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WOMEN PREFER RECIPROCITY: GENDER-RELATED DIFFERENCES IN ACADEMIC NETWORKING ON TWITTER

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Abstract

Within scholarly communication, social media such as social networking sites or microblogging services like Twitter facilitates more divers and flexible forms of academic communication, community development, and networking. In light of ongoing discussions on the gender gap in science, the question arises if and how gender influences the academic use of social media. So far little is known about gender-related differences in the academic use of social media. In this paper we focus on the special use case of Twitter and investigated gender-related differences in the academic networking of computer scientists.

This study analyzed a sample of 850 Twitter accounts of professors and PhD students. Independent factors were the gender and the academic status of the account owner. The activity of the account was considered as control variable. Dependent variables were the number of researcher followers and the number of reciprocal researcher followers (i.e., number of followers that follow back in the sense of mutual following). Thereby, reciprocal (mutual) following was conceptualized as an indicator for a stronger community development motive. Furthermore, different subgroups of followers with respect to gender, academic status and reciprocity of the following behavior (e.g., reciprocal female professor followers) were considered for explorative analyses to gain deeper insights.

Overall, the two-way MANCOVA revealed no significant gender difference for the total number of researcher followers. However, for the number of reciprocal followers, we found that the accounts of females had significantly more reciprocal followers. Also, the explorative analyses of the different subgroups of followers strengthen the finding that females establish more reciprocal following relations. In addition, the pattern of the findings for the subgroups of followers suggests a preference of females for following other females and a gender-related networking behavior across the academic hierarchy.

The presented findings provide evidence that female researchers establish more reciprocal relationships on Twitter than male researchers do. This implies a stronger community development motive among female academic Twitter users. It should be noted that our findings relate to computer science which is a male-dominated field and it would be interesting for future research to investigate gender-related differences in female-dominated or gender-balanced academic domains. Our findings provide first insights in the impact of gender on academic networking behavior in social media. Further research is needed to strengthen these findings and to clarify the underlying processes.

Keywords: Academic networking, gender, Twitter, community development, motives for following.

1 INTRODUCTION

Social media are increasingly being used by researchers for private as well as for professional purposes. In particular, communication and collaboration via the social web have found avid adoption among academics (e.g., [1], [2]). Academic users of social media appreciate the possibility of networking with other academics as well as non-academic audiences, promoting openness and sharing of information, publicizing and development of research and giving and receiving support [3]. While there is an ongoing public as well as academic debate of the gender gap in science and an increasing wealth of findings on gender-specific media use, little is known about the effect of gender on social media use among academics. Disciplines like computer science with a relatively large gender gap as well as a strong affinity for digital media provide an intriguing domain for the exploration of female media use in male-dominated areas of science. In this study, we analyze the effect of gender on the usage motives and the behavior of academic Twitter users in the field of computer science, based on the uses and gratifications theory.

One important feature of social networks is that they allow users to establish connections among each other. On many platforms, such as Facebook or ResearchGate, both users actively agree on such connections. However, the so-called “following” connections facilitated by the microblogging service Twitter are unilateral by default. Accordingly, a Twitter user can choose to follow an account, but this does not necessarily mean that he/she is followed back by the account owner. As a result, the relationships on Twitter are partly unilateral and partly reciprocal (mutual following, i.e., following and being followed back). Following back, that is, the establishment of reciprocal relationships, requires awareness of one’s followers and the willingness to build a bilateral connection. Thus, reciprocal relationships can be characterized by a stronger community development motive compared to unilateral following relationships. In the light of more cooperative behavioral patterns among women [4] the social networking behavior of female academic users could be assumed to be more reciprocal. Twitter therefore provides an interesting environment for the investigation of gender-specific academic social media usage. We analyze whether the community development motive is more pronounced among female academic Twitter users from the field of computer science by analyzing reciprocal following relationships, taking into account additional factors such as the academic status and the usage intensity.

2 THEORETICAL BACKGROUND AND PRIOR WORK

2.1 Motives for Academic Twitter Use: The Uses and Gratification Approach

A number of analyses have explored motives for social media adoption among academics. In this vein, our study builds upon uses and gratification theory (U&G), which is based on the assumption of an active user choosing from diverse media contents for a variety of subjective purposes (motives). The U&G approach was originally developed for television viewing (e.g., [5], [6]), but can be also applied to new interactive and social media (e.g., [7], [8], [9], [10], [11], [12]). Among the general population, six key motives for social media use have been identified [11] [13], namely information, entertainment, social interaction, community development, self-expression, and self-actualization. According to Shao [11] these motives can be related to three separate but interdependent activities on social media: consuming (for information and entertainment uses), participating (for social interaction and community development uses) and producing (for self-expression and self-actualization uses).

The microblogging service Twitter supports a number of uses in an academic context, such as information seeking, relationship management, and signaling affinity to particular issues and people [14]. Prior research [15] has shown that Twitter usage among computer scientists is predominantly motivated by information seeking, with community development playing an important role as well. With respect to reciprocal relationships, it should be noted that following a Twitter account provides other gratifications than following back. While following a Twitter account might mainly be directed by the information seeking motive, following back is more heavily motivated by community development. As mentioned above, Twitter connections are unilateral by default and require no affirmation from both parties: a user can follow another user without the need for the other user to follow back. In other words, connections on Twitter can be either unilateral as a simple follower relation without following back or reciprocal by a mutual following of both parties. Analyses of following relationships or behavior may therefore provide insights into motives for Twitter use.

2.2 Gender Gap in Science and Gender-Specific Media Usage

Over the previous decade, efforts were made to increase the number of women in science. However, despite some improvements, the so-called gender gap in science prevails (https://www.nsf.gov /statistics/2017/nsf17310/data.cfm). Similarly, gender has long been a key antecedent explored in digital divide studies where female users traditionally have been slower to adopt and showed less avid Internet use (cf. [16]). Yet, in terms of general Internet use, the gender gap has been shown to narrow over the previous years, while gender differences remain for distinct Internet uses (e.g., [17]; see [18] for similar findings on general computer use). Accordingly, gender does not only appear to influence if, but also how users employ social media. Studies of online participation and the digital divide have characterized female Internet use as more cooperative, more directed at social interaction and more civil – in accordance with traditional „caregiver“ [19] or „kinkeeper“ roles.[20]. These previous findings suggest that females may be more inclined to online networking which could result in a higher propensity for reciprocal online relationships. However, it is an open question whether gender-specific communication styles (still) exist in academic online communication or whether females have adapted to the communication style of the majority of their male colleagues. In addition, findings on counter-

stereotypical behavior in online media [21] suggest that gender-specific communication behavior might disappear with the ongoing use of social media, including Twitter.

Taken together, these findings reveal two different developments. On the one hand, the gender gap still persists in scientific domains dominated by males, like computer science. On the other hand, the digital gender gap may be decreasing both in the extent and form of new media usage. In fact, new media may have a positive influence on counter-stereotypical behavior. Thus, the question arises whether there is any gender-specific academic usage of social media like Twitter. For this study we use a dataset of Twitter accounts of computer scientists [22] dataset available on: http://dx.doi.org/10.5281/zenodo.12942). The dataset has previously been used for a study of academic Twitter use motives among computer scientists [15] and provided evidence that for this audience, Twitter is primarily an information network, but also delivers community development gratifications. In this study, we used the dataset to investigate gender differences in the social networking behavior of computer scientists (professors and PhD students). Thereby we analyzed the influence of gender on the number of following relationships including both unilateral following and reciprocal (mutual) following relationships.

3 METHODOLOGY

3.1 Data Sample and Extraction of Variables

Our dataset represents Twitter data (tweets, follower network, etc.) of 9,191 Twitter accounts of computer scientists. The accounts were collected as the followers of accounts of computer science conferences and their real names could be matched against author names from the computer science bibliography DBLP [23] with an accuracy of 73%. 586 protected accounts were removed from the dataset (since their tweets and network data are not publicly available), resulting in a set of 8,605 user accounts. For the present study we used the following main variables:

- The *academic status* of researchers in the dataset was extracted by using a profile-based biographical approach. Therefore, the textual self-descriptions which users can store in their Twitter profiles were matched against key phrases like “professor” or “phd student” and the corresponding roles “Prof”, “PhD”, or “none” (no or ambiguous match) were assigned to users.
- The *gender* of Twitter users (“female”, “male”, “none”) was identified by an approach similar to Mislove, Lehmann, Ahn, Onnela, and Rosenquist [24]: the real names of users were matched against lists of common names. These lists included data from the US social security administration (http://www.ssa.gov/oact/babynames/background.html) where we considered the most popular 1,000 names for each year between 1960 and 2010, the US census bureau (http://www.census.gov/topics/population/genealogy/data/1990_census/1990_census_namefiles.html) where we used all frequent names from the 1990 census data, and popular baby names in Germany (http://www.beliebte-vornamen.de/). We normalized all names to lowercase and then assigned a gender to users by performing exact string matching against the names on the lists. If a name was ambiguous, that is, appeared in both the male and female lists, we did not assign a gender to the user (“none”).
- The variable *activity of the account* is indicated by the *number of organic tweets in 2013*, that is, the number of tweets that were neither a retweet nor sent in reply to another tweet in the year 2013.
- The variable *number of researcher followers* was derived by counting how many of the 8,605 researchers are (unilateral or reciprocal) followers of the corresponding user.
- The variable *number of reciprocal researcher followers* designates how many of the following relationships to researchers were reciprocal, that is, the number of followers that follow back.

For additional explorative analyses we differentiated between specific subgroups of followers and reciprocal followers in relation to the gender and academic status of the users. In particular, the following variables were extracted:

- The *number of PhD followers, number of Prof followers, number of male researcher followers, number of female researcher followers* were derived by counting the number of followers that were identified as PhDs/professors or male/female, respectively.

- The variables *number of reciprocal PhD followers*, *number of reciprocal Prof followers*, *number of reciprocal male researcher followers* and *number of reciprocal female researcher followers* indicated how many of the users' follow relationships to PhDs/professors and male/females, respectively, were reciprocal.
- The variables *number of female Prof*, *male Prof*, *female PhD*, *male PhD*, *reciprocal female PhD*, *reciprocal male PhD*, *reciprocal female Prof*, and *reciprocal male Prof followers* additionally considered the gender as well as the academic status of the followers.

Since not all followers could be identified as male/female and PhD/professor, the numbers of the subgroups are substantially lower. Thus, the analyses with these subgroups are explorative and provided only tentative insights.

For the analyses reported in this paper, we employed the Twitter user data of 1,481 accounts of computer scientists that could be identified as professors or PhD students by the biographical approach. Overall, the dataset comprised 570 professors and 911 PhD students. Of the 570 professors, 60 were identified as female, and 306 as male; for 204 professors we could not identify their gender. Of the 911 PhD students, 119 were identified as female, 365 as male, and 427 could not be identified. The resulting sample of 850 Twitter accounts was analyzed in relation to gender, academic status, and reciprocity (that is, mutual following of both users).

For the cross tables of gender and academic status there was a significant unequal distribution of gender for PhD students versus professors ($Chi^2 = 8.416$; $p = .004$): male accounts equally included PhD student and professor accounts. However, female accounts included more PhD student accounts than professor accounts. The numbers of valid cases subdivided by gender and academic status are listed in Table 1.

Table 1. Number of analyzed accounts subdivided by gender and academic status of the account owner.

	Gender		
Academic status	Female	Male	Female or male
Professor	60 (16%)	306 (84%)	366 (100%)
PhD student	119 (25%)	365 (75%)	484 (100%)
Professor or PhD student	179 (21%)	671 (79%)	850 (100%)

3.2 Design

Independent variables were the gender of the account owner (female versus male) and the academic status of the account owner (Prof versus PhD). As control variable we included the activity of the account measured by the number of organic tweets in 2013. Organic tweets were defined as tweets that were neither simply retweeted nor sent in reply to another tweet.

As main dependent variables we used the number of all researcher followers and the number of reciprocal researcher followers (i.e., mutual following of both users). Additionally, we analyzed the listed specific subgroups of followers (see list of extracted variables) as dependent variables. The analyzed subgroups of researcher followers were female, male, Prof, PhD, female Prof, male Prof, female PhD, and male PhD followers. Analogously, the analyzed subgroups of reciprocal followers were reciprocal female, male, Prof, PhD, female Prof, male Prof, female PhD, and male PhD followers. In this context, the term "followers" means researcher followers. Followers that could not be identified as researchers were excluded from the analyses. The dependent variables were not independent from each other (because they are partly subgroups of each other, for instance, the set of reciprocal researcher followers of a user is a subset of the set of all researcher followers of that user). Rather, all dependent variables were significantly correlated ($p < .001$ for all correlations with values between $r = .984$ and $r = .376$).

4 RESULTS

The means and standard deviations (subdivided in relation to gender and academic status of the account owner) of the dependent variables can be found in Table 2 for the subgroups of unilateral followers and in Table 3 for the subgroups of reciprocal followers.

Table 2. Subgroups of unilateral followers - means and standard deviations (in brackets) for the number followers in dependence of the gender and academic status of the account owner.

Gender	Female			Male			All		
Academic status	PhD	Prof	All	PhD	Prof	All	PhD	Prof	All
Subgroup of followers									
Researcher (all)	17.24 (27.69)	38.27 (61.86)	24.29 (43.31)	15.92 (32.50)	40.12 (67.92)	26.96 (53.10)	16.24 (31.37)	39.82 (66.89)	26.39 (51.18)
Female researcher	3.33 (5.61)	7.50 (12.33)	4.73 (8.67)	2.31 (4.84)	5.73 (11.10)	3.87 (8.47)	2.56 (5.05)	6.02 (11.31)	4.05 (8.51)
Male researcher	8.51 (13.92)	17.40 (28.54)	11.49 (20.42)	7.94 (15.04)	19.86 (31.92)	13.38 (24.97)	8.08 (14.74)	19.46 (31.43)	12.98 (24.08)
Professor	2.05 (3.84)	7.48 (11.54)	3.87 (7.78)	1.83 (3.99)	6.63 (10.48)	4.02 (8.02)	1.88 (3.95)	6.77 (10.65)	3.99 (7.97)
Phd	3.88 (5.82)	7.32 (12.72)	5.03 (8.87)	3.67 (7.46)	7.06 (13.87)	5.22 (10.99)	3.72 (7.09)	7.10 (13.67)	5.18 (10.57)
Female professor	0.36 (0.82)	1.38 (2.40)	0.70 (1.61)	0.26 (0.88)	0.79 (1.76)	0.51 (1.38)	0.29 (0.87)	0.89 (1.89)	0.55 (1.43)
Male professor	1.04 (2.05)	3.77 (6.06)	1.96 (4.08)	0.98 (2.17)	3.69 (5.70)	2.22 (4.38)	1.00 (2.14)	3.70 (5.75)	2.16 (4.32)
Phd	3.88 (5.82)	7.32 (12.72)	5.03 (8.87)	3.67 (7.46)	7.06 (13.87)	5.22 (10.99)	3.72 (7.09)	7.10 (13.67)	5.18 (10.57)
Female PhD	0.68 (1.19)	1.47 (2.56)	0.94 (1.80)	0.68 (1.44)	1.12 (2.43)	0.88 (1.97)	0.68 (1.38)	1.18 (2.45)	0.89 (1.93)
Male PhD	1.92 (3.01)	3.05 (5.60)	2.30 (4.09)	1.67 (3.20)	2.88 (5.46)	2.22 (4.41)	1.73 (3.15)	2.91 (5.47)	2.24 (4.34)

Table 3. Subgroups of reciprocal followers - means and standard deviations (in brackets) for the number followers in dependence of the gender and academic status of the account owner.

Gender	Female			Male			All		
Academic status	PhD	Prof	All	PhD	Prof	All	PhD	Prof	All
Subgroup of followers									
Reciprocal researcher (all)	12.18 (18.54)	17.90 (27.08)	14.09 (21.87)	9.21 (13.18)	14.60 (22.78)	11.67 (18.38)	9.94 (14.71)	15.14 (23.53)	12.18 (19.18)
Reciprocal female researcher	2.60 (4.40)	3.65 (6.31)	2.95 (5.13)	1.54 (2.00)	2.41 (4.35)	1.94 (3.70)	1.80 (3.42)	2.61 (4.74)	2.15 (4.06)
Reciprocal male researcher	6.08 (9.37)	8.72 (13.22)	6.97 (10.85)	4.89 (6.94)	7.95 (11.87)	6.28 (9.63)	5.18 (7.61)	8.08 (12.09)	6.43 (9.90)
Reciprocal professor	1.77 (3.27)	4.68 (7.30)	2.75 (5.17)	1.32 (2.67)	3.59 (5.51)	2.36 (4.36)	1.43 (2.83)	3.77 (5.85)	2.44 (4.54)
Reciprocal PhD	2.61 (3.80)	2.77 (5.17)	2.66 (4.29)	2.06 (3.35)	1.93 (4.25)	2.00 (3.78)	2.19 (3.47)	2.07 (4.41)	2.14 (3.90)
Reciprocal female professor	0.34 (0.73)	0.87 (1.59)	0.51 (1.12)	0.21 (0.70)	0.45 (1.05)	0.32 (0.88)	0.24 (0.70)	0.52 (1.17)	0.36 (0.94)
Reciprocal male professor	0.91 (1.80)	2.32 (3.54)	1.38 (2.60)	0.73 (1.52)	2.08 (3.19)	1.35 (2.52)	0.78 (1.60)	2.12 (3.24)	1.35 (2.53)
Reciprocal female PhD	0.52 (0.99)	0.67 (1.43)	0.57 (1.16)	0.44 (0.96)	0.35 (0.90)	0.40 (0.93)	0.46 (0.97)	0.40 (1.01)	0.44 (0.99)
Reciprocal male PhD	1.34 (2.02)	1.25 (2.53)	1.31 (2.20)	1.00 (1.73)	0.88 (1.90)	0.94 (1.81)	1.09 (1.81)	0.94 (2.02)	1.02 (1.90)

With respect to the unequal gender distribution of the academic status we performed a two-way analysis of covariance for the academic status and gender (of the account owner) as independent variables and the activity of the account owner as covariate. Due to the correlations between the dependent variables we chose the multivariate analysis of covariance (MANCOVA, i.e., all dependent variables were analyzed together in order to account for their interdependencies). The statistical values of the MANCOVA are listed in Table 4.

For the academic status we found main effects on the number of followers and the number of reciprocal followers. The accounts of professors had significantly more followers and more reciprocal followers than the accounts of PhD students. There was no significant gender difference for the number of followers. However, there was a tendentious (non-significant) gender difference for the number of reciprocal followers, that is, female accounts had a higher number of reciprocal followers. There were no significant interactions between gender and academic status.

The additional explorative analyses of the subgroups of followers showed that the main effect for the academic status on the number of followers could be analogously found for all subgroups of followers, that is, female, male, Prof, PhD, female Prof, male Prof, female PhD, and male PhD. Also with respect to reciprocal female, reciprocal male, reciprocal Prof, reciprocal female Prof, and reciprocal male Prof there was an analogous main effect for the academic status of the account owner, that is, the accounts of professors had higher numbers. (However, for reciprocal PhD, reciprocal female PhD and reciprocal male PhD no significant influence of the academic status could be found.)

Table 4. Values of the 2-way MANCOVA for influence of gender and academic status of the account owner (with activity as covariate) on the number of the different subgroups of followers.

	Gender		Academic Status		Gender x academic status	
	F	p	F	p	F	p
Subgroup of followers						
Researcher (all)	0.048	.827	22.218	< .001	0.268	.605
Female researcher	3.141	.077	22.721	< .001	0.143	.705
Male researcher	0.385	.535	21.193	< .001	0.801	.371
Professor	0.478	.490	53.268	< .001	0.130	.718
PhD	0.011	.916	10.748	.001	0.014	.905
Female professor	7.411	.007	36.781	< .001	3.700	.055
Male professor	0.003	.954	50.919	< .001	0.010	.921
Female PhD	0.779	.378	10.355	.001	0.748	.387
Male PhD	0.180	.671	7.468	.006	0.048	.827
Reciprocal researcher (all)	2.889	.090	7.548	.006	0.012	.915
Reciprocal Female	9.679	.002	4.952	.026	0.008	.927
Reciprocal Male	0.906	.342	7.488	.006	0.208	.649
Reciprocal Professor	3.477	.063	39.828	< .001	0.484	.487
Reciprocal PhD	3.490	.062	0.236	.628	0.066	.797
Reciprocal female professor	10.490	.001	19.958	< .001	2.671	.103
Reciprocal male professor	0.657	.418	35.648	< .001	< 0.001	.996
Reciprocal female PhD	4.648	.031	0.016	.899	1.431	.232
Reciprocal male PhD	4.162	.042	0.975	.324	< 0.001	.993

There were no gender differences for the subgroups of followers, except the subgroup of female professors. The accounts of females had a significantly higher number of female professor followers. The tendentious gender effect on the number of reciprocal followers could be verified as a significant gender effect for the subgroups reciprocal female, reciprocal female Prof, reciprocal female PhD, and reciprocal male PhD followers. Additionally, for female accounts, we found a tendentiously (but not significantly) higher number of reciprocal Prof followers and reciprocal PhD followers. However, there

were no significant gender-related differences for the number of reciprocal male and reciprocal male Prof followers. There were no significant interactions between gender and academic status for the analyzed subgroups of followers.

5 CONCLUSION

Our analyses confirm an influence of the academic status of the account owner on following behavior observed in earlier studies. In terms of gender influences, we found no gender differences in relation to the number of researcher followers (with only one exception as accounts of females had a higher number of female professor followers). For the number of reciprocal followers, the gender of the account owner influenced almost all types of reciprocal followers. These findings indicate that female computer scientists establish more reciprocal relationships on Twitter than their male colleagues. However, there were two remarkable exceptions: There were no gender-related differences for the number of reciprocal male followers and reciprocal male Prof followers.

Our findings provide initial insights into gender-specific differences in social media use among academics, specifically relating to the following behavior of computer scientists on Twitter. They imply a stronger community development motive among female academic Twitter users, in line with our theoretical argument in relation to prior research on females' higher affinity to online networking. These distinct motivational and behavioral patterns may result in distinct gratifications derived from platform use. In other words, female users may experience somewhat different benefits from their Twitter use than their male counterparts. Of course, more extensive analyses, based on content analyses and surveys, would be necessary to examine the implications in more depth.

Our findings are limited by the sample size employed in this analysis (N=850), as only about half of the overall sample could be clearly identified as male or female. It should also be noted that our findings were based on a rather small female subsample in an overwhelmingly male domain (computer science). On the one hand, this limits the generalizability of our findings to male-dominated academic domains. On the other hand, it provides specific insights on the behavior of female computer scientists that work in a predominantly male discipline (i.e., female researchers constituting a minority in a discipline with a sizeable gender gap). Our findings reveal that female computer scientists – even in this predominantly male discipline – exhibit a more cooperative and relationship-directed behavior in the sense that community development is more pronounced. This is in line with prior findings reported in the theoretical background (cf. [1]). Thereby, it remains an open question how such gendered social media behaviors might affect females' academic careers and their success in computer science, in particular.

Besides our main findings, the explorative analyses of the diverse subgroups of followers reveal notable exceptions to the female preference for reciprocal relationships. There were no gender-related differences for reciprocal male followers and reciprocal male professor followers. This, in turn, indicates that female computer scientists consider males and male professors differently. Another notable exception is the higher number of female professor followers for females' accounts whereas there were no gender-related differences for other subgroups of researcher followers. This exception suggests that females in higher academic positions have gender-related preferences when following the accounts of other computer scientists. It would be of interest to explore if and how this finding implies that a social network such as Twitter could serve to facilitate networks of female researchers providing mutual support. Previous studies found that female students in STEM (science, technology, engineering, and math) fields perform better when taught by female professors [25]. Thus, social capital generated through peer-networking could strengthen female participation in academia and serve to reduce the gender gap. Future studies of gendered social media use should therefore investigate both specific reasons for following and following back as well as potential professional outcomes. Finally, it should be noted that our findings from a predominantly male domain (computer science) might not be applicable to a female-dominated discipline or a domain with gender parity. Studying a more female-dominated academic domain as well as a balanced domain (equal gender distribution) would be relevant to strengthening these findings and to clarify the underlying processes. Especially in the face of the ongoing discussion on the gender gap in science, further studies on other social media with a stronger academic focus (e.g., Academia, ResearchGate) are needed.

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