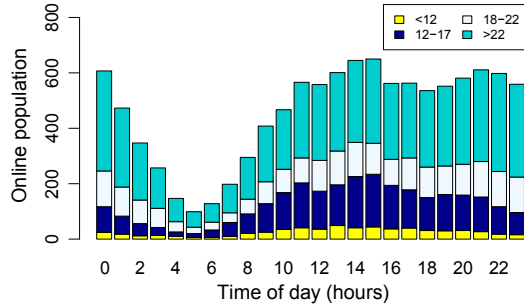


(a) Player gender



(b) Player age

Figure 6: Hourly fluctuations in the online population.

window containing consecutive actions of an avatar separated by no more than ten minutes.¹

For each hour of a day, we could then identify how many avatars and players were active. Figure 6 displays the number of active players from a random day within the trace period. The plot is divided to show the pattern of the gender and the age of active players. The number is the smallest around 5AM, while it is the largest around 8–9PM. There was no particular gender-specific pattern ($p>0.1$). Age-wise, we see an increase (from 21.0% to 31.8%) in the activity of players aged 4 to 16 between June and August, which corresponds to the summer vacation in Taiwan.

The second measure, the number of avatars owned, also indicates the activity of gamers. Figure 7 shows the number of avatars per player. The distribution is skewed, meaning that the majority of players own a small number of avatars, whereas some players own more than 10 avatars. In fact, 74.7% of players owned no more than 4 avatars. We find that gender does not play a role in determining the number of avatars owned ($p>0.1$).

4.2 Prevalence of Gender-Swapping

Players are free to choose the gender of their avatars, resulting in the phenomenon of gender swapping [10]. Here, we present the prevalence of gender swapping in Fairyland Online and its correlation with certain demographical features.

First we see that over a third of players owned at least one gender-swapped avatar. Table 1 shows that female players are more likely to own gender-swapped avatars than male players ($p<0.001$). This is consistent with past research that a sizable fraction of players swap genders, and females tend to do so more than males [37].

¹The data reveals that nearly all (98.4%) of consecutive actions are separated by less than one hour.

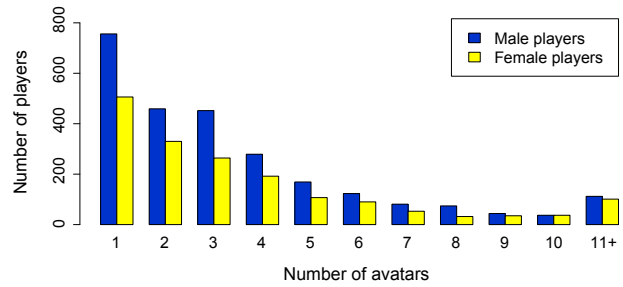


Figure 7: The distribution of the number of avatars owned by each player. The distribution is right-skewed.

Region	Male player	Female player	Total
Urban	675 (37.4%)	537 (35.9%)	1212 (40.7%)
Rural	282 (44.6%)	254 (36.0%)	536 (35.6%)
Total	957 (37.0%)	791 (45.3%)	1748 (40.3%)

Table 1: The number and the fraction of players (against the total) with gender-swapped avatar(s) in the urban and the rural areas of Taiwan.

The geographical location, living in urban or rural regions, was found not to be correlated with gender swapping ($p>0.1$).

We then analyzed gender swapping tendencies and the number of avatars owned. Figure 8 shows the prevalence of gender-swapping as a function of the player age and the number of avatars owned. It shows the gender-swapping ratio, defined as the number of gender-swapped avatars divided by the total number of avatars owned. The upper plot in Figure 8 shows that older players are more likely to swap genders than younger players. The bottom plot in Figure 8 shows that the number of avatars has a positive correlation with the ratio of gender swapping. The prevalence of gender swapping among the older and more experienced players suggests that there may be intriguing behavioral motivations and patterns, which we discuss in the subsequent section.

4.3 Summary

In this section we examined the demographic features of players to understand which offline and online traits correlated with gender swapping. We found that gender-swapping ratios were independent of where people live and when they played the game. The ratios, however, showed a strong correlation with players’ age and how active they were. The fact that older players swapped genders more often means that gender swapping may reflect some mature psychological aspects. That the gender-swapping ratio was higher for players with more avatars may indicate that experienced players know the benefits of gender swapping.

5. EFFECT OF GENDER SWAPPING ON IN-GAME BEHAVIOR

To understand how gender swapping impacts a player’s behavior, we study four major activities of Fairyland Online: avatar levels, private communication, friendship formation and preservation, and trade. Among these, avatars’ game levels represent personal achievements and progress, while the latter three represent social actions. For each of these, we verify the extent to which behaviors of gender swappers deviate from those of non-swappers. We introduce the following notation for the four player-gender combinations, the “gender tuple”:

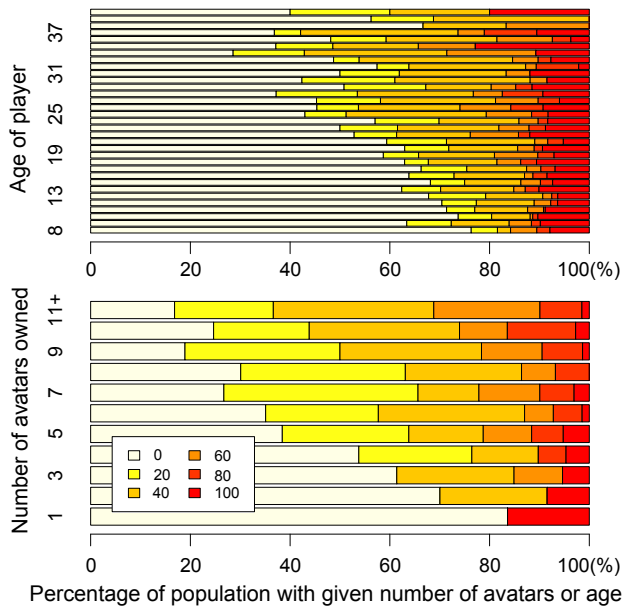


Figure 8: The dependence of the fraction of gender-swapped avatars owned by a player on players’ age and the total number of avatars owned.

$A.B$ = Player of gender A controlling avatar of gender B .

For instance, $M.M$ and $M.F$ indicate a male playing as a male and a female avatar, respectively.

5.1 Levels: Individual Achievements

Avatar levels represent the measure of personal development and progress in a game that is often the primary objective of gamers in an MMORPG [13, 36]. A higher level is obtained when players complete missions successfully and collect enough points. Primarily the avatar level indicates the player’s skill and the time they have put into the game. We asked, does gender swapping give the player any advantage in attaining higher levels?

To see the impact of gender swapping on game levels, we studied game players who have played with avatars of both genders, ignoring all other players who own avatars that are of one gender. This left us with 1,386 players. Among those, we extracted the highest levels of their male and female avatars (as they may own multiple avatars with the same gender). We then calculated the level difference between one’s highest-level male and female avatars, plotted in Figure 9. For females (upper panel), their strongest female avatars’ level tends to be slightly higher than that of their strongest male avatars’ level and vice versa (lower panel), indicating that more players achieved the highest levels with their “straight” avatars. The peaks are close to zero, indicating that for many players the difference is rather minute.

While this may seem to indicate that gender swapping correlates negatively with avatar levels and in practice is not particularly advantageous, Figure 9 is likely biased as players spend varying amounts of time with different avatars, which is the strongest indicator of one’s level. We find, in fact, that in Fairyland Online players are prone to playing longer with avatars of the same gender as their own. To quantify the effect, we examined the rate at which users leveled up with and without gender swapping. Figure 10 shows the relationship between the final avatar level and the total time played in Fairyland Online for the four different gen-

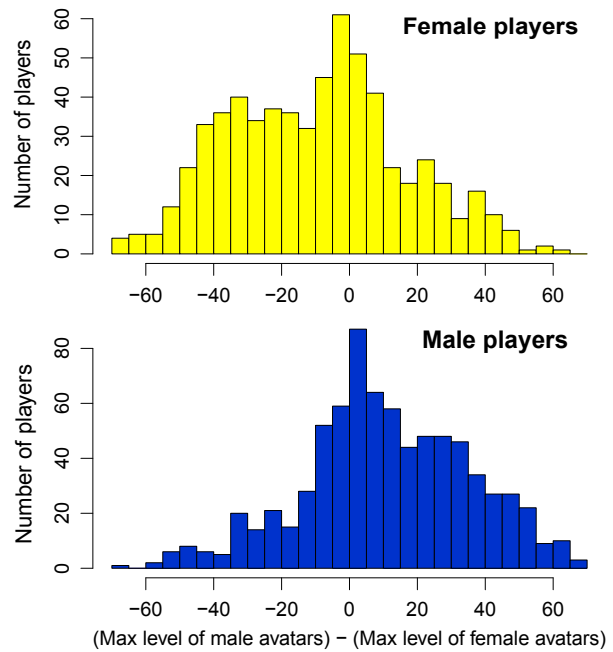


Figure 9: The difference in male and female avatar levels, for female (top) and male (bottom) players.

der tuples for the 1,386 players. Here the x -axis is the final avatar level, and the y -axis is the total amount of time played by the avatar (starting at level 1).

From Figure 10 we can make the following three observations. Firstly, leveling up takes an increasing amount of time as one’s level rises (seen from the shape of the curve). This is a common feature of many games that incorporate the level system. Secondly, male players level up more quickly than female players. To verify this, we computed the total time played until one reaches a given level, and inferred the average time spent at each level. We then tested if there was any meaningful difference in the average time spent between the male and female players at each level using the Kolmogorov-Smirnov (K-S) test. We found sufficient evidence to support that the two average time distributions are different ($D=0.0611$ and $p<0.01$). This is also in line with previous study that male players are more efficient “achievers” in the virtual world than female players [36]. Thirdly, both male and female players achieve a given level more quickly via a male avatar than via a female avatar. This finding is especially intriguing for female players, because this suggests a concrete benefit of gender swapping. For instance, $F.F$ players (i.e., female players logged on with female avatars) played on average 19.24 hours more to reach level 50 than $F.M$ players. We again used the K-S test and confirmed meaningful difference between $F.F$ and $F.M$ players ($D=0.1824$ and $p<0.001$). Since the gender of an avatar is a cosmetic factor with no difference in abilities in Fairyland Online, this means that female players exhibit a rather drastic transformation into male-like aggressive, achievement-oriented characteristic when pretending as a male avatar [8].

5.2 Whisper: Private One-to-One Messaging

Here and in the two subsequent sections we study user-to-user interactions. The first one is “Whisper”, a private one-to-one communication function. While players can whisper to any user in the

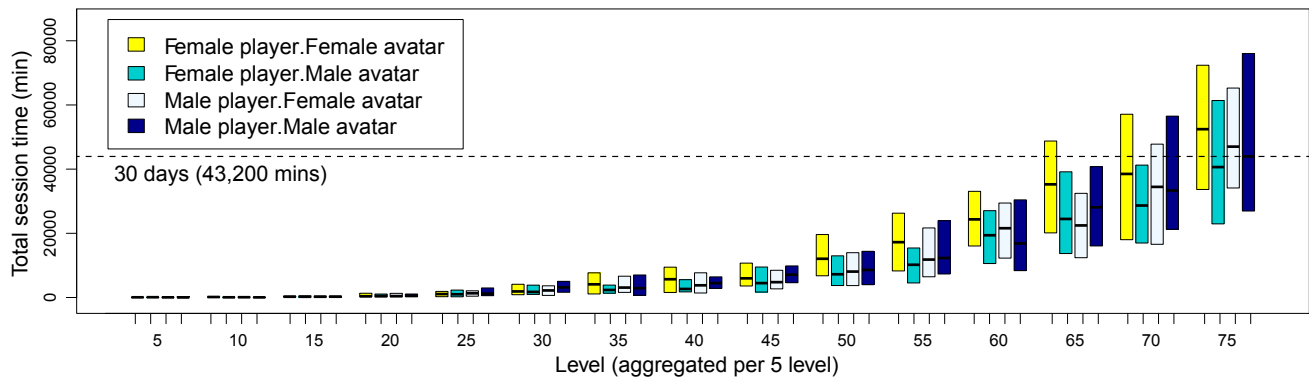


Figure 10: The total session time played as an avatar, as a function of the final avatar level shown for all four player-avatar gender combinations.

game, the messages are revealed to the sender and the receiver only, as opposed to public broadcast. Whispering thus can reveal the patterns of affinity between users.

In order to determine the effect of gender in whispering, we examined the probability that a given user of type $A.B$ sends whispers to another user of type $A'.B'$ from the entire data. Since whisper interaction is directional, there are 16 possible gender combinations ($A.B \rightarrow A'.B'$). For comparison, we also computed its null values, the expected probability of whisper when we assume that the sender of a whisper selects its receiver at random regardless of their gender combination, by randomly matching 10,000 pairs of avatars in the network.

Table 2 displays the magnification factor of the probability of whisper (i.e., the real probability divided by its random expectation). Therefore a value larger than 1.0 (marked in bold) indicates that the whispers occurred more frequently than expected. The table shows a trend where a whisper is likelier to take place between avatars of different genders, whichever the players' genders are. For instance, a male player with a male avatar ($M.M$) is 1.26 to 1.34 times likelier to send a whisper message to a female avatar (both $M.F$ and $F.F$) than expected by chance. In contrast, the probability dropped roughly by a third to a half when the other player had a male avatar ($M.M$ or $F.M$), irrespective of the true gender of the other player.

Despite this interesting trend we may need to take caution, as whisper does not necessarily imply a substantial relationship; since one can send a whisper to any random player, some whispers may only be a failed, unreciprocated attempt to strike up a real, substantive conversation. Hence to find patterns of a sustained, concrete conversation that took place for some measurable time, we chose and focused on all avatar pairs that exchanged no less than 35 whispers in total, of which there were 36,820 avatar pairs. As they were reciprocated whisper pairs, we ignored the sender-receiver relationship, and examined how the gender configurations affected the length of the conversation, presuming that a longer conversation meant a more substantial relationship.

We compared the duration of conversations between three types of player pairs: female and female, female and male, and male and male. When we considered all conversations (involving at least one whisper message), we found that the median and the mean durations were 3.1 minutes and 33.7 minutes, respectively. The large discrepancy between the two indicates a possible right-skewed distribution of conversations (e.g., certain conversations lasting several hours or more). Looking at the 36,820 pairs (with 35 whispers

		Receiver type			
		$M.M$	$M.F$	$F.M$	$F.F$
Sender type	$M.M$	0.64	1.34	0.50	1.26
	$M.F$	1.30	0.76	1.07	0.59
	$F.M$	0.51	1.18	0.83	1.99
	$F.F$	1.25	0.57	2.09	0.87

Table 2: The frequency of whispers divided by random expectation across all possible gender tuples.

or more), we found that the median and the mean duration were 32.6 minutes and 125.9 minutes, respectively.

In Figure 11 we show the relative duration of the long conversations for the different types of player gender pairs. We normalized the duration so that the highest bar is 100. For each player pair type, we show two bars: one where the avatar genders are the same and another where avatar genders are opposite. The figure shows that players engage in a lengthier conversation when their avatars are of different genders regardless of the true genders of the players. In fact, the conversation duration increased 1.62- to 1.77-fold when the avatars were of the opposite sex. Controlling for avatar genders, we also find that conversation involving a female player lasts longer. This supports a well-established notion that females tend to socialize more actively than male players do in online games [17].

5.3 Friendship: Sustained social ties

The next interaction we analyze is friendship. In Fairyland Online, each avatar maintains a “friend list” of other avatars. Unlike whisper, a friendship tie is bidirectional in that both avatars must agree to be friends. Once friends, users can easily locate and contact each other inside the virtual world. We examine whether gender swapping affects the chance of people becoming friends.

To compute the effect of avatar gender on the chance of forming a friendship tie between different avatars, we first note that there are 10 possible gender configurations in a bidirectional link (player1.avatar1 and player2.avatar2). Then we count all friendship links between gender types, and compare it with the randomly expected number of friendship links without considering genders. The resulting magnification factor (i.e., observed frequencies divided by random expectation) are shown in Table 3. The table is symmetric, as friendship is bidirectional. The larger-than-expected pair types (the values larger than 1.0) are marked in bold.

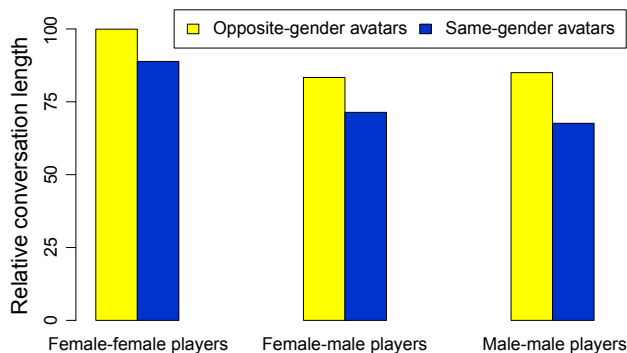


Figure 11: Duration of long whispers (i.e., conversations).

	<i>M.M</i>	<i>M.F</i>	<i>F.M</i>	<i>F.F</i>
<i>M.M</i>	1.03	1.08	0.82	0.97
<i>M.F</i>	-	1.07	0.84	0.77
<i>F.M</i>	-	-	1.08	1.26
<i>F.F</i>	-	-	-	1.23

Table 3: The prevalence of friendship divided by random expectations across all possible gender tuples.

The table shows a higher probability of friendship formation between the same-gendered players, so that a male player is likelier to befriend another male player than a female player, and vice versa. Interestingly, controlling for player genders, we found that the players were slightly likelier to form a friendship tie when their avatars had opposite genders. For instance, two female players were 1.26 times more likely to become friends with each other when their avatars differed than when they did not. Since players are not told of the real gender of other players and can only see the avatar gender, this appears to indicate the possibility that a subconscious, implicit selection process may be at work [26]. The pattern of people being linked more often when they are of the same gender but of different avatar genders was observed also in the whisper network.

5.4 Trade: Exchange and Sales of Items

Lastly, we study the patterns of Trade, namely the exchange and sales of items. The economic activity of item acquisition and currency transfer is a staple of MMORPGs, as players need various items to strengthen, heal, or embellish their avatars. Since items are often directly related to one’s performance, trade is a highly strategic activity and can incur other activities as its precursor or aftermath: private conversations often precede trading and social ties can be formed afterwards [26]. Highly valuable items can fetch such a high price that some players become serious businessmen dedicated to item acquisition and sales, often making a handsome sum of real money by selling them online or offline [31].

We investigate whether a player’s or an avatar’s gender has any impact on trade. Fairyland Online provides a wide variety of items for use and trade. Furthermore, some items are indispensable in that players need those items to qualify for a level-up (a Fairyland Online-specific example would be a bunny required at a certain level that can be lured with a particular herb). All these needs are motivations for trade, which can take a form of item-to-item bartering or straight-up sale for gold.

Our data contain all trading interactions, allowing us to observe details of the trade activities including the item traded and its price.

To see the relation with gender, we first extracted the most traded items during the ten-month observational period and built a list of its market value (price), the median gold fetched in sales. We intentionally omitted bartering (item-for-item) because the market value of an item was difficult to determine from such data. Table 4 shows the five most traded items along with their median market prices.

We then examined the frequency of trade and the price of each item between different gender combinations. For simplicity, we examined the average selling and buying prices that the items fetched from trades between the four gender combinations (*M.M*, *M.F*, *F.M*, and *F.F*). The difference between the two, i.e., the average selling price *minus* the average buying price, would be the expected monetary gain for the selling player. The net gains calculated in this fashion are also shown in Table 4.

We find a few interesting patterns regarding trade in Table 4. First, the selling and the buying prices can vary widely depending on the player’s gender as well as that of the avatar: for instance, Healing Potion is sold at a higher price when the seller is a *F.F* than when they are *F.M*, even though the real player gender is the same. Second, focusing only on significant net gains (defined to be exhibiting more than a 5% gain over the median market price), we find that female players in general make better, more profitable salespeople than males do. When we control for the player gender, we also saw that female avatars were likelier to succeed in profiting from trade than male avatars. This could imply that male players benefit through gender swapping in trades.

We also tracked select items, which revealed to us some interesting potential mechanisms of price determination. The Healing Potion, for instance, is a popular item among players who were warriors or enjoyed combats, i.e., usually male avatars. Hence, such “achievers” may be willing to buy them above market price if they need to. Then their willingness could be exploited by those who do not need the item, for instance female avatars who are more of the “socializer.” This could be a plausible explanation for the sizable discrepancies in the expected net gain of Healing Potion between *F.F* and *F.M*, as we saw also in other contexts that female players become drastically aggressive and masculine when controlling a male avatar. A similar dynamic might apply to other items as well, although many other factors may well be at play that need further examination.

5.5 Summary

In this section, we investigated how peoples’ behaviors change when they swap genders of the avatars they control. Our major findings include that male players achieve higher levels faster than females in general, but female players also do so when they play with male avatars; and players tend to whisper more to opposite gender avatars, but they are likelier to become friends with players of the same gender. Our study also showed that female avatars in many cases profited from trade than male avatars did. The fact that many items were sold at different prices for the male and female avatars at statistically significant levels may imply an intricate relationship between the traded items and avatar genders.

Since there are no built-in capability differences in male and female avatars, the fact that we observe significant behavioral changes implies that people act according to the perception or the image of the gender that they are playing and of the gender of the interacting players. Therefore there may also be advantages in gender swapping, not innate but derived from people’s subjective perception and the resulting responses, leading to the intriguing differences in the behavior patterns [17].






Item	Item name	Description	Market price (median)	Expected transaction gain (sell – buy)			
				<i>F.F</i>	<i>F.M</i>	<i>M.F</i>	<i>M.M</i>
	Healing Potion	Used after combat	1137.5	125.0	-100.0	-133.0	66.6
	Blood Circulator	Used for fast regeneration	959.5	160.7	-34.5	25.0	-100.0
	Iron Ingot	Used for smithing	125	91.3	-17.5	36.8	0.01
	Apple Cider	Used for quests	416.6	-83.3	-200.0	41.6	0.0
	Cotton	Used for making yarn	40.3	152.5	17.5	-154.8	-8.3

Table 4: Five most traded items with their median bartered market price in gold. The expected transaction gains (net profit) are also shown. Gains that exceed the market value by more than 5% points are marked in bold.

6. IMPLICATIONS

In this paper, we have examined the gender swapping behavior in MMORPG. Through several key interaction patterns, we found that male players act and get treated more like a female when playing with a female avatar (e.g., chatted for a longer period of time, enjoyed increased affinity by other *M.M* players, traded items at a higher price), and vice versa for female players. Our major findings on how gender roles and identity are associated with avatars (rather than players) suggest several interesting applications, of which two major ones are:

- *Bot detection.* As the business model of MMORPGs is subscription-based and requires the players to commit substantial amounts of time, the level of realism expected by the users is very high. The proliferation of ‘bots,’ automatons controlled by computer AI, is widely accepted as the most serious threat to an MMORPG’s success. Bots lack the ability to interact with other players in any interesting manner all the while helping their masters (deployers) with an undeserved advantage by performing repetitive, menial tasks such as resource harvesting without break. Thus bots damage the realism of the game and the game balance required to maintain human players’ interests, and detecting them is an urgent matter. Bot detection often works by “weeding out” in-game avatars that lack the complexity and nuance shown by true humans. The richness of intriguing human behavior that we witnessed when we factored in gender suggests that gender could also be a useful parameter in detecting bots [23].
- *Online identity fraud detection.* Our findings here could also be potentially useful in detecting online identity fraud [12], which can sometimes result in a serious damage, either financially or physically [2]. As one’s true identity is easily hidden online—in this context, the gender and age would be the most prone to be lied about—from a conversation partner and needs to be deduced from personal behavioral patterns only, the user behaviors of gender-swapped players as reported here could assist in building profiles of potential criminals.

Similar to detecting bots and fraud, detection of malicious users and other types of potential criminals (sybils and cheaters) is often conducted by analyzing user behaviors in many web services [9, 30, 34]. Our study can produce valuable insights in this regard.

7. CONCLUSION

In this paper, we studied the issue of gender in large-scale MMORPG social interaction networks, and investigated an interesting problem in human behavioral research called *gender swap-*

ping. While there have been some past studies on the issue, they were based on uncontrolled online opinion surveys, which could have been subject to self-selection bias. Unlike the previous works, we used the complete interaction and profile data of the players from Fairyland Online, thereby easily overcoming the limitations of self-selection bias and small scale. We searched for intriguing patterns of social behavior that were potentially correlated with gender swapping, and found several significant trends in conversation, friendship formation, and economic behavior.

Our biggest finding was that (a) gender swapping is prevalent across player gender and age, and it becomes more prevalent with the players’ age, experience, and activity; (b) while in an online setting people try to make friends with the opposite sex, they turn out to be of the same gender in real life, indicating that assuming an alternative identity does not completely mask the real persona; (c) female players tend to act more masculine and achievement-oriented when acting as a male than actual males do; and (d) people’s personalities and strategies (such as when trading for items or gold) depend on their assumed identities, an example being that female avatars, regardless of the player’s real gender, appear more successful at trade.

With these interesting findings, we believe we have demonstrated the potential of massive user data sets from MMORPGs in studying intriguing and important human psychology and behavior. Free of self-selection bias and limitations of scale, we were able to make two novel observations that had not been shown in previous studies: one is that both male and female players tend to talk more with avatars of the opposite gender; two players tend to become friends with others whose real gender is the same as one’s own even though they only know the virtual gender of others.

We foresee multiple interesting avenues for taking our research further, as our ability to observe human behavior and analyze them ever improve both online and offline. Here we propose two possible examples. First, a natural extension of our work would be to consider more types of user interactions including many-to-many interactions, i.e., group dynamics, which can be significantly more complex than one-to-one interactions that we studied here. Since a main attraction of MMORPGs can in fact be found in group activities, exploring how gender affects such interactions would be a necessary next step. Second, if we could define and retrieve even more details of the interactions—the content of a conversation, for instance—there would be an exponential development in how we analyze and understand the full complexity of human social behavior. One example usage of the conversation data would be a study of the role of verbal cues and gender identities, as it is believed that verbal cues can be instrumental in revealing a person’s identity, and we would find many applications of the lessons learned from how gender swappers change their language patterns.

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