the purposes of gathering data. Included in the modifications to the game are an evaluation of skill and evaluation of enjoyment, which export the data to an Excel spreadsheet. Also included are variations on Tetris gameplay experience. These modifications include, separately: no increased piece drop-rate by level, increased point accumulation rate (500 points per line cleared as opposed to 100), a time-cap (capped at two minutes of play). These modifications do not impede the performance or rules of the game.

*Design*

The experiment was divided into five sections. The first section was a dual practice and evaluation stage. In this stage, participants practiced playing Tetris, and following their practice run, had their skill level measured. Evaluation was conducted after playing one game without increased piece drop rate by level. After this, a ratio of performance to time was calculated. Following the evaluation stage, participants were shown either the second, third, fourth, or fifth section (where their exposure is based on counter balancing). The second block was a repeat of the initial practice conditions, this time treated as a full trial, which was then followed by an evaluation of enjoyment (where the evaluation is attached below). The third block was concerned with delivering the higher point accumulation rate (of 500 points per line clear as opposed to 200), after which the participant’s enjoyment was evaluated again. The fourth block measured performance and enjoyment under time restrictions-- the players were only given two minutes to accumulate points. The fifth and final block was a game of real-world Tetris-- the points rate is 100 points per line, with multipliers, the speed increases 200 ms per level. This experiment was a within subjects design, where the speed and skill level of the participant were the two independent variables, with enjoyment standing as the dependent variable, and skill used as a between-subject covariate.

*Procedure*

The participants gave informed consent. Then, they were given written instructions describing the task. The directions stated that participants will play five rounds of Tetris and in between rounds be given an evaluation of their performance and feelings. After an explanation of the controls of the Tetris game as to how they map onto the keyboard, the participants were instructed to continue on with the experiment. This began the five blocks of the experiment.

The first block of the experiment evaluated the “skill” of the participant in Tetris. For the purposes of grading participants, skill was determined by the ratio of score to time within the final practice run. Participants played through four more blocks of Tetris, designed to evaluate the effect of certain conditions on performance and enjoyment. In specific, these variables are: no added drop speed by level, higher points rate with no added drop speed, time restriction with no added drop speed, and added drop speed by level. Between and after the Tetris games, participants were evaluated on a battery of 10 statement ratings on the Likert scale of their engagement while playing, and after the conclusion of play, participants were instructed to contact the experimenter who waited away from the participant to give final debriefing.

The Engagement Evaluation is as follows:

Engagement Evaluation

1.     I enjoyed playing Tetris\*

2.     Time seemed to stand still or stop

3.     I couldn’t tell I’m getting tired

4.   I felt like I can’t stop playing

5.   I got wound up

6.   Playing seemed automatic

7.   I played without thinking how to play

8.   Playing made me feel calm

9.  I lost track of time

10.  I really got into the game.

\*1st statement ratings not included in statistical analysis

# Results

The results of this study indicate a strong relationship between Tetris condition and participant’s simple enjoyment rating (Likert scale 1-7). Performing an ANOVA on our collected data using Tetris condition as a within-subjects variable (4 levels) and simple enjoyment as the measure revealed a significant effect of Tetris condition on enjoyment (*p* < .005, *F* (3, 24) = 7.361). The specific condition that produced a highly significant effect was the higher-points condition, in which participants received 500 points per line clear. What this suggests is that the most compelling component of a game (in terms of producing simple enjoyment) is more points. To expound upon this, we might think of this trial as isolating the idea of “gratification” from “challenge” within Tetris. Intriguingly, this result does not support our hypothesis; in fact, it could be said that this result is diametrically opposed to our initial hypothesis. This effect is illustrated by Figure 1, Mean Enjoyment by Condition. The specific means are also shown in Figure 3. Left: Figure 1, Mean Enjoyment by Condition

The second important analysis was an ANCOVA again using Tetris condition as a within-subjects factor and simple enjoyment as a measure, but this time using player skill as a covariate. This analysis showed that the effect of condition on enjoyment was still marginally significant (*p* < 1, *F* (3, 21) = 2.47), implying that our hypothesis on skill as a varying factor in enjoyment was not supported. This effect is illustrated by Figure 2, Enjoyment vs. Skill Level.

Above: Figure 2, Enjoyment vs. Skill Level

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Condition** | **Mean** | **Std. Err** | **Conf. Int. Lower** | **Conf. Int. Upper** |
| Control | 2.111 | 0.423 | 1.135 | 3.087 |
| Points | 4.222 | 3.02 | 3.02 | 5.424 |
| Time | 2.111 | 0.93 | 0.93 | 3.292 |
| Challenge | 2.556 | 1.605 | 1.605 | 3.506 |

Above: Figure 3, Table of Means

Furthermore, ANOVA results using Tetris condition as a between-subjects factor and average engagement survey answer as a measure produced no significant effects. Similarly, an ANCOVA of condition on average engagement survey answer using skill as a covariate revealed no significant effects.

**Discussion**

Tetris, we theorize, is the simplest iteration of a flow-machine. Since a flow-state is generally induced through the perception of high-risk and intense concentration (Czikszentmihalyi), we can theorize that Tetris, through providing only a fail-state, and by increasing challenge when a player increases level (thereby indicating a higher level of skill), mimics the conditions for a flow-state. We theorized, in addition, that measuring enjoyment and engagement would give an accurate dipstick reading of a player’s prior flow-state during gameplay. As it turns out, this was not as accurate a reading as we had theorized. In fact, as shown in the results section, simple enjoyment ratings were quite dissonant with engagement survey answers. Furthermore, our iteration of a bare-bones Tetris game appeared to not have the same engagement effects as the versions of Tetris one might find in the wild—so to speak. Our bare-bones Tetris seems to have, in what was a minor surprise, induced boredom as opposed to engagement and enjoyment. Both of these issues will be addressed in the latter part of the discussion.

Despite our hypotheses not being supported, our study did in fact reveal something akin to a truth about the state of modern gaming. What our results tell us is that, beyond any other factor in a game, gratification is the key to simplistic enjoyment. Giving players more points resulted in higher enjoyment, a whopping 2 points higher on average than any other isolated condition tested. We can also see this trend occurring in the world of modern gaming. In this age, we have games at our fingertips; finding at least one game on any average person’s phone would not be unlikely, without any heed paid to their identity as a “gamer” or not. A few years back, there was a constant onslaught of criticism by those who thought of themselves as “gamers” of this new idea of a “casual” gamer; someone who didn’t think of games as a major part of their life, but who played them on a regular basis. A quote by Shigeru Miyamoto, famed Nintendo game designer, described this notion quite succinctly, if in a negative light:

[These are] the sort of people who, for example, might want to watch a movie. They might want to go to Disneyland," he said. "Their attitude is, 'okay, I am the customer. You are supposed to entertain me.'… (Miyamoto, Shigeru)

This is to say, casual gamers are playing not for the experience so much as they are to be entertained. This clearly demonstrates the rift that our study highlighted with our results—gratification, “entertaining” the customer, is the more popular effect of gaming, despite being a phenomenon entirely outside of what an engaging game may, in theory, present. In this sense, we have demonstrated a well-known phenomenon. In further research, it would be a very intriguing addition to the study to also measure enjoyment and engagement within an extended session of play in a more mentally engaging game, versus a more casual game. Ideally, in a study using the prior mentioned paradigm, the aim would be to isolate the causes of higher engagement and enjoyment, and which specific factors each is linked to—perhaps, even, to isolate the conditions of a flow-state.

Continuing from the previous-- flow is a difficult mental state to measure. In particular, we find something akin to Heisenberg’s Uncertainty Principle—in trying to measure flow, we negate the flow-state. Therefore, less reliable measures must be used—in the case of this study, a post-play survey. These kinds of survey-based measures can of course only measure a person’s perceived flow-state, though such is the nature of survey-based measures. For this study, such survey-based methods were implemented due to the simplicity of integration with the Tetris task itself. In further studies of this nature, ideally a customized survey would be piloted and implemented to better suit the research. A particular shortcoming of this study’s battery of survey ratings was observed in the participants’ perception of the negative or positive connotation of the statements. Within the survey, all statements were intended to be taken positively; a higher value indicated higher engagement with the game. In this respect, the survey used did not have high internal validity, as participants did not engage with it as was expected—participants cited that they rated some statements highly, but not because they felt good about the statements. We believe this is the root of the disagreement between participants’ simple enjoyment ratings and their average ratings on survey statements. In further critique of the methodology behind the survey ratings, the survey statements were adapted from a study that used far more engaging games, to which Tetris simply cannot compare. While we did cut some statements that didn’t seem to fit the Tetris experience or that seemed redundant, this does not change the fact that our usage of the survey was in fact different than the intended usage, which may be responsible for some dissonance in average answers.

A final point of critique is the actual structure and presentation of the Tetris stimulus. With consideration of our Tetris stimulus as a game, we expected that participants would be more easily and naturally engaged with our study than with a study that does not provide the same mental engagement as a game. On this count, we were proven incorrect. When initially piloting this study, the practice stage was three rounds long and the battery of survey ratings was 17 questions long as opposed to just 10. Along with this, there were no time constraints on any rounds except for the specifically time-capped round, which was capped at ten minutes. The effect this had on participants seemed to be extraordinary boredom—as though the simple construct of the study was refraining them from pursuing more interesting activities. In these initial runs, we found that enjoyment ratings decreased to abysmal level as the experiment went on, eventually prompting some subjects to quit before the study was over, or to make comments on the length of the game. In order to strengthen the experiment, we added the overall time-cap of five minutes per round (except for the time-cap round, in which play time was restricted to two minutes), counterbalanced the order of Tetris conditions (in order to circumvent data being tainted by a boredom factor), and reduced the number of survey ratings to 10. While this did decrease the boredom effect, it did not do away with it entirely, and thus the study is still mildly tainted by an air generalized boredom. What this means for our data is generally lower-than-expected enjoyment ratings across the board. In further studies, it would be pertinent to emulate Tetris to a greater degree of realism: implementing sound effects, music, animations—the seeming ephemera. On closer inspection, these seemingly unnecessary aspects of a real-world game of Tetris are exactly what our stimulus was lacking, and in that regard we may theorize that adding in these aspects may very well increase overall engagement and negate boredom effects. What this might suggest, should such a study be executed, is that perhaps it is not simple the mechanic that makes the game, but the atmosphere of the experience itself.

In the ideal world, further research on the topic of flow in video games will help improve all types of gaming—aiding in the design of games that are more fully engaging and more wholly enjoyable. The benefits of isolating the basic conditions for a flow-state within games is impressive in its infinitude. Not only would games, as we think of them, become enhanced in their quality, but devices such as learning games, brain-training games, and games for numerous other non-gaming purposes become more effective through providing a more engaging space for growth and purposeful activity. Certainly, there is a place for research at the intersection of flow and gaming—continuing the study of games from a cognitive viewpoint could arise indispensable tools for purposeful game design.

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