Is a "Friend" a Friend? Investigating the Structure of Friendship Networks in Virtual Worlds

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Abstract
In this paper, we examine online friendships at a network level. We focus on three structural signatures: network size, balance (triangles), and age homophily in the friendship ego-networks of 30 users of the virtual world Second Life. In relation to previous findings from studies of offline friendship networks, our results reveal that online networks are similar in age-homophily, but significantly different in size and balance.

Keywords
Social Network Analysis, Virtual Worlds, Second Life, Friendship

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Theory

Introduction
Most researchers agree that the Internet is a highly social medium. Although research shows that users more commonly use the Internet to communicate with

friends that they first met in the real-world [2, 6], making new friends online is not uncommon. Katz and Rice [8] note that 16% of respondents of their recent survey report having made at least one friend online, amounting to approximately 25 million new Internet-based friendships in the US alone.

There has already been a fair amount of work comparing online and offline friendships [4, 11, 12]. However, much of it focuses on friendship at the individual or dyad level and little research has examined online friendship at a network level. This is a potentially problematic gap. From studies of offline friendship, we know that individuals have difficulty reflecting on the structure or influence of their own friendship networks, so self-reports offer little insight into the characteristics of online friendships at a network level [3]

Therefore, the goal of this work-in-progress is to build upon existing literature that compares online and offline friendships at an individual or dyad level, and offer preliminary insight into how online and offline friendships compare at a network level. Specifically, we look at the structural signatures of friendship networks among users of the virtual world Second Life (SL), and compare those signatures to patterns that have previously been observed in offline friendship networks. Although our data do not allow us to make direct comparisons of the online and offline networks of the same people, we can explore whether online networks in our sample contain the structural signatures that we would expect to find, based on previous studies of offline friendship networks.

Friendship Network Structures

For this work-in-progress, we focus our comparison of online and offline friendship networks on three structural signatures: network size, balance, and age homophily. All three of these structural signatures have been found to vary by age group, with adolescents', adults', and older adults' networks showing different patterns. By comparing whether structures in the online networks of users in these three age groups follow the patterns that have been observed in offline friendship networks, we will be able to begin to draw conclusions about whether, at a network level, online friendships map to offline friendships.

The first structural signature we examine is network size. Studies of offline friendship networks have found that, on average, adolescents tend to have between three and five friends [7]. Then, network size tends to increase into adulthood, with adults reporting an average of 7.6 friends [9]. This figure remains fairly stable until older adulthood when a variety of lifestyle changes, including retirement, causes a decline in overall network size to an average of five to six friends [7]. Using this overall pattern as a benchmark for comparing online and offline friendship networks, we would expect online network size to be smallest for older adults, largest for younger adults, and in the middle for adolescents. Therefore, we hypothesize:

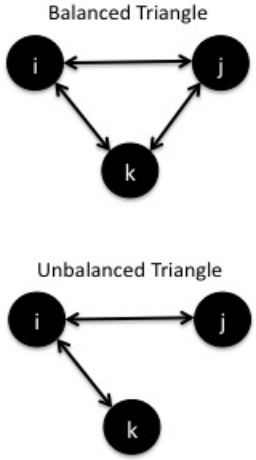

Figure 1. Balanced and unbalanced triangles.

H1. Among the three age groups studied, **(a)** adults will have the largest ego-networks; **(b)** adolescents will have the second largest ego-networks; and **(c)** older adults will have the smallest ego-networks

The second structural feature that we use to compare online and offline friendship networks is balance. One way to measure balance in a network is to look for the presence of triangles, where *i* is friends with *j, j* is friends with *k,* and *k* is friends with *i* (see Figure 1). Research on offline friendship networks suggests that adolescents do not like to participate in unbalanced friendships and may be more likely than either younger or older adults to terminate a friendship that is unbalanced [5]. Therefore, in online friendship networks we expect,

H2. The ego-networks of adolescents will have a higher proportion of triangles than either the ego-networks of adults or older adults.

The final structural feature that we use to compare online and offline networks is age homophily. Studies of offline friendship have found that adolescents have a strong tendency to form friendships with others of the same age, typically within a year or less of their own age. This preference diminishes over time with adults commonly reporting close friends who are, on average, around 6 years younger or older, and older adults showing a significant tendency to connect with friends who are several decades younger than themselves [10]. Therefore, in online friendship networks, we would expect to find:

H3. Among the three age groups studied, **(a)** adolescents will have the most age-homophilous ego-networks; **(b)** adults will be next most age-homophilous ego-networks; and, **(c)** older adults will be least age-homophilous networks.

Methods

Data. This research uses data gathered in the Fall of 2007 from computer logs of the user activity in the virtual world Second Life (SL). In SL, users interact with one another via avatars and can socialize, join groups, own land, and build a wide range of objects. Users can also designate other users as "friends;" which affords a variety of privileges including being able to easily contact one another, see one another online, locate one another in SL, and use one another's virtual possessions, depending on the level of friendship access granted. For this paper, we considered someone a member of a friendship network as long as they were designated as a "friend," regardless of the level of access granted.

In total, there are 9,962,359 SL users in our dataset, however, for this analysis we focused only on users who have at least two designated "friends," to ensure that it would be possible to observe the presence of triangles. From the 1,169,023 users who have at least two friends, we further limited the data set to only users who reported ages between 13 (the minimum age required to be in SL) and 100 years old. Age is self-reported at the time of registration, and users are allowed to enter any 4 digits they want to represent the year of their birth. So, some ages reported by users in our data set were implausible (-200 years old, or 4999 years old, for example). Because our analyses depended on more-or-less accurate age comparisons, we excluded users with implausible ages.

Table 1. Network Size by Age Group

	Mean	St. Dev	Median
Adolescents	215.2	209.18	128.5
Adults	25	40.83	7
Older Adults	29.4	46.84	15.5

F = 7.4253 (p < 0.01)

From the remaining 1,147,988 users, we sampled ego networks (sampled user and that user's friends) of 10 users from the each of the following ages (total n = 30 networks): 13-14 years old (adolescents), 29-30 years old (adults), and 55+ years old (older adults). These ages correspond to the ages typically studied in the offline friendship network literature, with the "adult" age representing the mean age in the dataset. The resulting dataset included 30 networks comprised of 2,696 users (2,224 unique users). Of course, because they were self-reported, we cannot be sure that the ages reported by the users in our sample reflect their actual (real-world) ages. However, the age distribution from our data (M = 29, SD = 9.8) is similar to distributions found in other studies of virtual world users, including Yee [14] (M = 26.5, SD = 9.1) and Williams [13] (M= 31.2, SD = 9.7). Therefore, there is a reasonable expectation that the reported ages of the users in our sample are accurate.

Analysis. Network data were imported into UCINet [1], which was used to calculate network size and percentage of triangles (actual number of triangles observed/total number of possible triangles). The mean of each of these measures for each age group was calculated and compared using ANOVAs and post-hoc Tukey-Kramer tests in JMP.

Age homophily was tested by creating a mean age differential score for each ego-network. This score was created by taking the mean of the absolute values of the age differences between each ego and each of his/her friends. The mean age differential for each age group was calculated and compared using ANOVA and post-hoc Tukey-Kramer tests in JMP.

Results

H1 (a-c) proposed that older adults in our sample would have the smallest networks, adolescents would have the second largest ego-networks, and younger adults would have the largest networks. The data in Table 1 show that, overall, users have more friends online than offline. Further, on average, adolescents tend to have the largest online friendship networks. Post-hoc tests reveal that adolescents' networks are significantly larger than either adults (p = 0.0062) or older adults (p = 0.0075), who tend to have networks of similar size (p = 0.9966). Therefore, H1 was not supported. Instead, a nearly opposite trend was revealed – adolescents have the largest networks and younger and older adults have substantially smaller networks.

There are several possible explanations for these results. First, by SL's grid design, adolescents in our sample occupy a different part of SL than adults. There may be structural differences between the Main Grid (for adults 18+) and the Teen Grid (for adolescents 13-17) that make adolescents more likely to add friends in SL. For instance, the Teen Grid is geographically smaller than the Main Grid, and so it may be easier to find other users to be friends with.

Alternatively, the trend may suggest some kind of social or developmental difference between children and adults with regard to online friendship. Perhaps, in contrast to trends observed offline, adolescents are better-equipped or more motivated to make online friendships than their adult counterparts. This is an area for future research.

Table 2. Proportion of Triangles by Age Group

Age Group	Mean	St. Dev.
Adolescents	0.29	0.11
Adults	0.56	0.3
Older Adults	0.51	0.28

F = 3.3873 (p = 0.0487)

Table 3. Mean Age Differential by Age Group

Age Group	Mean (years)	St. Dev.
Adolescents	1.63	2.7
Adults	7.93	10.56
Older Adults	25.29	22.67

F =2432.084 (p < 0.0001)

H2 proposed that adolescents' networks would have a higher proportion of triangles than either adults' or older adults' networks. Table 2, shows that, overall, adolescents' have a significantly lower proportion of triangles in their networks than adults or older adults. However, post-hoc Tukey-Kramer tests reveal only a marginally significant difference between than adolescents' and adults' networks (p = 0.0557), and no difference between adolescents' and older adults' networks (p = 0.1257) or adults' and older adults' networks (p = 0.9137). Therefore H2 was not supported, and as with network size, the observed effect was opposite of the predicted effect. Once again, it is possible that this difference is an artifact of SL's design, or sign of a social or developmental difference between children and adults online, both of which are directions for future research.

H3 (a-c) proposed that adolescents would have the most age-homophilous networks, adults next-most age-homophilous networks, and older adults least age-homophilous networks. Results in Table 3 show that, on average, adolescents in SL are separated in age from their friends by about one and a half years, adults by close to 8 years, and older adults by just over 25 years. Therefore, H3 (a-c) was supported.

What is especially interesting about this result is that the age differentials for each group are very similar to age differentials reported in the offline friendship network literature (adolescents = less than one year, adults = 6 years, older adults = 20+ years [10]). This can be partially explained by structural constraints of SL, where teens occupy an age-restricted portion of the world for 13-17 year olds, so it is not possible for them to make friends who are more than three years older or younger. However, adults and older adults are free to make friends with any users who are 18+. So, it is not immediately clear why their age differentials would be so similar to those found in the offline world, especially given that Second Life and the offline world have different constraints on who individuals meet and interact with. This is an area for future research, perhaps best addressed through qualitative interviews with users to identify if they are actively choosing friends of specific ages, or if there is some structural constraint driving this pattern that we are unaware of.

Discussion

Based on the results reported here, it appears that online friendships may be somewhat, but not entirely, similar to offline friendships at a network level. In SL, unlike in the offline world, adolescents tend to have larger, less balanced networks than either younger or older adults. However, age differentials between adolescents, adults, older adults and their friends tend to follow a pattern that is more-or-less similar to the offline world. These results suggest that friendships in SL may bear some resemblance to friendships in the offline world at a network level, although it is not clear whether these similarities emerge because of users' friend preferences, or because of some structural constraint in the design of SL that is driving friendship choices. Further, we should be cautious about over-generalizing the similarity between online and offline networks, because they are significantly different along several important network parameters.

As with any exploratory study, these results should be interpreted with caution. In future research, we hope to confirm the trends observed here by increasing the sample size and studying larger networks. In addition,

using data from other virtual worlds, we plan to investigate whether the patterns observed here apply only to SL, or to online friendships more generally. However, despite these limitations, our results represent an important first step towards understanding how well online friendships map to offline friendships at a network level.

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