

# Conflict, Confidence, or Criticism: An Empirical Examination of the Gender Gap in Wikipedia

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## ABSTRACT

A recent survey of contributors to Wikipedia found that less than 15% of contributors are women. This gender contribution gap has received significant attention from both researchers and the media. A panel of researchers and practitioners has offered several insights and opinions as to why a gender gap exists in contributions despite gender anonymity online. The gender research literature suggests that the difference in contribution rates could be due to three factors: (1) the high levels of conflict in discussions, (2) dislike of critical environments, and (3) lack of confidence in editing other contributors' work.

This paper examines these hypotheses regarding the existence of the gender gap in contribution by using data from an international survey of 176,192 readers, contributors, and former contributors to Wikipedia, including measures of demographics, education, motivation, and participation. Implications for improving the design and culture of online communities to be more gender inclusive are discussed.

## Author Keywords

Wikipedia; Online Communities; Gender; Production Communities; Survey; Empirical; Conflict; Confidence; Criticism

## ACM Classification Keywords

H.5.3. [Information Interfaces and Presentation]: Group and Organization Interfaces – Web-based interaction, Collaborative computing, Computer-supported cooperative work

## General Terms

Measurement

## INTRODUCTION

A recent survey conducted by the United Nations

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University found a somewhat surprising result: less than 15% of contributors to Wikipedia are women [14]. Several studies of Wikipedia readership would suggest that the number of men and women reading Wikipedia is roughly equal: 56% of Wikipedia readers are men, according to a Pew Survey in 2010 [45]. In a text-only environment where gender cues are ostensibly removed and often not outwardly known, why is there such a staggering difference between the number of male and female contributors? The problem does not seem to be one of the overall community readership or awareness, but a problem of making the jump from readership to contribution.

In other online organizations such as open source software project, research has found a large number of male contributors relative to female contributors [30]. However, it is not entirely obvious that Wikipedia would naturally have this kind of a gender gap considering it is not a technical community. The goal of the Wikipedia is to make the world's knowledge available to everyone for free. Men and women both share this goal, and women have insight into the world's knowledge that men may not be fully representing in Wikipedia.

This paper seeks to delve deeper into the question of what is hindering women from transitioning from being readers to being contributors, and what may be causing female contributors to stop contributing. Drawing on theory from psychology and gender research, we hypothesize that gender differences in responses to conflict contribute to the dearth of female contributors. Similarly, research on confidence differences in expertise has demonstrated women may not assert their knowledge and expertise as worthy to contribute to the community. Previous research has shown differences in the style of collaboration with respect to giving and receiving criticism exist. We posit that this disparity contributes to gender differences in motivations for contributing. Teasing apart these gender differences with respect to conflict, confidence, and criticism would be difficult if not impossible with behavioral editing data. Using a sample from a large general user survey of Wikipedia allows us to dive into gender differences in perceptions and motivations of

readers, contributors, and former contributors to get a more complete picture.

## **CONTRIBUTION**

Exploring the underlying mechanisms that contribute to the gender contribution gap is important for three reasons.

First, any time a demographic is underrepresented in an organization it is imperative to ask what is causing the demographic to be shifted: personal preference, selection, retention, attraction, or discrimination. Only by understanding the root cause of the gender gap can interventions and organizational programs to recruit and retain female contributors to Wikipedia be designed. Sue Gardner, executive director of the Wikipedia Foundation, has made it a priority to have 25% female contributors by 2015. Having empirical insight as to the cause will aid in that campaign.

Second, the lack of women contributing to Wikipedia has arguably skewed the information found on the site, resulting in a male-dominated knowledge base in some parts of Wikipedia. Because Wikipedia has become widely used as a knowledge resource, with 42% of Americans turning to it for information online, the knowledge that this large portion of society receives should be representative of both men and women in our society [45]. For example, in Wikipedia biographies of females are more likely to be missing than biographies of males [32,33]. Additionally, media critics have pointed out some qualitative comparisons on traditionally female topics (fashion designers, *Sex and the City*) to male topics (*The Sopranos*, *The Simpsons*) suggest other topics besides biographies may be lacking due to the skew [8]. As Gardner states it: “everyone brings their crumb of information to the table, if they are not at the table, we don’t benefit from their crumb” [8].

Third, recent research exploring what makes teams collectively intelligent (high performing across a variety of tasks) has shown that groups with a higher proportion of women outperform more male-dominated groups [44]. Women on average have a greater ability to read interpersonal cues and the motivations of others. If Wikipedia projects [47] and committees [48] within Wikipedia are lacking women, they are not living up to the full performance potential that having a higher proportion of women in the organization could bring.

## **HYPOTHESIS DEVELOPMENT**

Recently the gender contribution gap was addressed in the media with a public discussion by gender researchers and industry experts in online organizations. This paper synthesizes writings from these experts paired with the gender research literature from the social sciences on gender differences to develop hypotheses as to what may be causing the gender contribution gap. Four empirically testable hypotheses were found from the research literature.

Supporting quotes from those articles are found below, along with further development from theory on the psychological foundations of those hypotheses.

## **Conflict**

Several authors suggested that the high level of conflict in the editing and writing process within Wikipedia contributes to the gender contribution gap. Referring to the high conflict culture in Wikipedia, Cassell writes that “rather than seeming like collaborations around the construction of knowledge, [talk pages] are full of descriptions of ‘edit-warring’ — where successive editors try to cancel each other’s contributions out — and bitter, contentious arguments about the accuracy of conflicting points of view” [7]. Known as “the encyclopedia anyone can edit,” Wikipedia may seem like an easy place to contribute knowledge, but in reality Cassell suggests that “to have one’s words listened to on Wikipedia, often one must have to debate, defend, and insist that one’s point of view is the only valid one” [7].

Strong evidence in the research literature on gender and conflict supports the claim that women tend to avoid conflict more than men [4,12,31,43]. Women tend to react to high conflict situations with greater levels of anxiety, increased cardiovascular activity, and stronger negative immune responses than men [17,23,40]. In developmental psychology, research suggests that boys and girls manage conflict in different ways: girls are more likely to accommodate and compromise while boys are more likely to react with hostility [36].

The heavy levels of conflict within Wikipedia may lead to a gender contribution gap for several reasons. From a cultural and societal view, “debate, contention, and vigorous defense of one’s position are often still seen as a male stance” [7]. That is, there may be social pressure, often implicit, for female contributors to not engage in the conflict necessary to contribute to Wikipedia. The literature on gender differences in prescriptive stereotypes suggests that the expression of anger violates the prescriptive norm for feminine behavior, and women tend to be penalized for expressing anger to a greater extent than men [3]. In addition, research on gender stereotypes shows that when women assert themselves in a conflict situation, they are met with significant backlash [38,39]. A previous study on the gender contribution gap in an online email distribution list found that “whereas men tended to say that they found the ‘slings and arrows’ that list members posted ‘entertaining’ (as long as they weren’t directed at them), women reported that the antagonistic exchanges made them want to unsubscribe from the list. One woman said it made her want to drop out of the field of linguistics” [18,19,20].

Previous research in negotiations has found that women tend to avoid negotiating and engaging in conflict, even at significant cost [1]. In some cases women will pay \$1,353 to avoid negotiating the price of a car, and as much as 20%

of adult women say they never negotiate at all, even when they recognize the need to negotiate [1]. Since the Wikipedia model is largely based on considerable amount of conflict resolution, interpersonal debate, and negotiations to arrive at a single “neutral” point of view, gender differences in willingness to engage in these activities could have a significant impact on contribution.

The amount of conflict within Wikipedia may not even be due to many editors being contentious. As one author points out, the nature of Wikipedia is such that “the openness of such communities means that a minority of high-conflict members (including, for example, a misogynist or an internet troll) can have a disproportionate effect on the tone and dynamics of the community” [33].

Following from expert observations and previous empirical research, hypothesis 1 suggests the nature of conflict in Wikipedia in part leads to a gender contribution gap.

**H1:** *Female Wikipedia users are less likely to contribute to Wikipedia due to the high level of conflict involved in the editing, debating, and defending process.*

### **Confidence in Expertise**

Experts suggested that gender differences in confidence in perceptions of personal expertise and the value of one's contribution contribute to the gender gap in Wikipedia. More specifically, authors argue that men on average have a stronger belief in their expertise on subjects and they are more motivated to assert their opinions (often as facts) to the rest of the world. Referring to previous research on this area, Herring writes that “men regularly post longer messages to online discussion forums than women do, and they rarely apologize for message length, even when they go on for 20 screens, whereas women apologize even for short messages. Some women may lack the confidence to contribute to Wikipedia or feel that it would be presumptuous of them to do so” [20]. Etzkowitz and Ranga agree with this take on gender differences in confidence and suggest that “women have often been reported to have much less self-confidence than men, which has a negative impact upon their drive to communicate their opinion to the wider world” [11].

Gender differences in confidence in personal expertise have been shown across disciplines and age groups and are most pronounced in fields such as math, problem solving, engineering, and science [6,21,22,27]. These findings hold across age and achievement groups, from the elementary school level [13] to junior high and high school [37] and undergraduate and graduate levels [10]. In a meta-analysis, gender differences in some areas were shown to be even greater in secondary and post-secondary students than for younger students [21].

The confidence differences, however, are not an indication of differences in actual ability and expertise. In some cases, even when females achieve as well or better than their male

counterparts, they remain under-confident in their performance [13,46]. The confidence difference may not result from females being under-confident overall, but may be caused by males being overconfident even when incorrect [25]. For example, in one case data from achievement tests showed that girls are more likely to choose “I don't know” as an item response when they are unsure of the answer than boys, demonstrating male reluctance to admit when they do not know the answer [24].

It is worth pointing out that this hypothesis, like the others being suggested, is made with respect to population averages (general descriptive data) rather than prescriptive or deterministic outcomes. Of course, as Margolis writes, while “many women love to argue, debate, and write provocative books, there are still too many women who lack sufficient confidence to think that they are expert enough to define a subject” [26].

**H2:** *Female Wikipedia users are less likely to contribute to Wikipedia due to gender differences in confidence in expertise to contribute and lower confidence in the value of their contribution.*

### **Criticism of Others**

While the process of being involved in improving Wikipedia is widely called “contributing”, often the “contribution” involves deleting or modifying another editor's work rather than taking a blank article and producing an original body of knowledge. Similarly, while we often use the term “collaboration” in the sense that many people are collectively producing knowledge. More often in Wikipedia the collaboration process is not synchronous interpersonal collaboration, it is asynchronous individuals writing and editing articles with a technology to mediate and aggregate the output. A large part of contributing, then, is one person editing the work of others that he or she has never met, and competing (rather than collaborating) for one's words to cancel out the contributions of others.

Two major streams of literature in social science can speak to this phenomenon. The first theorizes that women prefer cooperative tasks over competitive tasks. As children, girls are more likely to select activities where there is no winner while boys select competitive games [5]. The theoretical reasons for these differences are investigated in several streams of research, but overall, theories range from an evolutionary base in which men simply enjoy competing more than women, to more nuanced reasons such as men's overconfidence in their ability to win, and a difference in how men and women receive and internalize feedback from winning or losing [28].

The second suggests that men and women respond differently to criticism. Specifically, experimental work has shown that men on average do not respond as much to either positive or negative feedback as women [34,35]. Women tend to respond to positive feedback by increasing

their self esteem slightly, while men are relatively unaffected. When receiving criticism, women's self esteem is substantially decreased as a result, while that of men is again relatively unchanged [22,34].

It follows that gender differences in contribution may result because "a woman who wishes to share knowledge with others might not choose to be part of a forum where engaging in deleting others' words is key" [7]. Put differently, while women may be very interested in participation in "collaborations around the construction of knowledge", they are much less interested in the critical nature of the work in which "successive editors try to cancel each others' contributions out" [7].

**H3:** *Female contributors are less likely to contribute to Wikipedia because they prefer to share and collaborate rather than delete and change other's work.*

#### Discretionary Time

Lastly, one fairly simple explanation for the gender differences in contribution is that women may simply have less discretionary time to commit to contributing to Wikipedia. Women may be more involved in other volunteer and community activities, or family and personal responsibilities and not have as much discretionary time to be more involved. One expert suggests that "since women often have less time than their male counterparts, they may simply have chosen to contribute to other sites instead" [29].

Classic economic research examining human capital posits that one of the reasons for the pay gap between genders is that women take on more household responsibility, and thus have less time available to spend on market work than men [2]. Empirical research among dual career academic households, ostensibly a progressive sample of professionals, finds that among faculty members who are married with children, household labor is distributed in traditional roles, with wives doing substantially more domestic labor than their male counterparts [42].

**H4:** *Female contributors are less likely to contribute to Wikipedia because they have less discretionary time available to spend contributing.*

#### METHODOLOGY

The Wikimedia Foundation in collaboration with United Nations University – MERIT conducted the first worldwide general user survey of Wikipedia during the fall of 2008, from October 18th to November 12th.

The survey went out to 22 language editions, including English, German, Spanish, French, and Russian, and included a total of 176,192 respondents including readers, occasional contributors, regular contributors, administrators, and bureaucrats. Survey items were developed based on previous research on open source software communities and with modifications and additions suggested by the Wikimedia community. Participants were solicited using a banner ad or page header on the top of Wikipedia sites. More details of the survey including tabulated data with an overview of results [15], quality perceptions [16], and age and gender differences [14] can be found at <http://www.wikipediastudy.org>.

#### Sample

For the purpose of this paper, the analysis will focus solely on the English version of the survey with 40,699 participants. Gender issues can be complicated to understand and compare when crossing cultural and language divides. While the English version may still cross many cultural boundaries, it does give us at least a common ground in the language to understand the readership and contribution patterns. Demographic information for the English participants is shown in Table 1. While only one survey was given, depending on the first question in which participants were asked "How do you interact with Wikipedia" the participants were given different questions. This was done because the motivational questions are different if the participant responded "I am a reader of Wikipedia, but I never edit any content", "I am an editor", or "I was a contributor but stopped contributing". That is, it does not make sense to ask a reader "Why do you contribute?", nor would it make sense to ask a current editor "Why did you stop contributing?" The sample sizes (shown in Table 1) reflect sub-samples of respondents to the same survey, but are treated as separate samples since

	Total	Readers	Contributors	Ex-Contributors
<b>N</b>	40,699	22,170	18,573	557
<b>Male</b>	30,197	14,493	15,695	448
<b>Age</b>	26.59	25.88	26.99	30.88
<b>Years of Education</b>	14.12	13.82	14.68	14.74
<b>Partner (Yes)</b>	12,309	6,577	5,690	191
<b>Children (Yes)</b>	6,085	3,347	2,674	123
<b>Employment</b>				
<b>Full Time</b>	11,895	6,168	5,687	165
<b>Part Time</b>	2272	1,295	980	28
<b>Student</b>	19,577	11,102	8,622	165
<b>Unemployed</b>	2107	901	1192	58
<b>Other</b>	3,310	2,640	2,037	103

Table 1. English Version of Wikipedia Summary Statistics

for the purposes of this study they are responding to a different form of the survey.

### Item Selection

Depending on whether the participant indicated they were a reader, contributor, former contributor, or indicated “no, I would not like to contribute more”, they were asked different question stems with respect to their motivation.

The items were taken from the following responses to four questions, given to readers, contributors and former contributors:

*Why don't you contribute to Wikipedia?*

*Why do you not want to be more active in Wikipedia?*

*Why do you contribute to Wikipedia?*

*Why did you stop contributing to Wikipedia?*

In response to each of these, respondents were given a list of reasons to rate and the option to select “other.” The “Why don't you contribute?” question had possible responses given as check boxes, and respondents were allowed to select as many as reasons as apply. Example responses include “I don't know how”, “I would never interact on the internet”, and “I am afraid of making a mistake and getting into trouble for it.” The “Why do you not want to be more active in Wikipedia” question had responses that were rated from 1=I disagree fully to 5=I agree fully and respondents were allowed to rate each reason independently. Example responses include “I don't have time”, “I don't feel comfortable editing other people's work”, and “I am afraid of making a mistake and being criticized.” The “Why do you contribute to Wikipedia?” question asked respondents to rate the top four reasons they contribute to Wikipedia, including “I do it for professional reasons”, “I like the idea of sharing knowledge and want to contribute to it”, and “I saw an error and wanted to fix it.” The question “Why did you stop contributing to Wikipedia?” had the same response systems as the “Why don't you contribute?” with check boxes and the option to select as many as apply. Example responses include “I didn't have enough time to go on”, “I became afraid of making a mistake and being yelled at”, and “I didn't like the direction in which Wikipedia developed.”

Items from the survey were selected to reflect the hypothesis being tested. Since readers, contributors, and former contributors were given different questions, in the analysis the same question may have two different coefficients (e.g. “I don't have time to contribute”) if it were asked to participants regarding “Why don't you contribute?” or “Why don't you want to contribute more?”

Survey items matched with their stems are given in Table 2 using the numerical superscripts. Survey items matched with the hypothesis they are testing are shown in Table 2 along with the coefficients tested and statistical significance level.

Items for hypothesis 1 were selected to reflect the gender differences in (1) no longer contributing because of conflict with other editors, and (2) a dislike for having to defend one's work and being criticized or yelled at.

Items for hypothesis 2 were selected to reflect gender differences in confidence of one's own knowledge, expertise, information, or value of contribution. When asked “Why don't you contribute?” or “Why do you not want to be more active?” participants may have selected that they don't possess enough knowledge or expertise, they don't have enough information, or their edits would be reverted. Since we can assume from the population of readers that male and female readers have equal knowledge and information, these questions do not measure actual knowledge possessed but perceptions of knowledge possessed and confidence to assert that knowledge.

Items for hypothesis 3 were selected to reflect gender differences in (1) perceptions of editing other contributor's work and (2) preference for collaboration. If female users prefer not to edit others work, and prefer to collaborate more on tasks this would show support for hypothesis 3.

Items for hypothesis 4 were selected to reflect gender differences in perceived discretionary time to contribute to Wikipedia. Participants were given an option of lack of time as being a reason for (1) not contributing, (2) not wanting to be more active, and (3) no longer contributing to Wikipedia. All of these were included as items to support hypothesis 4.

### ANALYSIS

The survey data were analyzed using each item as a dependent variable, being predicted from gender, age, years of education, whether the participant has a partner (binary yes or no), and whether the participant has children (yes or no). Descriptive data on all the independent variables are found in Table 1.

The question stem “Why do you not want to be more active in Wikipedia?” was asked on a scale from 1 (disagree fully) to 5 (agree fully), and is predicted using ordinary least squares. The question stem “Why do you contribute to Wikipedia?” allowed respondents to select the top 4 reasons they contribute and was coded as 4=most important reason and 1=fourth most important reason. Responses from this question were predicted using ordinary least squares. All other models were examined using a probit analysis, as each of the responses was either checked on the survey or unchecked (binary outcome).

### RESULTS

Empirical results by survey item and hypothesis are shown in Table 2. The coefficient next to each item in Model 1 is the female coefficient from each model (probit or OLS) where 1=female and 0=male respondents. Model 1 represents the raw difference in responses between men and women. This raw difference is important because the

difference in editing behaviors between men and women may be masked by other demographic and lifestyle differences. For example, if the sample happens to have a higher proportion of women with children than men with children, the effects would be confounded. Because of these types of possibilities, it is important to know both the raw difference and the controlled difference.

Hypothesis 1 examines the role of conflict in the gender contribution gap and is strongly supported from the survey data, having both large effect sizes and statistical significance. Controlling for other factors females were 26% more likely to select “I got into conflicts with other Wikipedia contributors” as a reason for no longer contributing. The coefficients for being afraid of being “criticized”, “yelled at”, and “getting into trouble” are all significant, and in the case of citing fear of being criticized women were 31% more likely to select it as a reason for not wanting to be more active in Wikipedia. These gender effect differences are stable in significance across raw and controlled outcomes.

Hypothesis 2 shows strong statistical significance and large effect sizes. Women are 43% more likely to select “I don’t have enough knowledge or expertise” and 22% more likely to select “I don’t have enough information” to contribute, despite presumably equal knowledge, expertise, and information between genders. Similarly women are 10% more likely to believe their edits are not valuable (they would be reverted or overwritten). When controlling for years of education and partner (both significant) the response rate to the item “I don’t have enough knowledge or expertise to contribute” is reduced significantly, but still has a large effect at 43%.

Hypothesis 3 shows strong support, with women 34% more likely to select “I felt less and less comfortable editing other people's work” as their reason for no longer contributing. Similar findings suggest women are 23% more likely to select “I don't feel comfortable editing other people's work” as a reason for not wanting to be more active. Women also showed a small preference for collaboration and cooperation as a reason for contributing. Effects for this

	<b>Model 1 Female Only</b>	<b>Model 2 Female with Controls</b>
<b>H1: Female Wikipedia users are less likely to contribute to Wikipedia due to the high level of conflict involved in the editing, debating, and defending process.</b>		
I am afraid of making a mistake and being criticized <sup>4</sup> .	0.366***	0.307***
I became a afraid of making a mistake and being yelled at <sup>3</sup> .	0.312**	0.249*
I am afraid of making a mistake and getting in trouble for it <sup>1</sup> .	0.149***	0.126***
I got into conflicts with other Wikipedia contributors <sup>3</sup> .	0.327**	0.264*
<b>H1: SUPPORTED</b>		
<b>H2: Female Wikipedia users are less likely to contribute to Wikipedia due to a lower confidence in their expertise and lower confidence in the value of their contribution.</b>		
I don't think I have enough knowledge or expertise to contribute <sup>4</sup> .	0.524***	0.431***
It's a waste of time: my edits would be reverted or overwritten <sup>1</sup> .	0.149**	0.104*
I don't think I have enough information to contribute <sup>1</sup> .	0.219***	0.224***
<b>H2: SUPPORTED</b>		
<b>H3: Female contributors are less likely to contribute to Wikipedia because they prefer to share and collaborate rather than delete and change other's work.</b>		
I don't feel comfortable editing other people's work <sup>1</sup> .	0.245***	0.232***
I felt less and less comfortable editing other people's work <sup>3</sup> .	0.390***	0.339***
Because I like mass collaboration/cooperation <sup>2</sup> .	0.035**	0.041***
<b>H3: SUPPORTED</b>		
<b>H4: Female contributors are less likely to contribute to Wikipedia because they have less discretionary time available to spend contributing.</b>		
I don't have time <sup>1</sup> .	-0.084	0.065
I don't have time <sup>4</sup> .	0.007	0.048
I didn't have time to go on <sup>3</sup> .	-0.192*	-0.305**
<b>H4: NOT SUPPORTED</b>		
Model 1 coefficients represent the increased likelihood for females of selecting that survey item as a motivation .		
Model 2 coefficients represent the increased likelihood for females of selecting that survey item as a motivation controlling for age, years of education, partner, and children.		
<sup>1</sup> Respondents =Readers, <sup>2</sup> Respondents=Contributors, <sup>3</sup> Respondents=Former Contributors, <sup>4</sup> Respondents who indicated “No” to the question “Would you like to be more active in Wikipedia?”		
* p < .05 ** p < .01 *** p < .001		

**Table 2. Hypotheses Items**

hypothesis are stable across raw differences and controlled effects.

Hypothesis 4 was not supported, and in fact found that men are 19% more likely to select “I didn't have time to go on” as a reason for no longer contributing. The other two measures of perceptions of available time as a reason for non-contribution were not significantly different between genders. These differences were stable across the raw difference and controlled models.

Overall, the gender differences that relate most strongly to differences in contribution within Wikipedia are dislike of conflict, differences in confidence in one's knowledge, expertise, and information available, and differences in their collaboration approach, namely, women prefer to collaborate and cooperate rather than edit other people's work.

### **FOLLOWUP ANALYSIS**

Previous research has shown that gender differences in confidence and avoidance of conflict may interact with age and education levels [21]. Similarly, research on gender and domestic labor has shown differences between men and women in special cases such as child-rearing; that is, women take on much more responsibility when they have children [42]. Further analysis was done using interaction terms for gender\*age, gender\*years of education, and gender\*children. With the exception of a handful of models in which the effect sizes were negligible (<0.02) these interaction terms were all non-significant and did not materially affect the overall model.

Control variables did not have any systematic significant impact on the model outcomes. In most cases control variable effects were non-significant, while in others effects were small but statistically significant. In a small number of outcomes they were large and statistically significant, but not of theoretical interest. They are stated here for completeness. In H1, respondents that reported having children were 13% more likely to choose “I am afraid of making a mistake and being criticized” and were 29% less likely to stop contributing due to conflicts with other contributors. In H2, respondents with a partner were 19% less likely to select “I don't have enough knowledge or expertise” as a reason for not contributing. In the H3 model, no control variables that were significant had a meaningful effect size. In the H4 model, respondents with a partner were 20% more likely to select “I don't have time” as a reason for not contributing more, and 10% more likely to select the same response as a reason they don't contribute at all.

### **LIMITATIONS**

Caution should be taken in interpreting a few aspects of this research. First, the data in this survey relies on self reported attitudes and beliefs and, especially in gender research, these behaviors and attitudes can be below the

conscious surface. Second, this data sample is over-represented by contributors rather than readers and more active contributors than less active contributors. However, this limitation is mitigated to some extent by the inclusion of readers and ex-contributors who would not otherwise be in a sample of contributors only. There are only data for those who chose to respond to the survey. Those with good associations with Wikipedia may have been more apt to respond, resulting in a biased sample in that those who had negative experiences may be under represented in the sample. Third, while the survey items often speak closely to the gender difference hypotheses in motivational and experiential differences, the survey items were designed for more broad purposes and in some places do not contain items that would be present if the survey could be designed specifically to address the gender contribution gap in Wikipedia. Lastly, a handful of hypotheses from both gender research and the expert panel were not able to be tested from the available data; for example, one hypothesis from Oda suggested that trolling and other assaultive behaviors accounted for women not contributing to Wikipedia [29]. While this study sought to empirically test all the most relevant and theoretically grounded hypotheses as to what accounts for the gender gap in contribution, like any study this one is limited to a select few testable hypotheses.

### **DISCUSSION**

This study found strong support for the hypothesis that the gender contribution gap is due in part to responses to conflict. While Wikipedia is the encyclopedia that anyone can edit, the process of doing so is not without interpersonal difficulty. Previous research has shown gender differences in the avoidance of conflict, however, these studies typically rely on experimental data rather than field data. This paper contributes to this stream of research on avoidance of conflict by both demonstrating that this phenomenon occurs even in computer-mediated environments in which gender is not salient, and that this effect impacts female engagement with the organization. In addition, it provides empirical field evidence to support this claim.

While confidence differences between genders with respect to math, sciences, engineering and technology have been explored in the fields of psychology and education, the findings from this paper extend this into the domain of online knowledge contributions. This striking finding that controlling for other factors women are 43% more likely to not contribute because they do not think they have enough knowledge or expertise informs both theory and practice.

Research on giving and receiving positive and negative feedback has demonstrated gender differences in affective outcomes (confidence and self esteem) but much less attention has been given on the impact giving and receiving feedback on withdraw from a task or an organization. This study shows that controlling for other factors women are

34% more likely to not contribute because of their comfort level in editing other's work. The impact of gender differences on giving criticism is understudied, and this paper takes a step in understanding the gender differences with respect to giving and receiving criticism can have on an organization that relies on continual improvement and the criticism from the crowd.

This study takes a stride forward in the research of online communities to better understand gender differences in the online experience. Even though interactions in cyberspace may be largely text based and anonymous, the gender gap in many areas still exists. The removal of explicit gender cues does not by itself create equal gender representation in an online community. As a research community and a design community examining socio-technical systems, understanding the gender differences in experiences of conflict, bolstering willingness to contribute knowledge, and aiding comfort levels in editing and criticizing other's work can be crucial to ensuring women are moving towards being better represented not only in Wikipedia, but in other communities such as software development, knowledge support systems, and online educational communities.

Designing online communities to have a more conducive environment for contributions from anyone makes the final product better for everyone. In the case of Wikipedia, it is not known the knowledge that is missing from the articles yet to be written and in the insights yet to be gained from the largely missing demographic of female contributors. Without empirical support to help understand the underlying "why" question of what is contributing to this problem, ineffective approaches to solving it may fall well short. Each of these findings of gender differences represents a solvable problem that online communities can begin to address to be more inclusive and welcoming to all potential contributors.

## **IMPLICATIONS FOR PRACTICE**

### **Conflict**

As Wikipedia becomes more mature and there are fewer articles that are "low hanging fruit" to edit [41], the editing behavior of existing articles is likely to become even more contentious and thus even more of a turn off for female contributors. Policies such as "Don't Bite the Newcomer" [49] are the in the right spirit, but perhaps have not penetrated the culture. Wikipedia culture can be very rules driven and one can very quickly find themselves being reverted and blasted on their user page for stepping over a rule you were unaware of. Wikipedia Administrators and editors should be encouraged to take it upon themselves to moderate conflict more carefully and with greater attention to human emotions. Other online communities can learn from these findings with respect to conflict as well. If a community tolerates a culture of conflict that males perceived to be simply "competitive" or witty and sarcastic,

they are likely to find themselves losing the many benefits female contributors can bring to the table.

### **Confidence**

Two key interventions could potentially narrow the gap in contributions due to differences in confidence: positive feedback and active invitations to contribute. One of the strongest boosters of confidence in expertise is positive feedback on performance. When women receive positive feedback they respond with a greater increase in self-confidence than men do [34]. Online communities should work to provide positive feedback when a contribution has an impact on the organization. For example, when contributors edit a page that later reaches a quality standard such as "Good" or "Featured", providing a badge or simply alerting them on their user page that their contribution was valued could boost confidence and the likelihood of future contributions.

While many contributors may not have the confidence in their expertise to jump write in editing an article, users have been found to respond to invitations and suggestions to participate [9]. Wikis and other contribution systems should include intelligent task routing and request systems to ask users for their participation in areas that the use may have the most confidence in editing. Confidence data could be mined by simple surveys of interest and expertise or past editing behavior.

### **Criticism**

The empirical support finding gender differences in willingness to edit other's work and willingness to delete others contributions has implications for many wiki-based platforms, including Wikibooks, Wiki-news, and Wikiversity. Even though the premise of these communities is the acceptance of free and open knowledge, if these communities do not provide tools or systems that ameliorate women's dislike of editing others work they will likely find women underrepresented both in their communities and in the knowledge that goes into their output.

Women on average tend to prefer collaboration to competition and criticism. In Facebook and Twitter and other more social platforms we find women are heavily involved. However, Wikipedia and other knowledge repositories by their culture and policies proclaim to be a place that is not meant to be social. For example a previous policy at Wikipedia discouraged users from treating Wikipedia as a social space by proclaiming "Wikipedia is not MySpace" [50]. Design improvements to online contribution sites should allow for collaboration which involves social interaction rather than mutual criticism. For example, allowing for social or educational discussion of an article or subject would allow collaborators to first interact and get a sense of each other's interests and abilities and perhaps provide social motivation to collaborate together on article editing. Within the existing structure of Wikipedia,



collaboration on WikiProjects [47] may encourage women to collaborate with other editors they have worked with in the past and foster a culture of collaboration rather than competition.

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#### REFERENCES

1. Babcock, L. and Laschever, S. *Women Don't Ask: Negotiation and the Gender Divide*. Princeton University Press, Princeton, NJ, 2003.
2. Becker, G.S. Human capital, effort, and the sexual division labor. *Journal of Labor Economics* 3, (1985), 533-538.
3. Brescoll, V.L. and Uhlmann, E.L. Can an angry woman get ahead? Status conferral, gender, and expression of emotion in the workplace. *Psychological Science* 19, 3 (2008), 268-275.
4. Brewer, N., Mitchell, P., and Weber, N. Gender Role, Organizational Status, and Conflict Management Styles. *International Journal of Conflict Management* 13, 1 (2002), 78-94.
5. Campbell, A. *A Mind of Her Own: The Evolutionary Psychology of Women*. Oxford University Press, Oxford, UK, 2002.
6. Campbell, N.D. and Hackett, G. The effects of mathematics task performance on math self-efficacy and task interest. *Journal of Vocational Behavior* 28, (1986), 149-162.
7. Cassell, J. Edit Wars Behind the Scenes. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/a-culture-of-editing-wars>.
8. Cohen, N. Define Gender Gap? Look Up Wikipedia's Contributor List. *New York Times*, 2011.
9. Cosley, D., Frankowski, D., Terveen, L., and Riedl, J. Suggestbot: Using intelligent task routing to help people find work in wikipedia. ACM Press (2007).
10. Dix, L.S. Women: Their underrepresentation and career differentials in science and engineering. *Proceedings of a workshop at the National Academy of Sciences*, National Academy Press (1987).
11. Etzkowitz, H. and Ranga, M. Nerd Avoidance. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/wikipedia-nerd-avoidance>.
12. Falbo, T. and Peplau, L.A. Power strategies in intimate relationships. *Journal of Personality and Social Psychology* 38, 4 (1980), 618-628.
13. Fennema, E.H. and Sherman, J.A. Sex-related differences in mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education* 9, (1978), 189-203.
14. Glott, R. and Ghosh, R. Analysis of Wikipedia Survey Data: Age and Gender Differences. 2010. <http://www.wikipediasurvey.org>.
15. Glott, R., Schmidt, P., and Ghosh, R. Wikipedia Survey – Overview of Results. 2010. <http://www.wikipediasurvey.org>.
16. Glott, R., Schmidt, P., and Ghosh, R. Analysis of Wikipedia Content: Quality of Wikipedia Content. 2010. <http://www.wikipediasurvey.org>.
17. Gottman, J.M. and Levenson, R.W. Marital processes predictive of later dissolution: Behavior, physiology, and health. *Journal of Personality and Social Psychology* 63, (1992), 221-233.
18. Herring, S. Gender and Participation in Computer-Mediated Linguistic Discourse. *Annual Meeting of the Linguistic Society of America*, (1992).
19. Herring, S. Gender and Power in Online Communication. In J. Holmes and M. Meyeroff, eds., *The Handbook of Language and Gender*. Blackwell, Oxford, 2003.
20. Herring, S. A Difference of Communication Styles. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/communication-styles-make-a-difference>.
21. Hyde, J.S., Fennema, E., Ryan, M., Frost, L.A., and Hopp, C. Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of Women Quarterly* 14, (1990), 299-324.
22. Johnson, J. Effects of successful female role models on young women's attitudes toward traditionally male careers. *Annual Conference of the Association for Educational Communications and Technology*, (1989).
23. Kiecolt-Glaser, J.K., Newton, T., Cacioppo, J.T., MacCallum, R.C., Glaser, R., and Malarkey, W.B. Marital conflict and endocrine function: Are men really more physiologically affected than women? *Journal of Consulting and Clinical Psychology* 64, 2 (1996), 324-332.
24. Linn, M.C. Meta-analysis of studies of gender differences: Implications and future directions. In J.S. Hyde and M.C. Linn, eds., *The psychology of gender: Advances through meta-analysis*. The Johns Hopkins University Press, Baltimore, 1986, 210-231.

25. Lundeberg, M. a, Fox, P.W., and Puncocar, J. Highly confident but wrong: Gender differences and similarities in confidence judgments. *Journal of Educational Psychology* 86, 1 (1994), 114-121.
26. Margolis, J. Hearing Women's Voices. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/hearing-womens-voices>.
27. Matyas, M.L. Science career interests, attitudes, abilities and anxiety among secondary school students: The effects of gender, race/ethnicity and school type/location. *Annual Meeting of the National Association for Research in Science Teaching*, (1984).
28. Niederle, M. and Vesterlund, L. Do Women Shy Away From Competition? Do Men Compete Too Much? *The Quarterly Journal of Economics* 122, 3 (2007), 1067-1101.
29. Oda, T. Trolls and Other Nuisances. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/trolls-and-other-nuisances>.
30. Powell, W.E., Hunsinger, D.S., and Medlin, B.D. Gender Differences within the Open Source Community: An Exploratory Study. *Journal of Information Technology* 21, 4 (2010), 29-37.
31. Rahim, M.A. A measure of styles of handling interpersonal conflict. *The Academy of Management Journal* 2, (1983), 368-376.
32. Reagle, J. and Rhue, L. Gender Bias in Wikipedia and Britannica. *International Journal of Communications* 5, (2011), 1138-1158.
33. Reagle, J. 'Open' Doesn't Include Everyone. 2011. <http://www.nytimes.com/roomfordebate/2011/02/02/w-here-are-the-women-in-wikipedia/open-doesnt-include-everyone>.
34. Roberts, T.A. and Nolen-Hoeksema, S. Gender comparisons in responsiveness to others' evaluations in achievement settings. *Psychology of Women Quarterly* 18, (1994), 221-240.
35. Roberts, T.A. Gender and the influence of evaluations on self-assessments in achievement settings. *Psychological Bulletin* 109, (1991), 297-308.
36. Rose, A.J. and Asher, S.R. Children's goals and strategies in response to conflicts within a friendship. *Developmental Psychology* 35, (1999), 69-79.
37. Rosen, B.C. and Aneshel, C.S. Sex differences in educational-occupational expectation process. *Social Forces* 57, 1 (1978), 164-186.
38. Rudman, L.A. and Fairchild, K. Reactions to counterstereotypic behavior: The role of backlash in cultural stereotype maintenance. *Journal of Personality and Social Psychology* 87, 2 (2004), 157-176.
39. Rudman, L.A. Self-promotion as a risk factor for women: The costs and benefits of counterstereotypical impression management. *Journal of Personality and Social Psychology* 74, 3 (1988), 629-645.
40. Smith, T.W., Gallo, L.C., Goble, L., Ngu, L.Q., and Stark, K.A. Agency, communion, and cardiovascular reactivity during marital interaction. *Health Psychology* 17, 6 (1998), 537-545.
41. Suh, B., Convertino, G., Chi, E.H., and Pirolli, P. The Singularity is Not Near: Slowing Growth of Wikipedia. *WikiSym*, (2009).
42. Suitor, J.J., Mecom, D., and Feld, I.S. Gender, household labor, and scholarly productivity among university professors. *Gender Issues* 19, 4 (2001), 50-67.
43. Valentine, P.E.B. Management of conflict: Do nurses/women handle it differently. *Journal of Advanced Nursing* 22, 1 (1995), 142-149.
44. Woolley, A.W., Chabris, C.F., Pentland, A., Hashmi, N., and Malone, T.W. Evidence for a Collective Intelligence Factor in the Performance of Human Groups. *Science*, (2010), 686-688.
45. Zickurh, K. Wikipedia, past and present. Pew Internet & American Life Project. 2011. <http://pewinternet.org/Reports/2011/Wikipedia.aspx>.
46. Zukerman, H. Persistence and change in the careers of men and women scientists and engineers: A review of current research. In L.S. Dix, ed., *Women: Their underrepresentation and career differentials in science and engineering*. National Academy Press, Washington, DC, 1987, 123-156.
47. Wikipedia: WikiProjects. <http://en.wikipedia.org/wiki/Wikipedia:WikiProject>.
48. Wikipedia: Arbitration Committee. [http://en.wikipedia.org/wiki/Wikipedia:Arbitration\\_Committee](http://en.wikipedia.org/wiki/Wikipedia:Arbitration_Committee).
49. Please Do Not Bite Newcomers. [http://en.wikipedia.org/wiki/Wikipedia:Please\\_do\\_not\\_bite\\_the\\_newcomers](http://en.wikipedia.org/wiki/Wikipedia:Please_do_not_bite_the_newcomers).
50. Wikipedia is Not MySpace. <http://en.wikipedia.org/wiki/Wikipedia:NOT#MYSPACE>.