Time to Play?

Activity Engagement in Multiplayer Online Role-Playing Games

H. S. Mahmassani, R. B. Chen, Y. Huang, D. Williams, and N. Contractor

The online session behavior of users in a multiplayer online role playing game is examined. Three dimensions of online sessions are studied: frequency of sessions, distribution of start and stop times, and duration. These measures are modeled and examined econometrically to understand their relationships with attributes of the users and their avatars. Frequency is analyzed by using a negative binomial regression to uncover relationships with contributing factors, such as the experience level of players and the number of avatars per user account. Start and stop time distributions are examined aggregately with discrete choice models that capture the probability of starting a session in relation to the sociodemographics of users. Duration models are estimated by using data on the characteristics of events that occur within the duration and other user sociodemographics and player attributes. Since sessions are not explicitly indicated within the data set, sessions were stitched together on the basis of an assumed threshold for offline duration. Overall, these models and results provide insight into temporal characteristics of online sessions, including their aggregate traffic characteristics, such as frequency, headways, and duration length. These results also provide information on the nature of online game playing from a user perspective.

The Internet has had profound effects on many aspects of life and has transformed, in complex ways yet to be understood, the manner in which individuals go about activities normally pursued in the physical world, including work, shopping, maintenance, and leisure. These transformative effects have been more evident in some segments of the population than others, for example, youth for whom virtual social networking appears to be an essential component of overall social engagement, strongly intertwined with its physical counterpart. Although analysts have shed some light on the role of information and communication technologies for work-related activities, from both a work management perspective (*1–4*) and a travel or spatial location perspective (*5–7*), much less is known about the extent to which the virtual world has become an integral component of individuals' leisure time.

Game playing has been an important use of computers since the introduction of personal computers in the early 1980s. However, online multiplayer games gained popularity only with the advent of broadband Internet in homes. Although online gaming in its early forms (e.g., Oregon Trail) gained favor with hardcore computer users, involvement was limited to those with access to networking capabilities in the academic or software development environments. Near-ubiquitous residential broadband access has been accompanied by increasing engagement in online multiplayer games over the Internet, initially by the population segment most commonly associated with leisure seeking and technology adoption, that is, young males, and now by growing numbers of people from a much broader demographic base (*8, 9*). In addition to their evident gaming features (e.g., scoring points by winning or accomplishing certain milestones), online games have a distinct social interaction component that may be just as significant a motivation for participating in such activity. As such, the lines between social networking and online gaming have become more blurred, with social networking sites offering many gaming options (e.g., Mafia Wars on Facebook, the quintessential social networking site) and online gaming environments acquiring an identity and presence of their own for virtual socialization and even business transactions (e.g., Second Life).

Because so much time is spent by so many people in online gaming environments, and because of its particular significance to younger cohorts, characterizing the patterns of online gaming as an important activity in individuals' daily and weekly activity engagement patterns is a logical pursuit. The field of travel behavior has long recognized the integral connections among time use, activity engagement, and travel. As such, characterizing online gaming engagement will contribute to understanding how information and communication technologies are transforming individual time use and activity patterns in critical ways and contribute to improved analysis tools for transportation policy that recognize the importance of the virtual world in determining activity and travel behavior in the physical world.

A major obstacle to understanding engagement in online gaming activity is the difficulty of obtaining data on participation in these activities. Such information is not typically obtained in traditional travel and activity survey diaries, and reliance on self-reported information on this matter is unsupported—anecdotal evidence suggests that gamers are apt to either misperceive or underreport the amount of time spent in an online gaming environment (*10–12*). However, that these games are computer based means that an exact log of events and activities conducted by a player in the virtual gaming environment could be recorded directly. Such information would therefore be available to the entity (server) hosting the game, although it would of course be subject to strict privacy rules. The work presented in this paper is based on such data, obtained for a game called Everquest II, which is a popular multiuser online gaming environment with adherents across the world. A sample of event logs for this game formed the basis of the analysis of activity engagement conducted in this study.

H. S. Mahmassani and R. B. Chen, Transportation Center, Northwestern University, 600 Foster Street, Evanston, IL 60208-4055. Y. Huang and N. Contractor, Science of Networks in Communities (SONIC) Lab, Northwestern University, 2-133 Frances Searle Building, 2240 Campus Drive, Evanston, IL 60208-2952. D. Williams, University of Southern California, Suite 121E, 3502 Watt Way, Los Angeles, CA 90089-0281. Corresponding author: H. S. Mahmassani, masmah@northwestern.edu.

Transportation Research Record: Journal of the Transportation Research Board, No. 2157, Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 129–137.
DOI: 10.3141/2157-16

The primary aspects of online gaming engagement addressed in this study consist of the frequency, timing, and duration of virtual gaming spells, viewed over a weekly horizon. These provide a ready picture of the extent and significance of online gaming relative to an individual player's total activity pattern, including both weekday and weekend engagement. Additional insight into factors that determine such engagement, both intrinsic to the game itself as well as extrinsic attributes of the players, particularly age and gender, are provided. A foundation is set for examining the dynamics of game activity engagement by studying the extent to which individual engagement increases or decreases over time and the factors that help explain such engagement. To the authors' knowledge, this is the first analysis conducted from an activity participation perspective for any of the major online game environments.

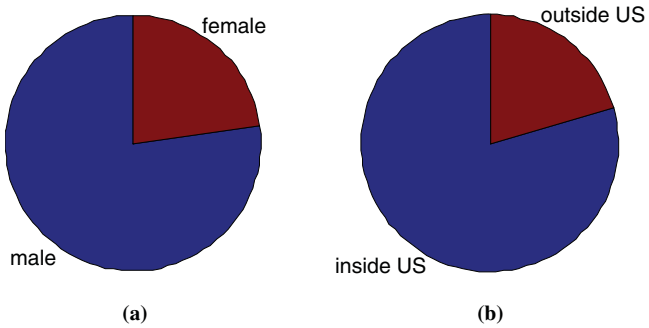


FIGURE 1 Distribution of (*a*) gender and (*b*) location of players.

DATA DESCRIPTION AND CONCEPTS

The data set consists of event logs for all players subscribing to the Everquest II game across four servers in 2006. Servers are located in Southern California and thus all time stamps are Pacific Standard Time. Event logs consists of the time stamp, location within the virtual world, and relevant characteristics of different event types within the game, ranging from economy-related activities, such as purchasing items, to death. For the purpose of this analysis, a sample of 750 individuals was drawn from the population of game players for the first week of August 2006. However, because of the need for the players' geographic locations to adjust for time zone differences, only 552 individuals were suitable for analysis. For each player, the time stamps of 12 of the most frequent types of events were analyzed to determine the online sessions of activity engagement of players. One activity carried out in the virtual environment does not necessarily correspond to one event in the log but possibly several. For example, the slaying of a monster may lead to an increase in experience points and at the same time may move the player to the next stage of a quest or to multistage tasks that require a sequence of events to be completed.

Since the start and finish of sessions or gaming spells are not directly recorded in the log, these are determined on the basis of an assumed threshold for offline periods, in which the duration of inactivity that exceeds this threshold indicates the player is offline. For this study, this threshold was assumed to be 20 min. Given the chronological ordering of events according to their time stamps, the time elapsed between events was determined for all events that occurred over the first week of August and compared against the 20-min threshold. Gaps that exceeded the assumed offline threshold (20 min) were considered offline durations, and the durations between offline durations were considered online session events, with a start time and duration. This method of reconstructing online sessions is called session stitching and has been used in other fields that examine the online sessions of players (*8, 13*). These studies used a similar threshold value. A look at the descriptive statistics of the player sample reveals some insight into the age range and sociodemographics of the players, as well as information regarding their avatars and accounts. The distribution of players according to gender and residential location is shown in Figure 1. Although, increasingly, a much broader demographic base engages in these games, players are predominantly male, at 82% of the sample, indicating that these games, or at least multiplayer online role-playing games, have reached a wider demographic but not yet to a significant level. Furthermore, 84% of the players in the sample reside in the United States. The location of players' residences has implications for the coordination of games among groups of players. If players are distributed globally, then coordinating efforts in the game, such as slaying major monsters, may be problematic.

Figure 2 shows the distribution of players for age, age of avatars, age of game accounts, and number of avatars each player has. The age range of players is 15 to 71 years. The figure shows that most of the players are in their 20s and 30s, suggesting that relatively few are teenagers or children who still attend school. This suggests that players may have rigid schedules; if jobs occupy most of the day, free time for these game activities would be found either after or before work. The age of the many of the avatars in the sample does not exceed 1 year. Compared to the age of the players' game accounts, which has a median value of about 2.1 years, the age of avatars is shorter overall. This suggests that many players associate multiple avatars with their accounts over time. This is important to the investigation of learning behaviors in the game. Although the observed avatars may have existed for a relatively short time, the player's account may span several years, suggesting these accumulated experiences would be reflected in the avatar. The number of avatars a player has at any one time ranges from one to 10 with one being the mode.

Overall these statistics are consistent with those from other online games. Two counterintuitive trends observed in this game and other games concern gender and mean age of players. Other studies have found that although females make up a minority of players, they are more intensive in their game playing relative to their male counterparts (*8*). Also, the mean age is counterintuitively around 35 years. One would expect that players for an online game would be younger. However, this further suggests that engagement in these games is not limited to the youth segment of the population (*9*).

EXPLORATORY ANALYSIS

This section presents an exploratory analysis of online gaming activity engagement and shows basic statistical summaries and tabulations of the key aspects of interest to the study. A total of 5,957 sessions were observed after the session-stitching process, described previously, was completed. This number reflects the exclusion of sessions for which the location of the player was unavailable and thus the start and stop times could not be adjusted for differences in time zone. The start and finish times of online sessions provide a measure of the number of sessions that start that could vary with the characteristics of the player and of the session itself. For example, individuals who work during the day are less likely to engage in online games for

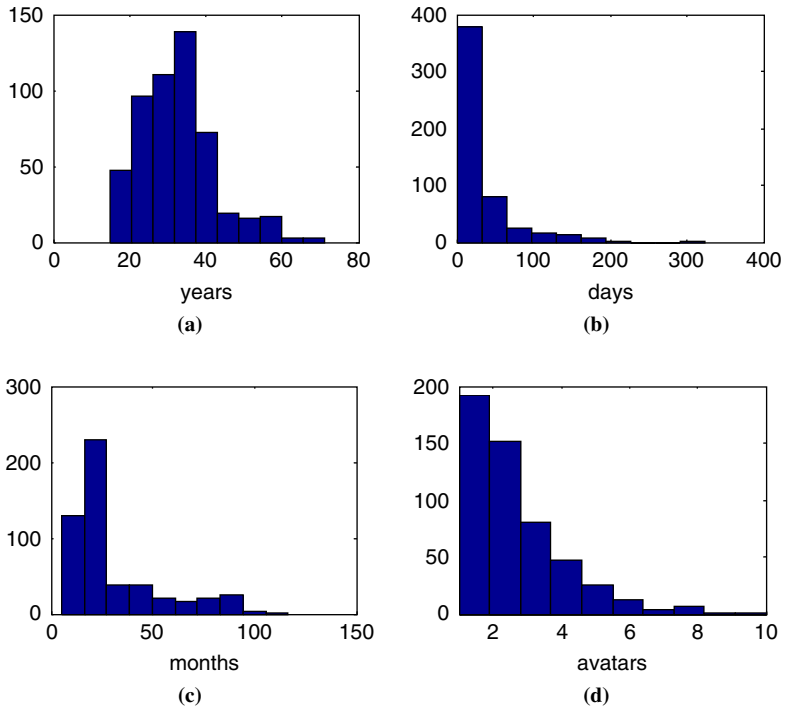


FIGURE 2 Distribution of players by (*a*) age of players (years), (*b*) age of avatar (days), (*c*) age of account (months), and (*d*) number of avatars.

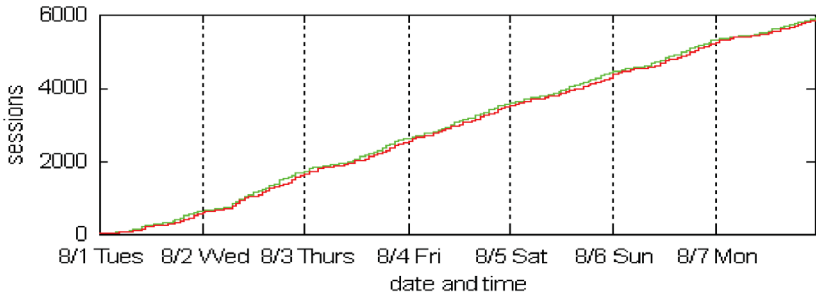
long durations. The number of sessions at a given time is important for systems management to ensure sufficient resources and capacity. For the users or players, information on the session start times of other players may be useful for activities that require networking or making social connections with other players. For online multiplayer role-playing games, some activities require the efforts of multiple players, and thus novice players who do not know many or any other players may try to be online to increase the likelihood of connecting with others. For travel behavior analysts, there is a need to understand and better position online game-playing activities with others, especially those involving multiple players or social networks.

The first characteristic examined is the cumulative number of users online in the virtual world environment over time. This provides a measure of the number of users playing the game over time and the number of sessions that begin relative to the number finishing. Figure 3 shows the cumulative number of session starts and stops for 1 week. A noticeable trend is that across all days, the total number of sessions starts out low in the first half of the day (12:00 midnight to 12:00 noon) and then rises sharply and decreases sharply after midnight. For Friday, Saturday, and Sunday this sharp rise occurs slightly earlier relative to the other days of the week. This is indicated in Figure 3*b,* where the number of sessions raises and falls cyclically over a week. Given that individuals typically sleep during first quarter of a day (12:00 midnight to 6:00 a.m.), this low period is reasonable. The shift in the sharp rise in sessions on the weekend could be explained by more free time for playing during the earlier part of the day, relative to weekdays. However, without information on the other activities in which players engage during the day, this cannot be known. This is indicated by the wider peaks on Friday, Saturday, and Sunday relative to other days, as indicated in Figure 3*b.*

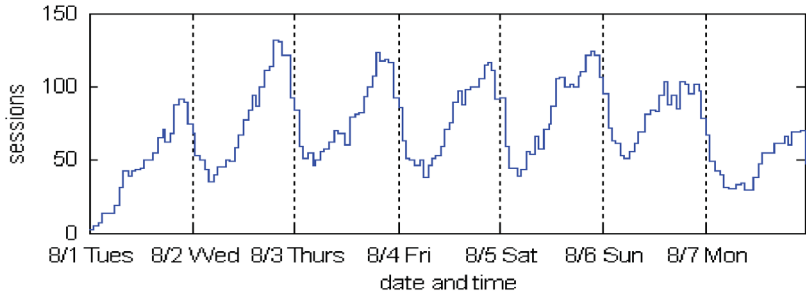
To characterize the choice of session start time, the percentage of players in the sample with start times falling within specific hours of the day are shown in Figure 4. The distribution of sessions start times reveals many characteristics of the relationship between the time of day and the decisions of users to start a session.

First, for all days of the week, there are more session starts in the later part of the day relative to the early part. This is also shown in Figure 3. A comparison of Friday to the other days shows a noticeable spike in the number of session starts in the middle of the day. A comparison of the weekend with weekdays shows more session starts between 10:00 a.m. and 3:00 p.m. on weekends relative to weekdays. These differences indicate possible differences for day of the week. More session starts in the middle part of weekend days may indicate that players have other mandatory activities during that time on weekdays, such as work, and thus show fewer observations between 10:00 a.m. and 3:00 p.m. The strong peak on Friday may indicate that players prefer to start playing during the afternoon relative to other periods of the day. Second, across all days, a midday peak occurs after 10:00 a.m. For Fridays, this is the top peak. Possible reasons range from playing during a break from mandatory activities, such as lunch breaks, to coordination with other players. However, without a closer examination of the characteristics of these users and of the sessions themselves, the motivations behind these session starts cannot be known.

The final characteristic examined in this exploratory analysis was the distribution of session durations across different hours of the day. Figure 5 shows the distribution of mean duration of the sessions starting in the corresponding times of day. First, the results indicate that the shortest durations occur in the morning period just before 10:00 a.m., except on weekends, when the shortest durations are sessions that start just after midnight. Second, the durations of



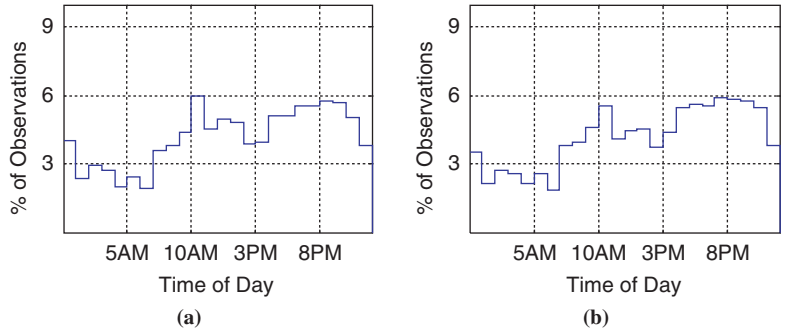
(a)



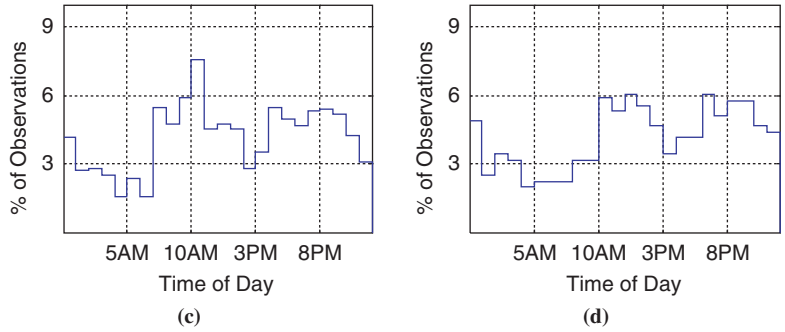
(b)

FIGURE 3 (*a*) Cumulative session starts and stops over 1 week and (*b*) number of sessions over time.

sessions started during Friday and the weekends are higher than those during the weekdays. The durations reach a peak of about 100 min on weekdays and about 150 min for other days. This is possibly because there is more free time to play these games on nonweekdays. A second curious characteristic of the mean session durations is that for Friday and weekdays, the sessions that start between 5:00 and 10:00 a.m. are the shortest, but on the weekends these sessions have some of the longest durations. A possible explanation for this is that players who start during these periods are pursuing activities that require more time, or perhaps these players enjoy playing the game for longer durations relative to players that start at other times.



(a) (b)



(c) (d)

FIGURE 4 Distribution of session start times (*a*) all days, (*b*) weekdays, (*c*) Fridays, and (*d*) weekends.

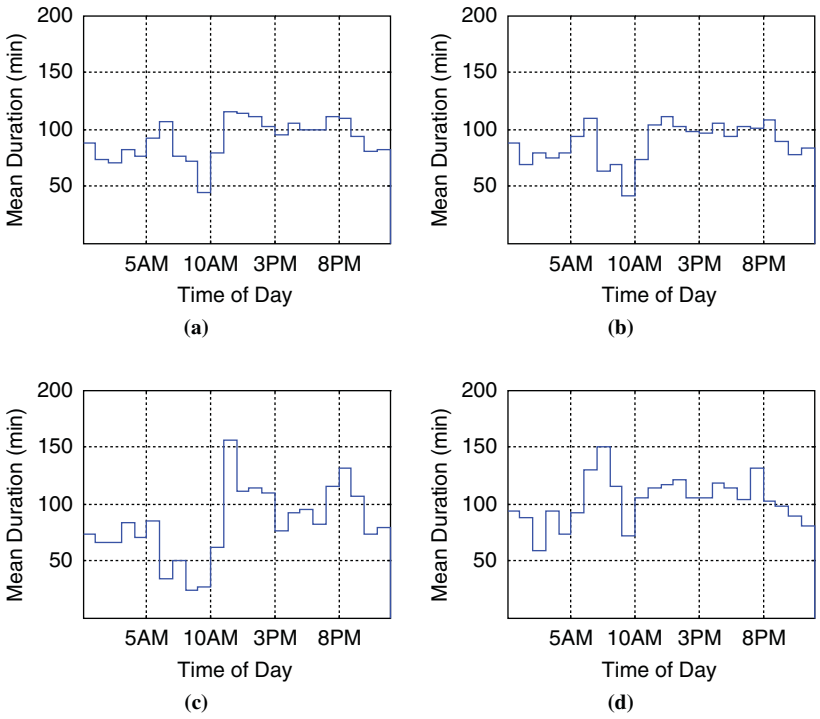


FIGURE 5 Distribution of mean session durations (*a*) all days, (*b*) weekdays, (*c*) Fridays, and (*d*) weekends.

Overall, the distribution of session start and stop times and the mean durations of sessions indicate that the level of players in the environment varies over time. This level is cyclical with low levels during the early parts of the day and rising levels later in the day. This appears to correspond well for common work and sleep schedules, in which players work during the day and sleep at the end of the day. For Fridays and weekends, this peak starts earlier relative to weekdays and lasts longer. In general, there are more session finishes in the early part of a day (after midnight) than in other parts.

A closer examination of the characteristics of users and sessions may reveal more insights about the players and their engagement frequencies, choice of start time, and durations. The next three sections examine the relationships among these characteristics of sessions, and the attributes of the players and their avatars or characters.

FREQUENCY OF ONLINE ACTIVITY ENGAGEMENT

The frequency of activity engagement is further examined by developing and estimating a negative binomial model that relates frequency to various attributes of the player, including experience level, sociodemographic characteristics, and attributes of the avatar, such as age. Frequency was measured in sessions per week. A negative binomial model was chosen to account for possible overdispersion where the mean is less than the variance (*14*). Overdispersion occurs for a variety of reasons related to the process generating the count data. The most common reason in many studies is that variables influencing the Poisson rate have been omitted. The estimation results for this model are shown in Table 1. All 688 sampled individuals were used in the estimation, since frequency does not require information on the time zones of the individuals. First, the overdispersion parameter is significant, indicating that the variance is larger than the mean. Second, the restricted log likelihood test suggests that the fitted model is better than the model with just the constant term. The McFadden pseudo *R*-squared value is 0.33, suggesting this model may not fit the data very well.

Overall the estimates indicate that the sociodemographics of the player have little significance with the frequency of engagement relative to attributes of the avatar and account. This is indicated by the low *t*-statistics for the indicator for residing in the United States, resulting in its being dropped. Playing frequency may have no relation to cultural differences. In general, as the age of the player increases, the propensity to engage in more-frequent playing decreases, although this parameter is not significant. As the age of the avatar increases, the propensity to more frequently engage in sessions increases, then decreases. There are several plausible explanations for this, such as the design of the game. In Everquest II, undoubtedly the tasks may become more involved, requiring more time, which may require all the budgeted game time from players. Players with young avatars may be faced with tasks that are easy and require less duration. Thus, these players can engage in the game more frequently

TABLE 1 Negative Binomial Model of Online Activity Engagement

Variable	Estimate	*t*-Statistic
Constant	2.4401	27.581
Age player (years)	–0.0051	–2.802
Age avatar (days)	0.0100	6.521
Age avatar[a] (115 days < age < 231 days)	–0.0077	–4.743
Age avatar[a] (age >231 days)	–0.0001	–2.455
Age account (days)	–0.0001	–1.906
Overdispersion parameter	0.4868	13.719

NOTE: Number of observations = 628; log likelihood (constants) = –2,147.258; log likelihood (convergence) = –2,115.803; and chi-squared = 2,127.608.
[a]Binary (1/0) variable.

within the budgeted game time. Alternatively, players with very skilled avatars may lose interest in the game and thus play less frequently. Both explanations are plausible but require further investigation into the dynamics of the player and avatar over time, to possibly distinguish how the two characteristics (player and avatar) interact and affect the frequency of engagement. As the age of a player's account increases, propensity to engage decreases. Similar to age of the avatar, a possible explanation is lack of interest from the player. However, closer examination of the motivations behind player perception of the game is required to fully address this question.

TIMING OF ACTIVITY SPELLS

The timing and duration of activity spells is then analyzed through specification and calibration of a "time of day for play" choice model, as well as a hazard-based model relating the duration of play sessions to various attributes of the player and his or her experience in this environment. A multinomial logit model form was used to estimate this choice. In the sample, the number of observations per person varied from one to several, if the person played the game several times a week. Not accounting for possible serial correlation may have implications on the coefficient estimates. Each player had a choice among eight periods for starting a session, the first period starting at 12:00 midnight and the last starting at 9:00 p.m. These results are shown in Table 2.

Period 8 (10:00 p.m. to 12:00 midnight) was used as the base or reference alternative. The results from the choice model reveal some important findings about the characteristics of the player and their choice of online session start time. First, with respect to age, only between 12:00 midnight and 12:00 noon do differences arise. Between 12:00 midnight and 6:00 a.m. there is a negative propensity toward playing the game for those age 36 years and older and between 3:00 a.m. and 6:00 a.m. for ages 25 to 35. This is shown in Tables 2 and 3; Table 3 shows the coefficient values across attributes across periods. This negative propensity is plausible given that most players would be sleeping between 12:00 midnight and 6:00 a.m. Also, the results show that this negative propensity starts earlier (12:00 midnight to 3:00 a.m.) for ages 36 and older, relative to other ages. Between 9:00 a.m. and 12:00 noon, players ages 36 and older are more likely to play relative to other ages, and between 6:00 and 9:00 a.m. ages 26 and older are more likely. Although normally players may have mandatory activities during these periods, such as work, players may be logging on during a lunch break. From Figure 4, it appears a large number of starts occur around 11:00 a.m. The results show that males are more likely to play during the late-night hours (12:00 midnight to 6:00 a.m.) compared to females. Estimates show that players residing in the United States have a strong propensity for playing in the early morning and a negative propensity for playing between 3:00 and 6:00 p.m. Overall, individual characteristics appear to matter less for periods after 12:00 noon for playing the game.

Fridays appear to positively affect playing between 12:00 midnight and 3:00 a.m. and between 6:00 a.m. and 12:00 noon. This is reasonable considering that many individuals do not need to work the next day, Saturday. The weekend positively affects playing throughout the day except the period between 3:00 and 6:00 p.m., which shows a negative sign. One reason is that individuals would rather spend their afternoons, whether on the weekend or a weekday, doing something besides playing the game. Also, nighttime in general appears to be a consistent period for playing regardless of day of the week.

TABLE 2 Choice of Start Time

Variable	Estimate	*t*-Statistic
Alternative Specific Constants		
Period 1	–0.6645	–4.613
Period 2	–1.1283	–6.402
Period 3	–1.3515	–8.942
Period 4	–0.0650	–1.162
Period 5	–0.1330	–2.360
Period 6	0.3096	3.382
Period 7	0.0314	0.414
Period 2 Variables	3:00 a.m.–5:00 a.m.	
Age 26–35 years (1/0)	–0.2154	–1.987
Age 36 years and older (1/0)	–0.3074	–3.294
Male (1/0)	0.1457	1.995
Reside in United States (1/0)	0.5137	4.684
Age avatar (days)	0.0352	7.395
Age avatar >30 days	–0.0234	–6.154
Age avatar >60 days	–0.0084	–3.694
Age account (days)	–0.0009	–4.648
Age account >2 years	0.0004	4.383
Period 4 Variables	9:00 a.m.–11:00 a.m.	
Age 36 years and older (1/0)	0.1464	1.826
Friday (1/0)	0.3370	4.220
Period 1 Variables	12:00 midnight–2:00 a.m.	
Age 36 years and older (1/0)	–0.3074	–3.294
Male (1/0)	0.1457	1.995
Weekend (1/0)	0.2640	2.866
Friday (1/0)	0.2640	2.866
Age avatar (days)	0.0352	7.395
Age avatar >30 days	–0.0234	–6.154
Age avatar >60 days	–0.0084	–3.694
Age account (days)	–0.0009	–4.648
Age account >2 years (days)	0.0004	4.383
Period 3 Variables	6:00 a.m.–8:00 a.m.	
Age 26 years and older	0.6050	5.037
Weekend (1/0)	–0.2391	–2.201
Friday (1/0)	0.3370	4.220
Reside in United States (1/0)	0.5137	4.684
Period 5 Variables	12:00 noon–2:00 p.m.	
Weekend (1/0)	0.2293	2.755
Period 6 Variables	3:00 p.m.–5:00 p.m.	
Weekend (1/0)	–0.2846	–3.171
Reside in United States (1/0)	–0.3240	–3.461
Period 7 Variables	6:00 p.m.–8:00 p.m.	
Male (1/0)	0.1457	1.995

NOTE: Number of observations = 524; log likelihood (constants) = –12,179.72; log likelihood (convergence) = –11,973.45; and rho-squared = 0.00989.

TABLE 3 Coefficient Values for Attributes Across Periods

Period	12:00 midnight–2:00 a.m. 1	3:00 a.m.–5:00 a.m. 2	6:00 a.m.–8:00 a.m. 3	9:00 a.m.–11:00 a.m. 4	12:00 noon–2:00 p.m. 5	3:00 p.m.–5:00 p.m. 6	6:00 p.m.–8:00 p.m. 7
Age 26–35 years		–0.2154	0.6050				
Age 36 years and older		–0.307		0.1464			
Male		0.1457					0.1457
Friday	0.2640			0.3370			
Weekend					0.2293	–0.2846	
Reside in United States			0.5137			–0.3240	

Overall, in relation to time of day for playing, nighttime and afternoon appear to be periods that are not strongly influenced by characteristics such as age. Only for the late-night period do players of different ages exhibit different propensities toward playing. This is reasonable considering that nighttime is typically free from work across all age groups and that more individuals do not sleep before 9:00 p.m. However, for the late night, depending on activities for the following day and on physiological reasons, players may vary in their playing. Some individuals need to sleep earlier relative to others. The results suggest that players older than 36 are less likely to stay up and play relative to players who are 26 to 35 years old. Fridays appear to show higher propensities only between 12:00 midnight and 12:00 noon, likely because players do not need to work the next day.

Another set of dimensions that provide insight into the time of day for playing is the age of the account and the avatar. These factors appear to influence choice only between 12:00 midnight and 6:00 a.m. The relationship between utility and age of the avatar and the account between 12:00 midnight and 6:00 a.m. is shown in Figure 6. The figure shows that the propensity for playing between 12:00 midnight and 6:00 a.m. increases with age of the avatar, but this rate decreases over time. Assuming that age is a measure of experience gained by the avatar, the results suggest that as players gain experience, they are more likely to play during late hours. This suggests that players with avatars with high experience levels tend to play late at night, possibly to coordinate with other players more easily. The age of the account, unlike the age of the avatar, is a measure of how long a player has been playing the game. A player may have an avatar with a low age but have an account that is many days old with multiple prior avatars. Figure 6 shows that the older an account, the less likely the player will play during late hours. A possible reason for this is loss of interest in the game over time. With lower interest, playing the game may not take much precedence during the late hours over other activities. This is similar to the negative coefficient for age of the account in the frequency model. Thus, over time players may lose interest and play the game less.

DURATION OF GAME ACTIVITY SPELLS

A duration model of game activity spells was estimated to show the relationship with characteristics of the player. These estimation results are shown in Table 4.

Two different parametric models were estimated to account for duration effects. The exponential model assumes a constant hazard function, and thus the probability of a gaming activity spell ending is independent of the time spent playing. For an exponential model, the distribution parameter in the hazard (P) is equal to 1.0. The Weibull model shows P to be very different from 1.0 statistically, so the exponential model is not valid. The positive value on P for the Weibull distribution indicates the hazard increases with increasing duration, meaning the player is more likely to exit the gaming activity spell as the duration increases.

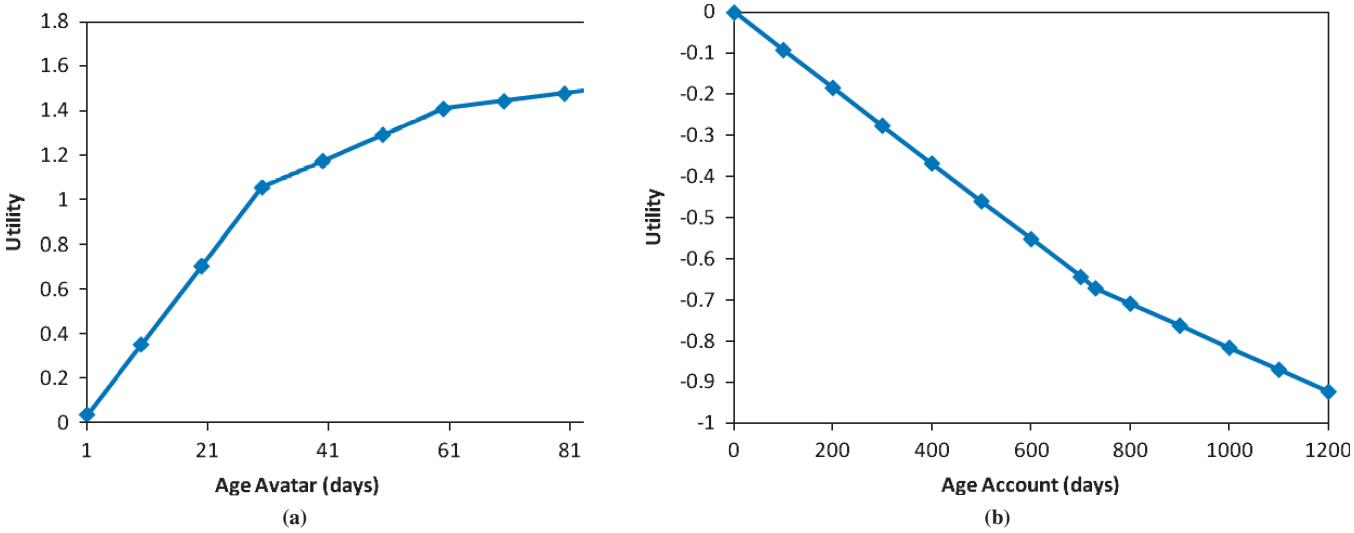


FIGURE 6 Relationship between utility and (*a*) age of avatar and (*b*) age of account, 12:00 midnight to 6:00 a.m.

TABLE 4 Hazard Function Parameter Estimates for Duration of Game Activity Spells

	Exponential		Weibull	
Parameter	Estimate	*t*-Statistic	Estimate	*t*-Statistic
Constant	8.5446	228.420	8.3096	111.009
FRIDAY (1/0)	–0.0559	–2.102	–0.1162	–2.194
WEEKEND (1/0)	0.1612	6.511	0.1804	3.625
LOC_US (1/0)	–0.1598	–5.421	–0.1701	–2.932
MALE (1/0)	0.1994	7.906	0.2186	4.278
Age 26–35 years (1/0)	0.0544	2.612	0.0652	1.559
Age account >2 years (1/0)	–0.1833	–8.122	–0.1944	–4.300
Age account >5 years (1/0)	–0.1411	–4.253	–0.1417	–2.138
Age avatar >1 month (1/0)	0.3007	11.658	0.3057	5.841
Age avatar >2 months (1/0)	–0.2237	–6.862	–0.2858	–4.418
P (distribution parameter)	1.0000	—	0.6824	84.975
Lambda	0.0002	18.000	0.0023	23.000
Log likelihood at convergence	–12,470.84		–11,674.69	
Log likelihood (constants)	–12,606.49		–11,749.39	
Number of observations (persons)	524		524	

The model estimates indicate that durations tend to be longer on Fridays and shorter on Saturday relative to other days. Given the results in Tables 2 and 3, this difference may be explained by considering the relationship between gaming activities with other activities. Tables 2 and 3 show a negative coefficient for playing during the afternoon on weekends. A possible explanation is that playing these games does not take precedence over other activities. Notice also that much of the game playing occurs at night, further suggesting that these games typically do not take a mandatory or priority role. The parameters for the duration model suggest that on the weekends durations are smaller, supporting the reasoning that given other activities and the time to pursue them, these gaming activity spells are adjusted for time of day and duration. However, further information on other activities the individual faces is needed to better understand this relationship. The estimation results also show that males tend to play shorter durations than do females. This is in line with other studies on the same data set that show that females who play these games tend to be more intense than their male counterparts, although statistically they are a minority (*8*).

Players with old accounts tend to play longer relative to players who just opened their accounts. Also, younger (less-experienced) avatars tend to play for shorter durations relative to more-experienced avatars. This may be because less-experienced characters or avatars have less-complicated tasks relative to more-experienced avatars that are further along in the game storyline. Individuals between 26 and 35 years old tend to play for shorter durations. Without knowledge of other activities in the players' schedules, the relationship of these durations to time budgeted for other activities cannot be fully investigated and determined.

CONCLUDING COMMENTS

Increasingly, members of all sociodemographic groups engage in online multiplayer games. This engagement is further encouraged by the popularity of online social networking, which has become ubiquitous in the daily activities of youth and adults. This study examined the behaviors of players in an online multiplayer game called Everquest II. The results of this study apply to this specific game and may not be generalized to all online multiplayer role-playing games. The results suggest that playing occurs mostly at night, and for late-night periods, the start of sessions varies with individual characteristics such as age. The results also show that day of the week plays a role, although without more information on other activities the reasons for these differences cannot be determined. The results show that engagement in these games is related to the experience of players. For example, players whose characters have more experience tend to play longer durations. Also players with very old accounts tend to play less frequently, possibly because of declining interest in the game.

In general, results suggest that engagement in these gaming activities is related to three factors: (*a*) attributes of the player, (*b*) attributes of the game, and (*c*) other activities in a person's activity schedule. The second factor adds a layer of complexity to study of these gaming activities. Players represent themselves in the game not directly but rather through an avatar or character that exists in the virtual environment. Thus to fully understand the behaviors of these players for the dimensions investigated in this study, a better representation is needed of the relationships among the player, his or her avatar, and the other activities of the players.

Studying the gaming activities of individuals is important to travel behavior, especially in the context of telecommunications. These games may be complementary to other online activities such that they trigger other activities that require trips, such as shopping or socializing with friends. An important attribute of these online games is that there is a social networking component that plays a vital role in the players' gaming experience. For example, some tasks, such as fighting monsters, require a group of players to be successful. Social networking components include guilds, which are similar to social clubs in the virtual environment. Thus, these online role-playing games are quickly becoming potential substitutes for socializing with other friends.

Although the data do not allow a complete profiling of who plays and how much, they contribute to an understanding of the significance of these activities to a broad cross section of the population that transcends popular stereotypes. Of course, one would also like to know a lot more about why people play these games and the different dimensions (recreation, social, skill, accomplishment, etc.) that such engagement fulfills for the individual players. In particular, the connection between activities performed virtually and those conducted in the physical world are of importance to researchers into travel behavior. Definitive conclusions on this aspect would require simultaneous (virtual and physical) data collection of a kind that is difficult to obtain by using purely passive means. Nonetheless, the insight obtained through analysis of the session logs about extent of frequency engagement, the timing and duration of such engagement, and its connection to characteristics of the player sheds light on this phenomenon of growing significance to society.

REFERENCES

1. Giuliano, G. Information Technology, Work Pattern and Intra-metropolitan Location: A Case Study. *Urban Studies* Vol. 35, No. 7, 1998, pp. 1077–1095.
2. Brewer, A. M., and D. Hensher. Distributed Work and Travel Behaviour: The Dynamics of Interactive Agency Choices Between Employers and Employees. *Transportation,* Vol. 27, No. 1, 2004, pp. 117–148.
3. Golob, T. F., and A. C. Regan. Impact of Information Technology on Personal Travel and Commercial Vehicle Operations: Research Challenges and Opportunities. *Transportation Research C,* Vol. 9, No. 2, 2001, pp. 87–121.
4. Mahmassani, H. S., J.-R. Yen, R. Herman, and M. Sullivan. Employee Attitudes and Stated Preferences Towards Telecommuting: An Exploratory Analysis. In *Transportation Research Record 1413,* TRB, National Research Council, Washington, D.C., 1993, pp. 31–41.
5. Mokhtarian, P. L., G. O. Collantes, and C. Gertz. Telecommuting, Residential Location, and Commute Distance Traveled: Evidence from State of California Employees. *Environment and Planning A,* Vol. 36, No. 10, 2004, pp. 1877–1897.
6. Mokhtarian, P. L. Telecommunications and Travel: The Case for Complementarity. *Journal of Industrial Ecology,* Vol. 6, No. 2, 2003, pp. 43–57.
7. Gould, J., and T. F. Golob. Consumer E-Commerce, Virtual Accessibility and Sustainable Transport. In *Social Change and Sustainable Transport* (W. R. Black and P. Nijkamp eds.), Indiana University Press, Bloomington, 2002.
8. Huang, Y., M. Zhu, J. Wang, N. Pathak, C. Shen, B. Keegan, D. Williams, and N. Contractor. The Formation of Task-Oriented Groups: Exploring Combat Activities in Online Games. *Proc., IEEE SocialCom-09,* Vancouver, British Columbia, Canada, 2009.
9. Williams, D., N. Martins, M. Consalvo, and J. Ivory. The Virtual Census: Representations of Gender, Race and Age in Video Games. *New Media and Society,* Vol. 11, No. 5, 2009, pp. 815–834.
10. Tychsen, A., M. Hitchens, and A. Drachen. Modeling and Analyzing Time in Multiplayer and Massively Multiplayer Games. *Games and Culture,* Vol. 4, No. 2, 2009, pp. 170–201.
11. Williams, D., N. Yee, and S. Caplan. Who Plays, How Much, and Why? Debunking the Stereotypical Gamer Profile. *Journal of Computer Mediated Communication* Vol. 13, No. 4, 2008, pp. 993–1018.
12. Chambers, C., W.-C. Feng, S. Sahu, and D. Saha. Measurement-Based Characterization of a Collection of On-Line Games. *Proc., Internet Measurement Conference,* 2005, pp. 1–14.
13. Huang, Y., C. Shen, D. Williams, and N. Contractor. Virtually There: The Role of Proximity and Homophily in Virtual World Networks. *Proc., IEEE SocialCom-09,* Vancouver, British Columbia, Canada, 2009.
14. Greene, W. H. *Econometric Analysis,* 5th ed., Prentice-Hall, Englewood Cliffs, N.J., 2003.

The Telecommunications and Travel Behavior Committee peer-reviewed this paper.