



Longitudinal gender and age bias in a prominent amateur new media community

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Abstract

Despite early hopes that the internet would facilitate more socially equitable communication, many age-old forms of discrimination appear to have been preserved. Men are routinely aggressive towards women, experienced users harass newcomers, and young people dominate new social and entertainment media. The current study statistically examines peer scoring and reviewing behavior by over 300,000 users of a prominent new media website over a seven-year period in terms of the gender and age of the users. Findings support previous research on male bias online as well as reveal a complex age hierarchy with gender interactions, which became rather homogeneous over time for all users except older males.

Keywords

age, amateur, art, gender, multilevel modeling, new media, participation, social media

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Introduction

Growing percentages of internet users post information and interact with others online. Online communities, in the general sense of online populations or community groups, in particular, have become a dominant part of contemporary culture and are rapidly growing (Caverlee and Webb, 2008). In many of these online communities, individuals come together to share information, engage in new forms of social interaction, play games, and carry out business, among other things. Individuals who meet in these digital environments communicate with each other primarily through some form of computer-mediated communication (CMC: Luther and Bruckman, 2008). While many forums are free and open to anyone with internet access, socially equitable outcomes for participants cannot be guaranteed.

Research has shown that the conversation styles of men and women differ (Tannen, 1994). Also, gender is associated with online experiences and behavior in these communities (Stefano and Lackaff, 2009). Such differences, which may lead to cross-gender misunderstandings, may discourage some women from participating. Nonetheless, the proportion of women on the internet has continually increased and has become nearly equal to that of men (Fallows, 2005; Losh, 2009).

Additionally, acknowledgment and recognition from others for online contributions made by men and women differ. Spender (1989) found that a higher value is often placed on work by men than on comparable contributions by women. Similarly, Wajcman argued that 'Qualities associated with manliness are almost everywhere more highly regarded than those thought of as womanly' (Wajcman, 1991: 11). The belief that men's contributions are desirable or admirable, whereas similar work by women is regarded as negative or repressible, is referred to by Coates (1986) as the 'Androcentric Rule'. More recently, Herring et al. (2004) also found that content produced by adult males and circulated to members of online communities may be given preferential treatment by the community, in comparison to content produced by other demographic groups. While technologies and women's participation levels have changed, recent research shows that gender does not disappear when the interactions move online. Kendall's (2002) research on *BlueSky* suggests that those who participate in that virtual community bring offline expectations and understandings that shape online interactions. In her later reflections about community and the internet, Kendall (2010) argues that her experiences with the *BlueSky* participants support earlier findings on the influence of gender in online interactions.

Some have recognized that access and use are different things. Hargittai (2002) found evidence of what she calls a 'second-level digital divide', meaning that internet access does not equal technological skill. In other words, computer literacy and online fluency may impact the way that individuals use the internet. Further evidence suggests that these online patterns also vary by age, with young people being singled out as prolific users.

This article complements earlier corpus linguistic work exploring the relationship between the media genres and social network structures of Newgrounds.com (denoted NewgroundsTM: Paolillo et al., 2007, 2010), a prominent amateur Adobe FlashTM animator community launched on 6 April 2000 (NewgroundsTM, 2007a). Combining preference data from user profiles with a content analysis of amateur movies, those studies

found that latent dimensions of movies' stylistic features were correlated with social network cliques made up of collaborative authors and their fans. The cliques often used features in their movies for purposes of group identification, solidarity, and rivalry.

The present study explores this complex and largely uncharted community from a different perspective. Irrespective of group memberships or artistic techniques, which may be peculiar to this website, it takes individuals as the unit of analysis. We ask the following general sociological questions, which are pertinent to any large new media site: how do community members' participation behaviors relate to their gender and age? Does participation in sites such as this involve the same gender and age dynamics as on the Web at large? Also, much of the previous literature is cross-sectional, studying online participation only in terms of samples of different people at different points in time. The current study will answer these important questions through a seven-year longitudinal analysis of public user profiles and movie reviews posted on the site, dating back to the site's inception.

Literature review

Gender and online participation

In the early days of the internet and online discussion forums, the rhetoric suggested that these would be egalitarian spaces (Danet, 1998; Herring, 2003). Drawing from the CMC literature, specifically media richness theory (Daft and Lengel, 1984), text-based media have been considered 'media poor' forms of communication in that they lack physical and auditory cues (Short et al., 1976). Nonetheless, the assumption was that fewer cues would render demographic characteristics, including age and gender, both irrelevant and invisible (e.g. Kiesler and Sproull, 1992); words and ideas would be evaluated on their merit alone.

Gender schema theory (Bem, 1981, 1994) suggests that individuals learn how culture and society define the roles of males and females. Based on this internalized knowledge, individuals assume traits they deem suitable for their gender. Because of these socially constructed roles, gendered communication styles and behaviors found offline tend to also appear online (Gefen and Ridings, 2005). While there was hope that the internet would enable men and women to participate equally in discussions, the reality was that women were largely either not present or inactive. Subsequent research found that participants in online forums were primarily adult, Caucasian males who spoke English and were tech-savvy (Herring, 1992; Royal, 2008).

With the introduction of the web and graphical browsers, however, the gender balance on the internet began to shift. By 2000, the internet population was evenly divided (Department of Commerce, 2002; Fallows, 2005). More recently, while the proportion of men and women who go online is similar, the type of use has been shown to vary. According to a Pew Internet and American Life report (Fallows, 2005), men are more likely to participate in online community groups. Men are also more likely to use the internet for entertainment and recreation (cf. Leung, 2001). In contrast, women are more likely to use the Web to communicate with others and to expand their social networks (Boneva et al., 2001; Fallows, 2005; Jackson et al., 2001; Leung, 2001).

Nonetheless, Kennedy et al. (2003) contend that, generally throughout history, men have limited and dominated women's technological experiences. Similar research has found that women participating in these spaces have encountered considerable negative feedback from men, including: deception, harassment, obnoxious behavior, sexism, and other forms of 'Net abuse' (Dibbell, 1993; Kennedy, 2000; Spertus, 1996; Van Gelder, 1996). In environments such as online chats and discussion groups, these antics have led to a drop in women's participation. In 2000, the participation rate for women in these forums was 28 percent, dropping to 17 percent in 2005 (Fallows, 2005). While the presence of factors such as discrimination may have negatively influenced women's online participation levels in the past, these attitudes and behaviors may be changing. In fact, the overall number of internet users is high and rapidly increasing, especially for young people (Madden, 2006).

Age and gendered internet use

Gender is not the only factor to consider when examining internet use. The age of the user has also been associated with both internet access and the propensity to pursue different personal goals online (Loges and Jung, 2001). For example, today's young men and women are considered to be technologically savvy (Oblinger and Oblinger, 2005; Prensky, 2001). Not surprisingly, these individuals, particularly from ages 18–29, are prolific creators of online content. For example, the average age of vloggers (i.e. bloggers who use video as the communication medium) investigated by Molyneaux et al. (2008: 4) was 23. In addition to uploading content, this group is also the most active in posting ratings and comments (Madden, 2007). Although only a small percentage (19%) of video viewers rate and comment on this type of content, viewers in the 18–29 age range were twice as likely to do so, compared with individuals between 30 and 49 (Madden, 2007: 7).

Video-sharing communities and Newgrounds™

Newgrounds™ has become a central place on the web for amateur Flash artists to share and develop their styles and techniques. At the center of the community's activity is a hosting service for amateur animations, which serves as a space for user ratings and comments.

According to Newgrounds™ creator Tom Fulp, young males aged 14–22 are the most typical users (Wei, 2006). Kendall (2007, 2008a) discovered that teenage boys and young men are most often the creators of animations on Newgrounds™. Luther and Bruckman (2008), who analyzed forum threads and held interviews with animators on Newgrounds™, similarly found all studied animators to be male, despite the fact that those who participated in that study represented a range of nationalities, experiences (novice to expert), and ages (16–29).

While Newgrounds™ has been in existence for almost 10 years, similar sites, such as YouTube™, launched in February 2005, are relatively new to the video sharing scene (Alexa™, 2009). Technological advances, such as the increased speed of internet connections, are somewhat responsible for the recent proliferation of online video sharing.

Hence, topics associated with video-sharing sites are recent additions to discussions related to Web 2.0 technologies, though they are quickly becoming central. Much research on these sites, including work examining user demographics, is in a nascent stage.

Video-sharing sites form a diverse cultural milieu of online self-expression and socialization. With greater bandwidth, easy-to-use software, and inexpensive equipment have come the formation of new subcultures with members dedicated to the production and consumption of amateur digital creations across many specialized sites. YouTube™, for example, began by facilitating webcam-like personal videos and re-editing of professional videos. Newgrounds™ and similar amateur art-oriented sites resemble Bauhaus environments, where artists can come together, develop techniques and sub-genres within common artistic media, and receive feedback from peers and fans.

Investigations done of these sites have typically provided snapshots at particular moments in time. For example, Molyneaux et al. (2008) explored the gender divide on YouTube™, and found that gender differences do impact the creation and reception of video blogs (vlogs) on that site. Whereas men posted 58 percent of videos, women posted only 33 percent, though the gender of the remaining 9 percent were indeterminable. Videos uploaded by men also received higher ratings, and men contributed almost 27 percent more comments (Molyneaux et al., 2008: 9).

Other research examined antagonistic behavior, and reactions to it, in videos on YouTube™. One group at the center of Lange's (2007) YouTube™ research were deemed 'haters'. Instead of offering constructive criticism, 'haters' posted cruel comments and severe feedback. Posting to this online community requires a certain level of maturity, in order to deal with such antagonism, which many individuals apparently accepted. However, some appear to have been intimidated by the 'haters' behavior, which negatively impacted their participation. As Lange asserts, 'severe feedback at extremely early stages [of participation] risks choking off experimentation, learning, and personal expression' (Lange, 2007: 24).

Irrespective of gender and age, there is also previous evidence of an aggressive environment on Newgrounds™. Besides the obviously violent themes of many of the animations, Kendall (2002) found evidence of members hazing and harassing newcomers. This echoes the more general literature (e.g. Lange, 2007), that new users are especially susceptible to criticism. Later research also found that some of the site's subgroups do not have positive relationships with each other (Kendall, 2008b; Paolillo et al., 2007, 2010).

Even so, the overall number of people going online to view and upload video content is growing at a rapid pace (Percell, 2010). Therefore, it is important to recognize that demographics – age as well as gender – may impact participation differently in different online environments. For these reasons, Newgrounds™ is an important community to explore.

Research questions

Studies examining online communities must choose variables that capture notions of participation, gender, and age appropriately in context. Among these, participation is

difficult to operationalize. More common in the CMC literature are studies defining participation in terms of review behavior rather than video posts. This is perhaps because reviewing is often intended as an act of interpersonal communication, and online video-sharing communities typically produce more reviews of videos than actual videos (e.g. Newgrounds™ users produce an average seven reviews for every one video). Given that an analysis of video posts would substantially lengthen the current article, the focus here is on reviewing behavior. Gender and age can be studied on Newgrounds™ using either user profile data or qualitative analysis of textual cues. As the current study is quantitative, user profile data were employed.

Hence, two research questions emerge. First, do users' participation behaviors relate to their genders and ages over time? Second, do any relationships that exist follow the trends seen in the literature for the internet at large?

Method

Population

Between 2000 and 2007, Newgrounds™ became one of the internet's largest new media portals, indexing over a million user accounts and 400,000 animations (Newgrounds™, 2007b, 2007c), as well as reporting over 500,000 unique visitors per day (Newgrounds™, 2007a).

The current study ends with a period of transition for Newgrounds™. Beginning in 2005, the site lost membership to corporate competitors, such as YouTube™ (cf. 'Descriptive results' in Results, Figure 4). To compete, Newgrounds™ initiated what the site's proprietors called 'The Great Redesign', which went live on 16 July 2007 (Newgrounds™, 2010). The current project's sample includes records created on the site between April 2000 and 19 March 2007, before the re-design initiative had become public. Hence, this article represents Newgrounds™' initial period of success.

Instruments

Every animated movie had its own webpage identifying: title, posting date, description, authors' usernames, number of reviews received to date, one recent review, and other movies by those authors. Associated pages listed archived reviews, including: reviewer's username, review date, a comment, and a score. Posting movies and reviews required account registration, with every account automatically receiving an empty profile/dossier page. Specifiable demographic characteristics comprised: gender (male, female, or unspecified), age (13–80 years), location, occupation, and school, with the last three being textboxes. The site's association of usernames with participation facilitated joining participation instances with demographics.

For this study, movie review scores and counts of reviews, both per day and to date, were the primary indicators of review behavior. Though the textual information provided in reviews and profiles would require content analysis beyond this project's scope, user locations were visualized using Global Positioning System (GPS) coordinates.

Procedures

Two datasets were obtained, parsed, and joined for this project, namely: an exhaustive sample of profile pages, and a large random+snowball sample of movie homepages and associated archived reviews. Data analysis involved standard descriptive statistics and multilevel modeling of the longitudinal data.

All 1.14 million user profiles on the site were downloaded between 14 and 19 March 2007, using the GNU Linux `wget` utility (Nikšić, 1996). Also, from 12 February to 20 March 2007, the home and review pages of 10,000 (an arbitrary large number) randomly sampled movies were collected and used as seeds for a ‘snowball’ sample, whereby all other home and review pages by those same authors and collaborators were iteratively collected. A sample of 292,881 unique movie pages by 147,926 unique authors resulted. Serial number indexing in page URLs facilitated sampling. Finally, the fact that this study downloaded the site’s archived reviews, from 2000–2007, diminished the importance of the particular collection date.

The site’s Terms of Use (Newgrounds™, 2007e) and `robots.txt` (Newgrounds™, 2007d) files were consulted for downloading restrictions. Downloads were required not to proceed ‘in a manner that sends more request messages to the Newgrounds™ servers in a given period of time than a human can reasonably produce in the same period by using a convention [sic] on-line web browser’ (Newgrounds™, 2007e). Also, no access restrictions were placed on the directories containing the data used for this study, and profile data were required to be anonymized. `Wget`’s parameters were set to respect the speed restriction, and no personally identifiable user information will be distributed in association with this study.

Automated parsing of the unstructured HTML pages (i.e. screen scraping) was required. The POSIX `grep`, `sed`, and `awk` utilities (IEEE, 2008), as well as several custom Java programs for capturing complex patterns in the webpage texts, were used. The scripts were developed by manually viewing their output for errors, checking the parsing quality of random pages, modifying the programs, and repeating until no errors were found. Only 307,150 profiles contained valid user information, with the rest having been deleted by either the user or an administrator. Of reviews, 2,032,534 were parsed.

For joining the data, SQL programming as well as the POSIX `join`, `sort`, and `cut` utilities (IEEE, 2008) were employed. Multilevel modeling, described at the end of this section, requires a person-period dataset, where second-level variables are listed in temporal order, nested within first-level variables (Singer and Willett, 2003: 16–23). For example, for each author, there are potentially multiple reviews, which are from oldest to newest, with each row containing: date, author’s and reviewers’ age and gender, and score. Finally, Julian Day Numbers (JDNs), a decimal date measure common in astronomy, were used to encode dates, because the Gregorian calendar’s irregularities add unnecessary complexity to statistical models. JDNs also possess a default precision (days) fitting the present study’s data, and can easily be converted back to Gregorian.

For visualizing locations, 1000 random locations were parsed from the profiles, cleaned of unreal locations, geocoded with Google™ (Google™, n.d.), and plotted with GPS Visualizer (Schneider, n.d.). Approximately one-half (564 of 1000) were actual locations;



Figure 1. Visualized random sample of user locations

Source: Created by GPSVisualizer.com (Schneider, n.d.). Reproduced by permission.

46,726 locations existed in all the profiles. Therefore, using ratio cross-multiplication, there were perhaps fewer than 30,000 actual location observations available.

To analyze these variables' associations and change over time with reviews, multi-level modeling was used, because review behavior is 'nested within' the perspectives of reviewers, authors, or movies. The levels of scores and review counts are suspected to be caused by socio-demographic processes. A linear functional form was chosen for this study's models, because a random sample of ordinary least squares (OLS) plots of individual users' change trajectories showed this to be appropriate. However, OLS is inadequate for modeling the entire dataset, because of the nested data structure (Singer and Willett, 2003: 84–85). The analyses employed the nlme and lme4 R packages (Bates and Sarkar, 2007; Pinheiro et al., 2007; R Development Core Team, 2009).

Results

Descriptive results

Figure 1 visualizes the random sample of user locations discussed in the previous section. Most reported being from North America, Europe, Australia, or New Zealand, with several in South America, the Middle East, and Southeast Asia.

Across all profiles, 254,833 users identified themselves as male, 35,939 as female, and 16,321 did not specify. This shows a clear dominance of males. Unfortunately, no known literature exists on which people are more likely to leave their gender unspecified online. However, in any case, males outnumbered females by more than 200,000.

Figure 2 shows that the distribution of user ages peaked at 18–20, declined, and had a small peak at 80 (from people entering the oldest possible age). The small peak at zero represents profiles not specifying an age. Also, because user ages were otherwise consistently in the teens and twenties, we assumed the 80-year-old ages were reported in jest. These outlying groups were excluded from analysis. The Terms of Use (Newgrounds™, 2007e) also forbade people under 13 from participating, and 13 was the minimum age users could specify.

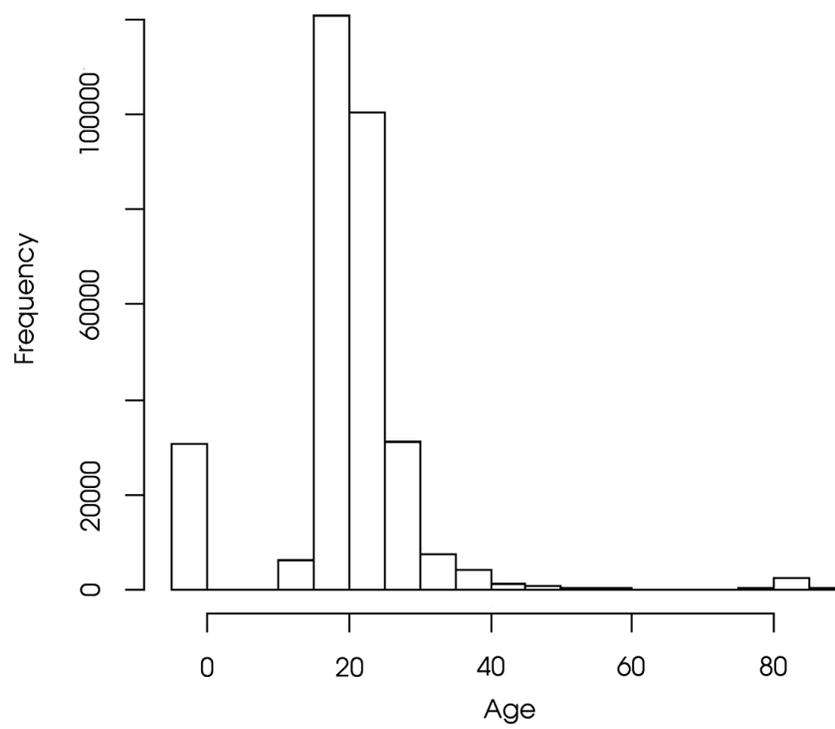


Figure 2. User ages

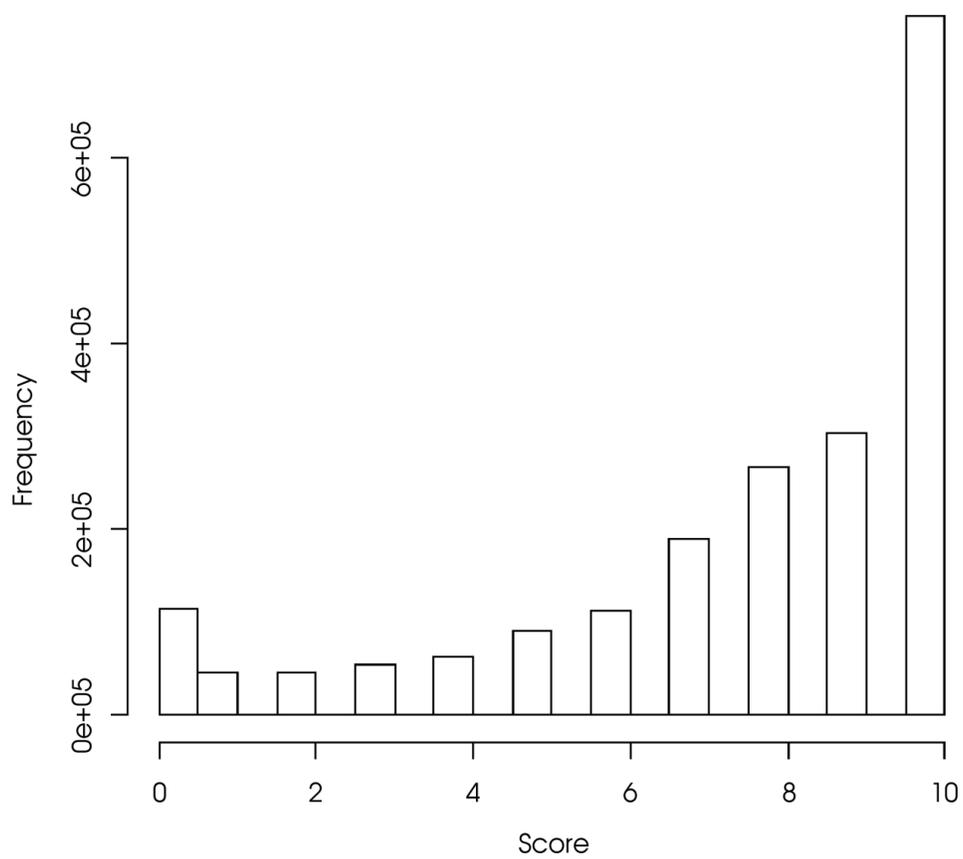


Figure 3. Scores

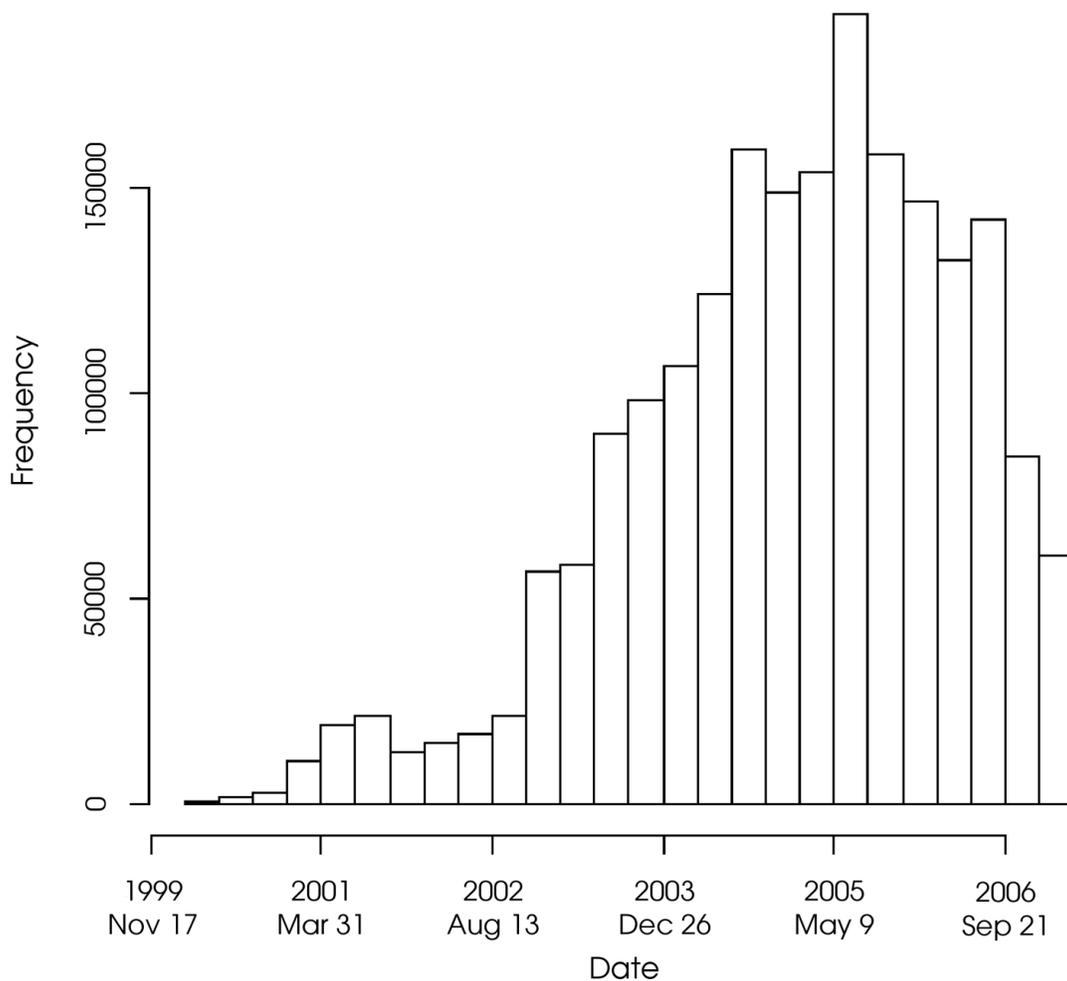


Figure 4. Site-wide review counts-per-day

Figure 3 shows how the distribution of score data curves exponentially upward, with a small up-turn near zero. This suggests that the act of reviewing on Newgrounds™ usually indicates positive ‘degree of approval’. If someone wishes to ‘blam’ a movie (i.e. to request it be administratively removed), they would more commonly use the 1–5 scale on movie homepages. Nevertheless, the few zero scores evince that some people leave very negative (i.e. ‘hater’: Lange, 2007) reviews, especially if a mediocre score constitutes the boundary between positive and negative reviews, which it may.

In the distribution of site-wide review counts-per-day (CPD: Figure 4), the right side of the curve is less stable than the left, because movies on the left had more time to amass reviews. Nevertheless, the distribution’s peak occurs shortly before the beginning of YouTube™, suggesting loss of membership to such sites.

Besides the raw score and time data, counts-to-date (CTD) and CPD measures were computed from the frequency of reviews for individual reviewers, authors, and movies. One would expect that every user’s CTD could only increase over time. However, some popular individuals might accumulate reviews faster than others, or in stages or bursts. With CPD, one could imagine many patterns, discussed in ‘Modeling results: review

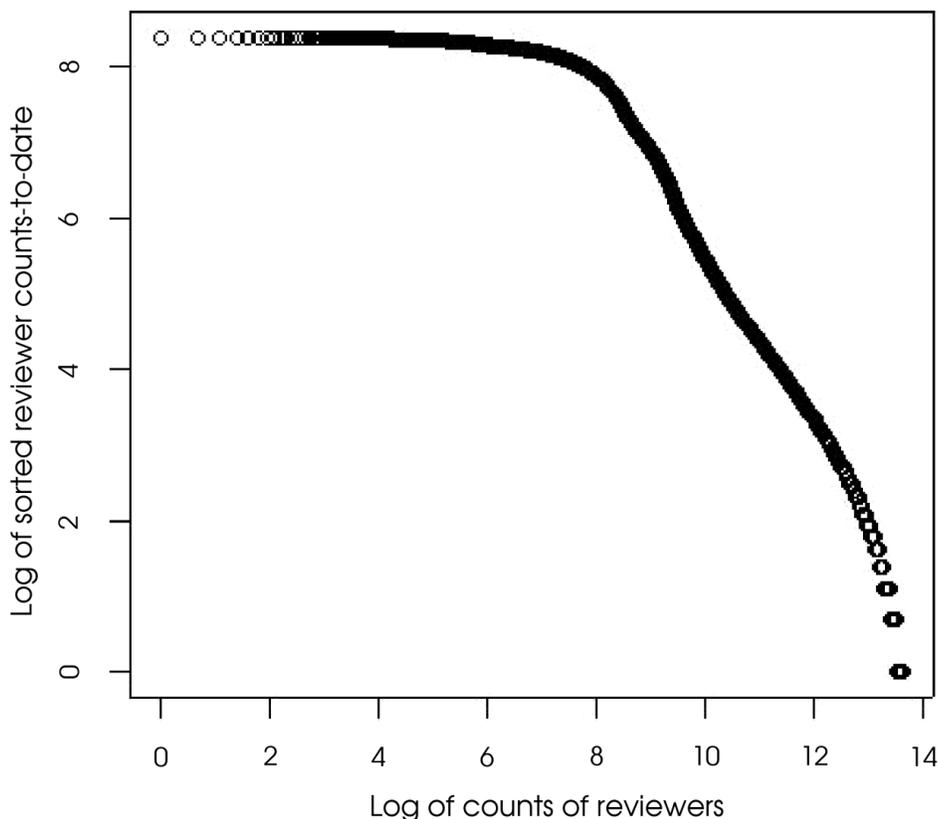


Figure 5. Sorted reviewer counts-to-date

CPD', below. When sorted over all users and times, each of these variables was nearly log-normally distributed, depicted in Figure 5. Interestingly, the Power Law commonly seen in web participation phenomena is not in evidence. Rather, many users gave many reviews, followed by a drop-off to those who gave few.

Finally, the gender and age variables varied, depending on whether the person was a reviewer or author. For reviewers, the most common age was 18, and for authors 20. Regarding gender, 115,122 unique reviewers in the sample specified male, 11,542 female, and 5351 did not specify. Fewer individuals participated as authors: 3981 specified male, 163 female, and 112 did not specify.

Modeling results: scores

Using a multilevel modeling approach, when scores given by reviewers were modeled by a single fixed effects term, namely the intercept (i.e. the mean of all reviewers' scores), the intercept was 7.61, with 740435 degrees of freedom for 853,341 observations of 112,906 reviewers. The intercept's standard deviation was 1.1, with 95% confidence interval (which is the confidence level used throughout) 7.61 ± 0.01 with $p < 0.0001$. Regarding model fit, Akaike Information Criterion (AIC) was 4196606, Bayesian Information Criterion (BIC) was 4196641, and log-likelihood (LL) was -2098300 .

Including time – in days, with day one the date of the oldest review – as an independent variable, the intercept became 7.09 ($CI = \pm 0.03$), and the estimated time slope parameter 0.00039 ($CI = \pm 0.00002$), meaning that average reviewer scores were around 7 at the beginning of the study and increased, on average, by a factor of about 0.0004 everyday. All parameters of the temporal model were statistically significant ($p < 0.0001$), AIC and BIC decreased to 4192610 and 4192680, respectively, and LL to -2096299 .

Both of these models were estimated using full information maximum likelihood and were nested, making an ANOVA comparison appropriate for inferring whether the unconditional growth change model fits better than means-only. The resulting likelihood ratio was 4001.966, $p < 0.0001$, demonstrating that a straight-line model is more effective as compared to a means-only model.

From this point onward, only the optimal models will be reported, derived through exploratory iterative re-fitting of models one variable at a time. All of the ANOVA model comparisons performed were statistically significant. The full models discussed below all have *pseudo-R*² (Singer and Willett, 2003: 103–104) values around 0.02. Parsimony did not seem to be an issue, given the large number of observations and the rather simple, relatively speaking, models selected. Age was centered about their modal values (18 for reviewers, 20 for authors); genders were coded as female = -1 , unspecified = 0 , and male = 1 ; and dates were coded as before. Therefore, to obtain a prediction for a 19-year-old female two years into the study, the parameters should be set to a ‘reviewer age’ of 1, a ‘gender’ of -1 , and a ‘date’ of $365 * 2 = 730$.

Equation 1 shows the model predicting scores given by reviewers. All of the parameters were statistically significant at $p < 0.0001$, except for ‘reviewer gender’, which was at $p < 0.01$. The widest confidence intervals were on ‘author gender’ ($CI = \pm 0.16$) and ‘reviewer gender’ ($CI = \pm 0.12$), with the rest less than ± 0.04 . AIC and BIC decreased to 4186191 and 4186401, respectively, and LL to -2093078 .

$$\begin{aligned} \text{scoresGivenByReviewers} = & 6.956171 + 0.00047 * \text{date} + 0.026884 * \text{authorAge} + \\ & 0.864546 * \text{authorGender} + -0.018222 * \text{reviewerAge} + 0.1149 * \text{reviewerGender} + \\ & 0.024815 * \text{authorAge} * \text{authorGender} + -0.00001 * \text{date} * \text{authorAge} + \quad \text{Eq.1} \\ & 0.000685 * \text{date} * \text{authorGender} + 0.000004 * \text{date} * \text{reviewerAge} + \\ & 0.000053 * \text{date} * \text{authorAge} * \text{authorGender}. \end{aligned}$$

The primary finding of this article, Figure 6, is a graphical representation of Equation 1, showing four trends arising from all 16 combinations of old vs. young, and male vs. female, reviewer score combinations.

Males over 20 were scored highly when they began their times on the site, and their scores increased on average. Young males became less highly scored the longer they remained. Older females received lower scores than males overall. The mean change trajectory of the entire analysis is shown with a bold line (e.g. Kelley, 2009; Kelley and Maxwell, 2008). As with older males, young users scored older females more highly than did older users. At the bottom, though young females’ scores began lower than older females’, they eventually increased to a comparable level. Young users also scored young females highly more often than did older users.

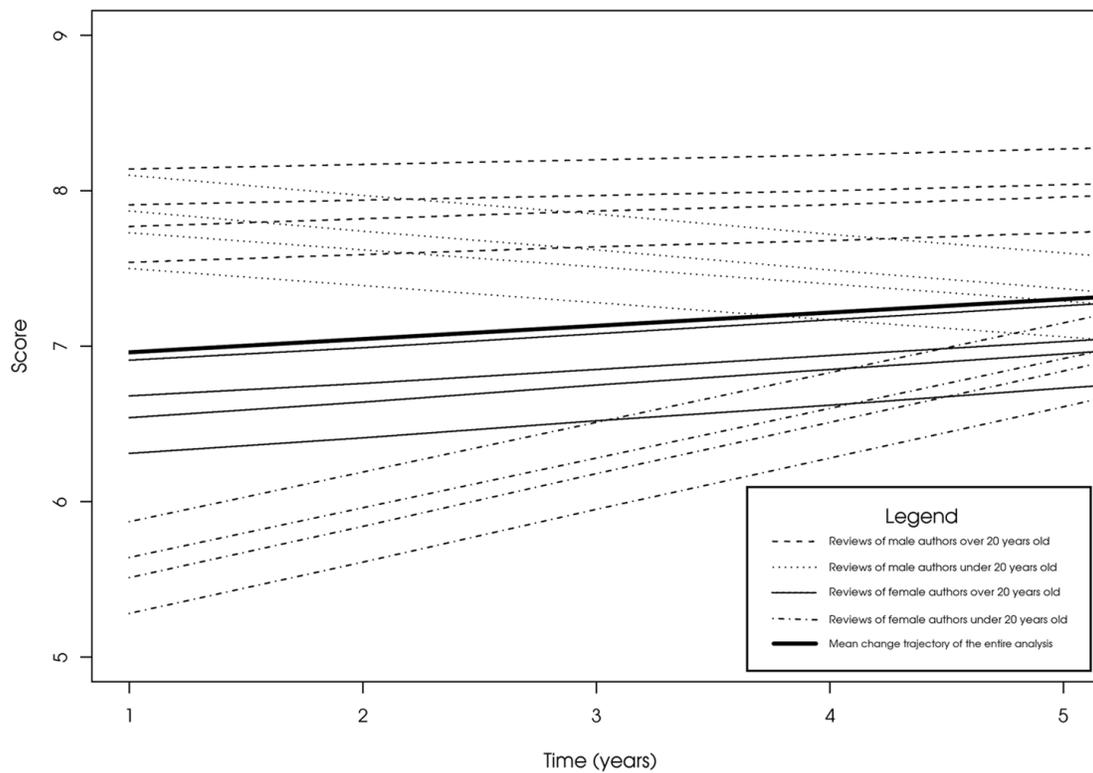


Figure 6. Reviewer score model

The equations for the analysis of scores received by authors and by movies are given in Equations 2 and 3. All of the reported coefficients were statistically significant at $p < 0.01$ or better, and had confidence intervals similar to those for Equation 1. Fit statistics for these models were $AIC = 4050534$, $BIC = 4050744$, and $LL = -2025249$ for Equation 2; and $AIC = 4094272$, $BIC = 4094482$, and $LL = -20471181$ for Equation 3.

$$\begin{aligned} \text{scoresReceivedByAuthors} = & 3.73954 + 0.000938*\text{date} + 0.021289*\text{authorAge} + \\ & 1.143606*\text{authorGender} + -0.007862*\text{reviewerAge} + -0.000013*\text{date} \\ & * \text{authorAge} + -0.000542*\text{date}*\text{authorGender} + 0.000078*\text{date} \\ & * \text{reviewerGender} + -0.000007*\text{date}*\text{reviewerAge}*\text{reviewerGender}. \end{aligned} \quad \text{Eq.2}$$

$$\begin{aligned} \text{scoresReceivedByMovies} = & 5.611661 + 0.000647*\text{date} + 0.026642*\text{authorAge} + \\ & 0.675404*\text{authorGender} + -0.005748*\text{reviewerAge} + 0.124808*\text{reviewerGender} + \\ & -0.010614*\text{authorAge}*\text{authorGender} + -0.000012*\text{date}*\text{authorAge} + \\ & -0.000524*\text{date}*\text{authorGender} + -0.000002*\text{date}*\text{reviewerAge} + \\ & 0.000034*\text{date}*\text{authorAge}*\text{authorGender}. \end{aligned} \quad \text{Eq.3}$$

All three models agree that, overall, scores have been slowly increasing. The reviewer- and movie-based analyses estimate the common starting score for an 18-year-old reviewer reviewing a 20-year-old author, both of unspecified gender, to have been between 5.6 and 7, whereas the author-based analysis estimates 3.7. This discrepancy might be due to preferential attachment, with a few popular authors receiving most high

scores. All models agree that authors older than 20 and male authors initially received higher scores, but authors under 20 and female authors received increasing scores, eventually mitigating the old-male advantage. The reviewer- and movie-based analyses agree that older males or younger females' scores increased. Also, scores given by male reviewers were higher overall, and reviewers above 18 gave increasing scores. The author analysis shows that male reviewers gave higher scores over time, but older male or younger female reviewers did the opposite. Hence, there may be a pool of either younger males or older females who both scored older males highly by default as well as scored young females better over time.

In summary, 'author gender' and, to a lesser degree, 'reviewer gender' had the largest effects on scores. In all analyses, male authors received higher scores than females, and male reviewers usually gave higher scores than did females. Figure 6 makes apparent that gender differences, which existed more prominently in the site's early days, were eventually somewhat mitigated for females and young males. However, older males maintained their privileged status throughout.

Modeling results: review counts-to-date

The remaining findings regard the quantity of movie review behaviors, where review counts were the dependent variable. Those variables were log-transformed and analyzed using Gaussian assumptions of errors, because distributions of the count variables were near log-normal.

The three equations for the CTD analysis are these:

$$\begin{aligned} \text{CTDofReviewsGivenByReviewers} = & -1.4347868 + 0.0017203*\text{date} + \\ & -0.0003188*\text{authorAge} + 0.0286988*\text{reviewerAge} + \\ & 0.0778506*\text{reviewerGender} + 0.0000012*\text{date}*\text{authorAge} + \\ & -0.0000169*\text{date}*\text{reviewerAge} + -0.0001513*\text{date}*\text{reviewerGender}. \end{aligned} \quad \text{Eq.4}$$

$$\begin{aligned} \text{CTDofReviewsReceivedByAuthors} = & -2.1027389 + 0.0032864*\text{date} + \\ & 0.0146993*\text{authorAge} + -0.0122896*\text{reviewerAge} + \\ & 0.0468039*\text{reviewerGender} + 0.0000074*\text{date}*\text{reviewerAge} + \\ & -0.0000204*\text{date}*\text{reviewerGender}. \end{aligned} \quad \text{Eq.5}$$

$$\begin{aligned} \text{CTDofReviewsReceivedByMovies} = & 0.11248563 + 0.00115834*\text{date} + \\ & -0.00107443*\text{authorAge} + -0.00647869*\text{reviewerAge} + \\ & 0.07126559*\text{reviewerGender} + 0.00000141*\text{date}*\text{authorAge} + \\ & 0.00000348*\text{date}*\text{reviewerAge} + -0.00001501*\text{date}*\text{reviewerGender}. \end{aligned} \quad \text{Eq.6}$$

As expected, the CTD all grew steadily over time. Movies began with larger counts in the beginning (1.12, in untransformed units), and authors the smallest (0.12), possibly indicating that movies were more the target of reviews than were authors. All grew at about one review per day, on average. The reviewer and movie analyses agree that younger authors, and movies by them, received more reviews initially. However, older authors and movies by them were given, and accumulated, more reviews over time. This

may reflect the scoring and reviewing frenzy that exists around new movies, and how old movies remain available in perpetuity. Similarly, the author and movie analyses agree that younger reviewers gave more reviews initially, but older reviewers contributed more over time. All analyses agree that male reviewers posted more reviews initially, but females' rates increased, whereas males' decreased. This suggests that females became more involved in the reviewing process, but males less.

Apparent disagreements between the models include: older authors receiving more reviews overall in the author analysis, as well as more over time than other authors, and older reviewers giving more than others in the review analysis, but fewer over time. If the older authors are established animators who come to Newgrounds™ and can maintain a fanbase, the first of these disagreements seems plausible. Paolillo et al. (2007, 2010) identified a small cluster of such authors. The second disagreement may apply to older users who discover Newgrounds™, engage briefly, find it to be a phenomenon for younger people, and leave.

Modeling results: review counts-per-day

A high complexity and number of possible patterns can occur in CPD data. Movie reviews, for example, might grow rapidly then diffuse slowly, having numerous peaks and tails over time, such as when sequels are released (Sinha and Pan, 2006). Similarly, authors might experience multiple peaks as they release movies. For reviewers, one could imagine almost any pattern, depending on the individual's habits.

Nevertheless, the normal distribution is quite robust. Given that the data seem to be log-normal, the following CPD models were computed using normal assumptions. More complex modeling could doubtlessly yield additional conclusions.

$$\begin{aligned} \log\text{CPDofReviewsGivenByReviewers} = & 0.5142116 + -0.0001691*\text{date} + \\ & -0.0007513*\text{authorAge} + -0.0064549*\text{authorGender} + \\ & 0.0000006*\text{date}*\text{authorAge} + 0.0000035*\text{date}*\text{reviewerAge}. \end{aligned} \quad \text{Eq.7}$$

$$\begin{aligned} \log\text{CPDofReviewsReceivedByAuthors} = & 0.0503818 + (0*\text{date}) + \\ & 0.00121093*\text{authorAge} + 0.00042306*\text{reviewerAge} + \\ & 0.00867642*\text{reviewerGender} + -0.00000062*\text{date}*\text{authorAge} + \\ & -0.0000003*\text{date}*\text{reviewerAge}. \end{aligned} \quad \text{Eq.8}$$

$$\begin{aligned} \log\text{CPDofReviewsReceivedByMovies} = & 0.030940417 + \\ & -0.000009187*\text{date} + 0.000578305*\text{authorAge} + \\ & 0.000768831*\text{reviewerAge} + -0.004798751*\text{reviewerGender} + \\ & -0.000000366*\text{date}*\text{authorAge} + \\ & -0.000000455*\text{date}*\text{reviewerAge}. \end{aligned} \quad \text{Eq.9}$$

The overall means began small (1.67 untransformed for reviewers, 1.05 authors, and 1.03 movies) and declined over time. One or more popularity peaks may have occurred in the distribution, but their long tails average to a value below the initial point, as people became less active reviewers. This would match the earlier conclusion that younger males give many reviews initially, but eventually lose interest. The author and movie

analyses also agree that, for older authors and their movies, the number of reviews they received per day increased, possibly as their reputations grew. This is supported by the movie and reviewer analyses, which say that older authors and movies are reviewed more per-day over time. Similarly, those analyses agree that authors and movies received more per day from older reviewers. Perhaps, as in fine art, the connoisseurs give more attention to experienced artists. The author analysis also shows male reviewers giving more reviews per day, which is consistent with previous results. Finally, all analyses agree that older reviewers reviewed more per day over time.

Only one inter-model inconsistency existed. The reviewer analysis found that reviewers review younger authors more per day than older authors. If one considers that movie and author results are more related to each other than to the reviewer results, this may not be inconsistent. The pool of mostly young male reviewers may review a larger number of young authors per day, such as those who keep the 'new flash' queue full, than they do more mature authors who publish less often. However, this need not contradict older authors receiving more reviews per day than younger authors, because many fresh new authors are probably reviewed infrequently, but fewer mature and established authors are reviewed more often.

Discussion

Several social categories emerged from this analysis. Newgrounds™ was perhaps most enjoyable for men, especially those in their 20s. Though all men gave and received higher scores than women, especially to/from other men, older men received higher scores than anyone. Older men's scores also increased over time, they rarely scored others based on gender or age, they became more selective over time, and they did not join the fray surrounding new movies. Instead, their reviewing behavior was minded more towards the long term. Almost as privileged were older woman. Also largely avoiding scoring others based on age or gender, older women reviewed whomever they liked, received higher scores than young women, and avoided the new movie fray.

Young men and women each had their own quandary. Both focused on reviewing older authors. However, young men began with scores comparable to older men, and fell out of favor over time. For young women, being neither male nor old, the level of praise they received only increased as they aged. Young men valued other young men more than young women valued them. Young women became like older users – choosier over time, perhaps because they saw the path to high scores more clearly than did young men. Not falling into the new movie fray, they were also less likely to burn out.

Overall, with the exception of the older male category, all of these social categories became less pronounced on the site over time. The most popular authors received the largest number of high scores; celebrity animators who maintained a presence on the site were older and garnered sustained praise from everyone. This group was identified as 'high production value' authors by Paolillo et al. (2007, 2010). Men also posted more movies per day than women. Additionally, younger users who participated on the site for a long time may have become 'natives', and have been more likely than older 'immigrant' users to stay. In general, young people dominated the site's population, yet older people were the site's primary beneficiaries.

Conclusions

Early CMC literature asserted that the internet would be a place where people of different genders and ages could participate equally. Subsequent research, however, discovered that the internet was not completely democratizing, in that offline social hierarchies and behaviors were sometimes replicated online (e.g. Gefen and Ridings, 2005). Indeed, similar behaviors have been found in online amateur art communities, including the one examined for this study (Kendall, 2008a, 2008b; Luther and Bruckman, 2008). Whereas these studies focused on small-scale user interactions at certain moments in time, our own previous research (Paolillo et al., 2007, 2010) suggested that Newgrounds™ possesses complex and evolving social structures, the extents of which are only visible from a longitudinal systemic perspective. Hence, the current study characterized millions of instances of user participation over the site's first seven years of existence, in terms of users' genders and ages. In so doing, complex interactions between gender and age were found, suggesting: increasing social acceptance of young women, decreasing social acceptance of young men, and an enduring tendency for older men to be more socially accepted than older women.

In addition to supporting previous research on male bias in contexts such as this, the current study revealed a complex age hierarchy with gender interactions. In this community, regardless of gender, the old are usually venerated by the young. Whereas young men often either competitively over-exert themselves or are hazed before burning out, young women often proceed cautiously and become respected connoisseur-critics. Additionally, a decidedly Western bias was observed in users' geographical locations, suggesting a possible scope to the generalizability of these findings. Finally, this study made several methodological contributions, including demonstrating multilevel modeling in web participation research, and how such modeling can be accomplished on a realistic dataset containing several million observations.

Large-scale research of online environments is still in a nascent stage. Aside from the human difficulties of content analyzing so many digital artifacts or interviewing so many people, current statistical programming languages such as R remain in need of the robust RAM sharing functionality necessary for computing the matrix operations with a realistic number of observations. However, even if such software existed, theoretical statisticians continue to grapple with ways of combining data on users' attributes and relations, especially in longitudinal models (e.g. Burk et al., 2007). Multilevel, and time series, models, like those in this study, are often employed.

Specific to Newgrounds™, this study identified the following issues as perhaps most worthy of further research: the competitive hazing of young men, the survival strategies of young women, and the mystique of older users. Additional quantitative research on the video-posting frequencies, review and profile messages, geographical locations, occupations, and schools of users having different ages and genders could also augment the web participation literature. Finally, as the present study's observations ended in 2007 – shortly before the site underwent a major re-design, and during the rise of corporate new media sites that try to draw users away from niche sites like Newgrounds™ – a replication of the current study with data after 2007 could illuminate in what form sites like Newgrounds™ have survived.

Beyond Newgrounds™, an interesting issue is whether the age hierarchy identified in this article is unique to Newgrounds™ – or other art sites with a similarly niche focus – or whether it also emerges on younger mainstream sites, such as YouTube™, which probably contain both former Newgrounds™ members and the more general public. Also, do gender and age effects equalize over time for women and young people on mainstream sites, as they did on Newgrounds™, and in what ways do older men maintain their elitism on different sites? Given the age groups concerned, our intuition is that the age hierarchy is related to the educational grades and developmental stages experienced by most teenagers and young adults, as they move through high school and college.

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