

Exploring How Preference and Perceived Performance Vary in Different Game Genres Across Time of Day

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ABSTRACT

Time of day effects have been observed for the last five decades in cognitive tasks, athletic performance, and even ethical behavior. However, in the context of games, little is known about how time of day influences preference or performance. We present a first study (N=504) to explore how preference and perceived performance vary over the course of the day, by game genre. We find that the genres *First-Person Shooter* and *Other RPG* are more popular at 6 p.m. to midnight. Conversely, the genres *Puzzle* and *Board / Card* are less popular at 6 p.m. to midnight. However, 6 a.m. to noon is a more popular time for *Puzzle* and *Board / Card*. Performance-wise, players feel they are more successful in *First-Person Shooter* games from 6 p.m. to midnight, and less successful at all other times. On the other hand, players feel they are more successful in *Puzzle* games from 6 a.m. to noon, and less successful from 6 p.m. to midnight. These inter-genre differences have a basis in the literature, which has postulated that cognitive function gradually declines throughout the day, but that athletic performance peaks in the evening along with core body temperature.

CCS CONCEPTS

• Applied computing → Computer games; • Human-centered computing → Empirical studies in HCI;

KEYWORDS

Game Genres; Time of Day; Preferences; Performance; Games

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1 INTRODUCTION

Time of day effects have been a topic of research for the last 45 years [4, 6]. Time of day affects task performance [4], unethical behavior [16], decision-making [17], athletic performance [26], and much more. This is thought to be mainly due to two factors: the body's

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Preference by Time of Day

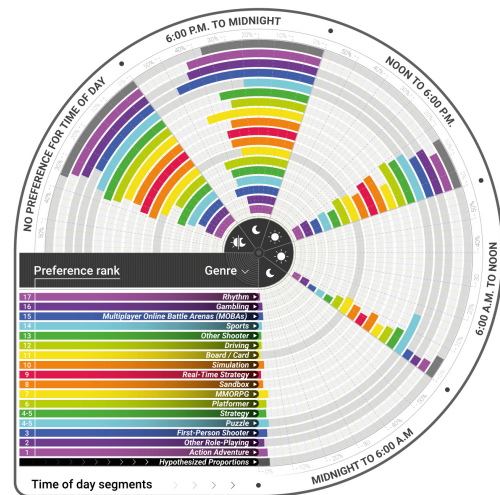


Figure 1: Preference by time of day. Genres ranked by overall preference. Each colored bar shows the percentage of players that prefer a time segment. Gray bars outline genres that have significantly different proportions from hypothesized proportions.

circadian clock [20], and sleep pressure (which increases the more time spent awake) [24]. But despite the significant work on this topic, there is little known about time of day effects on gamers. Such topics are nonetheless important to investigate, since understanding when gamers prefer to play certain games, and when they perform best at those games, can influence game design. For example, we may want to adjust the difficulty level depending on time of day, give players game recommendations depending on time of day, or adjust the game entirely a certain way depending on when we intend gamers to play that game (e.g., adding more puzzle elements). We may even seek to improve matchmaking algorithms in online competitive play by taking into account daily fluctuations. For instance, two groups of players at different ends of the day (e.g., a team from New York matched against a team from Seoul) could create skill imbalances not reflected in their algorithmic ranking.

Video games involve both cognitive and fine-grained motor control, and therefore it is logical to hypothesize that the effects from other domains may transfer to gaming. However, because games can differ significantly by game genre, any potential study must take into account possible inter-genre differences. We decided to conduct a survey study of 504 gamers. We had two main research questions:

RQ1. How do people's preferences for different game genres change throughout the day?

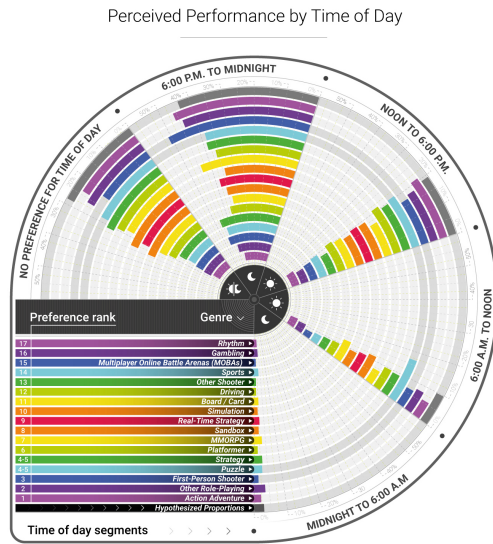


Figure 2: Perceived performance by time of day. Genres ranked by overall preference. Each colored bar shows the percentage of players that perceive their performance to be highest in a time segment. Gray bars outline genres that have significantly different proportions from hypothesized proportions.

RQ2. How do people’s perceived performance in different game genres change throughout the day?

See Figure 1 and 2. Overall, we found that:

- Gamers most preferred the genres *Action Adventure*, *Other RPG*, and *First-Person Shooter*.
- *First-Person Shooter* and *Other RPG* are more popular at 6 p.m. to midnight, comparatively.
- *Puzzle* and *Board / Card* are more popular at 6 a.m. to noon, comparatively.
- Performance-wise, players feel they are more successful in *First-Person Shooter* games from 6 p.m. to midnight, and less successful at all other times, comparatively.
- Players feel they are more successful in *Puzzle* games from 6 a.m. to noon, and less successful from 6 p.m. to midnight, comparatively.
- *First-Person Shooter* players are more likely to have a time of day preference for playing, and a time of day for when they believe they will be more successful, comparatively.

2 RELATED WORK

Cognitive Effects. One study examined the quality of chess moves in an online database with more than 1 million games of chess. Players in a chess game have to make on average 40 decisions, using a finite time budget. Researchers measured both the time taken and the quality of each move, and found that chess players make riskier decisions as the day wears on [17]. In another study on decision-making, researchers found that the percentage of favorable judicial rulings changes abruptly throughout the day. Favorable rulings drop gradually from 65% to nearly zero before a break, then jump back to 65% after a break [7]. Researchers studying ethical behavior observed what they called the morning morality effect. They found

that participants engaged in less unethical behavior in the morning than in the afternoon [16]. Other work has found significant effects of time of day on planning and memory tasks [14, 15]. Emotions, too, are strongly affected by time of day. A study of millions of Twitter messages found that an individual’s mood starts off high and deteriorates throughout the day [10]. Time of day differences have also been observed in Wikipedia editing activity [29], as well as the attributes of Mechanical Turk workers [1].

Physical Effects. Athletic performance is often superior in the evening, which is when core body temperature is typically highest [26]. However, variation exists depending on the specific activity. The accuracy of badminton serves are highest in the afternoon, as compared to the morning or evening [8]. First serves in tennis have higher accuracy in the morning. However, speed is highest in the evening [2]. Muscle strength peaks in the evening: back [5], leg [28], knee extensors [11], and other muscle groups all exhibit an evening peak. Swimmers are slower in the morning than in the evening [3], and this is even true for swimmers who exercise in the morning [18]. Higher time to exhaustion has been found in evening cycling as compared to morning cycling [21]. Total work output in cycling is higher in the afternoon than in the morning [12]. Across decades of studies, the most robust result is that athletic performance is typically highest in the evening time [26].

Circadian Clock and Sleep Pressure. The circadian clock is an internal body clock that is close to 24 hours [20]. This biological clock is synchronized with external environmental cues. External cues include light (known to be the strongest cue), and social cues [23]. Individual differences in propensity for sleeping at a certain time of day is known as a *chronotype*, with the two extremes being *eveningness* (sleeps later), and *morningness* (sleeps earlier) [13]. This changes with age: pre-pubescent children prefer *morningness*, adolescents prefer *eveningness*, and the elderly prefer *morningness* [19, 22, 30]. In addition to the circadian clock, another important factor is sleep pressure. Sleep pressure is the body’s need for sleep that accumulates as the day progresses; it is postulated that sleep pressure is responsible for decreases in cognitive functioning [24]. Both the circadian clock, and sleep pressure, are postulated to be the main reasons for time of day effects.

Video Games. As far as we know, this is the first study to directly look at time of day effects and video games. One study found that “video game addiction” (as measured by the Problem Videogame Playing scale [25]) is correlated to time spent playing on weekend mornings [27].

3 METHODS

3.1 Survey Development

A survey was developed to answer the research questions in this study. The survey, which took roughly 5-10 minutes to complete, asked respondents gamer classification questions, demographic questions, and questions related to the research questions. Of primary interest, the survey asked respondents to rank genre preferences, to indicate the time of day they prefer to play certain genres, and to identify when they believe they are most successful in playing various genres. To ensure the sample was comprised of video game players, the following question was asked at the beginning of the survey: “Please select ALL the various platforms in which you play

video games on at least a regular basis (3 or more hours per week)”. If the respondent selected “I don’t play video games on a regular basis,” he or she was excluded from completing the survey.

We first elicited respondents’ overall preferences. Respondents were asked to rank 17 video game genres based on a list from Elliott, Golub, Ream, and Dunlap (2012) [9]. We made minor adaptations to this list to account for current genres (e.g., we added Multiplayer Online Battle Arenas [MOBAs]). Finally, to ensure respondents knew how to distinguish the genres from one another, between three or four recent genre exemplars (popular and recent releases of each genre) were provided. For example, the exemplars for the Platformer genre were: “Sonic Mania,” “Mario Odyssey,” and “Mega Man 11.” The order by which the genres were presented to each respondent was random.

Next, we sought to address RQ1 (how do people’s preferences for different game genres change throughout the day). Our question focused on the time of day people prefer to play various genres. This question asked: “Assuming you had unlimited free time on a weekday (i.e. no work, school, family, or social obligations), please select the time of day you PREFER to play the following game genres.” Participants were invited to select one of six options for each of the 17 genres: 1) Midnight – 6 a.m., 2) 6 a.m. – Noon, 3) Noon – 6 p.m., 4) 6 p.m. – Midnight, 5) I don’t have a preference when I play this genre, and 6) I do not play this genre. Again, the genres were displayed in a randomized order.

Finally, we sought to address RQ2 (what time of day gamers expected their performance to be highest in various genres). This research question was addressed by the survey item: “Assuming you had no distractions, at what time of the day do you think you PERFORM most successfully when you play the following game genres?” The same six day part options were present for this item as was in the item used to address the first research question. Again, the genres were displayed in a randomized order.

3.2 Participants

A total of 504 self-identified video game players successfully completed the survey through Mechanical Turk (57.9% male, 41.7% female, 0.4% other). Mean age was 36.58, median age 34. Participants were all from the US. Participants were reimbursed \$1.00.

4 RESULTS

4.1 Game Genre Rankings

Respondents were ranked 17 genres from most favorite to least favorite. Rank order type survey questions are best addressed via nonparametric statistical techniques. To ensure the distribution of the ranks of these 17 genres was non-normal, one-sample Kolmogorov-Smirnov test statistics were computed; all the p-values were less than .001, indicating the non-normality assumption was held and that nonparametric testing was the appropriate course of action. Thus, a series of Wilcoxon Signed Rank tests were computed, with the hypothesized median being set to 8 (roughly the middle value between 1 and 17). Any genre that scored significantly higher or lower than the hypothesized median value indicates a difference from the assumed middle point rank. For genres that demonstrate statistically significant differences, values of the W statistic can be sorted from low-to-high to infer a ranked preference, from highest

Rank	Genre	Median	W	p-value
1	Action Adventure	5	31407.5	<.001
2	Other RPG	7	42696.0	<.001
3	1st-Person Shooter	6	46780.0	.001
4-5	Puzzle	8	58980.5	.620
4-5	Turn-Based Strategy	9	61367.0	.026
6	Platformer	9	63090.0	.002
7	MMORPG	9	66305.5	.005
8	Sandbox	9	66679.5	<.001
9	Real-Time Strategy	9	67883.0	<.001
10	Simulation	9	68412.0	<.001
11	Board / Card	9	69860.0	<.001
12	Driving	9.5	73981.0	<.001
13	Other Shooter	10	80929.5	<.001
14	Sports	11	84189.0	<.001
15	MOBA	11	85183.5	<.001
16	Gambling	13	98438.0	<.001
17	Rhythm	13	103359.5	<.001

Table 1: Video Game Genre Preferences and Ranks

preferred to lowest preferred. Table 1 presents the ranked order of the 17 genres. Note given the large sample size, a p-value of less than .01 was used as the cutoff for determining statistical significance.

4.2 Preference by Time of Day

Here, we address RQ1. A series of chi-square tests comparing the genre day part preferences to a hypothesized proportion were employed. To calculate the hypothesized day part values, all the responses were combined and weighted. For example, 15 people indicated they preferred to play the *MMORPG* genre from midnight to 6 a.m., and there was a total of 364 people that indicated they have a day part preference for when they play *MMORPGs* (individuals who did not play a certain genre were removed from the calculations). That percentage (4.12%) was multiplied by the percentage of people who indicated an *MMORPG* preference (364) divided by all the responses (6,449) to create the weight. Then, the percentages of each day part preference for each genre were added together. In other words, the hypothesized proportions represent baseline expectations for a specific day part by aggregating all day part preferences.

The most popular time of the day to play any genre was from 6 p.m. to midnight, while the least popular time, unsurprisingly, was from midnight to 6 a.m. Only four genres deviated from these set breakouts significantly – *Other RPG*, *First-Person Shooter*, *Puzzle*, and *Board / Card*. Table 2 presents the observed percentages by day part for these genres.

Gamers report preferring to play the *Other RPG* and *First-Person Shooter* genres at a higher rate from the 6 p.m. to midnight day part compared to the other genres for that same day part. Conversely the 6 p.m. to midnight day part seems to be much less popular times for gamers to play *Puzzle* and *Board / Card* games. Interestingly, 6 a.m. to noon is a more popular time for gamers to play *Puzzle* games compared to the other genres; the same is true (though to a lesser extent) for *Board / Card* games. Regardless of genre, noon to 6 p.m. seemed to be a consistent time in which gamers prefer to play. Finally, midnight to 6 a.m. is an even less popular time from other genres for people to play *Board / Card* games, but a slightly more popular time for people to play *Puzzle* games.

4.3 Perceived Performance by Time of Day

Here, we address RQ2. The same day part weighting procedure in RQ1 was used for RQ2. Only two genres differed significantly from the hypothesized proportions – *First-Person Shooter* and *Puzzle*

	Other RPGs (%Diff)	FPS (%Diff)	Puzzle (%Diff)	Board / Card (%Diff)	Hypothesized Proportion
Midnight – 6 a.m.	2.3% (-14.8%)	2.6% (-3.7%)	3.2% (18.5%)	1.7% (-37%)	2.7%
6 a.m. – Noon	3.7% (-48.6%)	3.8% (-47.2%)	16.7% (131.9%)	10.4% (44.4%)	7.2%
Noon – 6 p.m.	16.2% (-2.4%)	15.3% (-7.8%)	18.4% (10.8%)	17.9% (7.8%)	16.6%
6 p.m. – Midnight	44.2% (17.6%)	49.3% (31.1%)	25.2% (-33%)	30.5% (-18.9%)	37.6%
No Preference	33.6% (-6.7%)	29.1% (-19.2%)	36.5% (1.4%)	39.5% (9.7%)	36.0%
Chi-Square Statistic	13.60	28.65	68.62	14.83	N/A
p-value	.01	<.001	<.001	.01	N/A

Table 2: Time of Day Preferences (Observed vs. Hypothesized)

	FPS (%Diff)	Puzzle (%Diff)	Hypothesized Proportion
Midnight – 6 a.m.	2.3% (-12.1%)	2.6% (-0.6%)	2.6%
6 a.m. – Noon	7% (-27.5%)	17.4% (80.2%)	9.7%
Noon – 6 p.m.	17.5% (-8%)	20.3% (6.7%)	19%
6 p.m. – Midnight	51% (26.3%)	30.8% (-23.7%)	40.4%
No Preference	22.1% (-22%)	28.9% (2%)	28.3%
Chi-Square Test Statistic	21.75	36.06	N/A
p-value	<.001	<.001	N/A

Table 3: Time of Day Perceived Performance (Observed vs. Hypothesized)

games. Table 3 presents the observed percentages by day part for these genres.

Gamers believe they are less successful when playing *First-Person Shooter* from midnight to 6 a.m. and from 6 a.m. to noon compared to other genres. However, these genre players believe they are more successful when they game from 6 p.m. to midnight. They are also more likely to believe they are more successful when playing at certain day parts compared to other genres. For the *Puzzle* genre, players believe they were much more successful when playing the genre from 6 a.m. to noon, but much less successful from 6 p.m. to midnight compared to other genres. Again, gamers of either genre did not have strong feelings regarding their successfulness from noon to 6 p.m.

5 DISCUSSION

Overall, we find that there were some significant differences in preference across time of day, as well as perceived performance. We found that *Other RPGs* were especially preferred in the evening. *First-Person Shooter* games were also especially preferred in the evening. *Puzzle* and *Board / Card* showed an opposite trend, which were preferred instead in the morning, comparatively. Performance showed a similar trend for *First-Person Shooter* and *Puzzle* games, with *First-Person Shooter* players believing they performed best in the evening, whereas with *Puzzle* players a much greater proportion believed they would be successful in the morning, comparatively.

These results are interesting as it is possible to draw parallels with the time of day effects literature. Namely, because cognition has been shown to gradually decline over the course of the day (i.e., in part due to sleep pressure), it would make sense that *Puzzle* games would both be preferred and would be easier to perform highly at in the morning. *Board / Card* games, which are similarly cognitive in nature, show the same trend. On the other hand, *Other RPG* and *First-Person Shooter* games oftentimes require quicker reflexes and are faster in nature than *Puzzle* and *Board / Card* games. They may also be more likely to rely on muscle memory. As such, players prefer and may indeed be higher-performing in these genres, just as people have been shown to be higher performing at sports in the evening which coincides with higher core body temperature. It is extremely important to note, however, that overall, players still prefer to play games from 6 p.m. to midnight (perhaps because of cultural

norms and habits), and that the findings of significant differences are with respect to all game genres and all players on average.

Understanding time of day preferences and performance across video game genres would be helpful for game developers. For example, one can imagine that *Puzzle* or *Board / Card* games could be made more difficult when played in the morning (assuming the player was not awake all night), and that the difficulty could be lowered (or have more hint/tutorial facilities) during hours when cognition is likely not at its peak. Similarly, *First-Person Shooter* games could make the game easier (e.g., slower-reacting AI) during off-peak hours (i.e., not in the evening). We could also provide time-of-day-specific game recommendations on video game platforms (e.g. Steam) and websites. We could even adapt the gameplay itself depending on when players are playing, assuming that we find that certain game mechanics are more satisfying at certain times of day (e.g., increase the number of puzzle elements). Eventually, we may be able to infer how preferences for game genres (and more specifically, different game mechanics) fluctuate over the course of a day before a game is released, and build game affordances accordingly.

5.1 Limitations

One limitation of this study is that we were only able to ascertain “perceived performance” across game genres, and not actual performance. In order to more fully ascertain actual performance, a controlled laboratory study is needed. Another approach would be to use large-scale data from game companies which could provide corroborating evidence. Additional studies that control for the numerous factors (e.g., human activity patterns, social contexts of different games) related to time of day effects are needed. Nonetheless, these results can form the basis for future studies on this topic.

6 CONCLUSION

This is, to the best of our knowledge, the first study to directly study game genre and time of day preference or performance. This study provides a first step in finding inter-game-genre differences in both preference and perceived performance. These inter-genre differences have a basis in the literature, which has postulated that cognitive function gradually declines throughout the day, but that athletic performance peaks in the evening along with core body temperature. These results are an important first step in studying time of day effects and video games.

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