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ABSTRACT

Gender studies show numerous differences between genders in regard to technology, and emphasize that women are underrepresented in IT-related academic programs and careers. Because technology is so prevalent in our workforce, it is important to study how technology usage affects white-collared working women. We explore the relationship between three dimensions of technology overload and knowledge worker job performance (stratified by gender) through a quantitative analysis. Our results show that female knowledge workers perceive a more significant and negative relationship than men between technology overload and job performance even when they do not rely heavily on technology in the workplace. Addressing technology overload may thus positively impact women's career development.

Keywords (Required)

Gender, knowledge worker, technology overload

INTRODUCTION

Women are underrepresented in IT-related degree programs, and the number of women graduating with these degrees has continued to decrease over the years. From 1984 to 1985, 36.8% of computer and information science graduates were women, but from 2000 to 2001, this number decreased to 27.7% (Freeman 2004). The lack of women in these degree programs severely hurts the proportion of women in the IT field. In fact, women represented only 25.6% of the math and computer science work force in 2007, which is a decline from 31% in 1983 (National Science Foundation 2009). Women leaders are also underrepresented, as only 5% of CIO's in Fortune 100 companies are women and only 13% of board seats are held by women (Alliance for Board Diversity 2008; National Center for Women & Information Technology 2007). Unfortunately, this problem may stretch even further than just the IT community. Today, most knowledge work requires extensive use of computers and our dependence on technology has never been higher. Negative experiences and perceptions of technology may impact women's development and success in their careers and their career choices.

A range of research has explored the perceptions of technology related to gender. For example, previous research has demonstrated that women have higher levels of computer anxiety (Whitley 1997; Jackson et al. 2001), lower self-efficacy in IT careers, and less passion for computers than men (Michie and Nelson 2006). Our research investigates the relationship between technology overload and performance in the workplace. Technology overload is a phenomenon that occurs at the point in which more technology usage, which otherwise improved workers' productivity, has reached the point of diminishing marginal returns (Karr and Lu 2007). In other words, when technology overload occurs, adding more information technology leads to productivity losses instead of gains. In this paper, we investigate whether technology overload has a greater impact on women by studying the perceptions of knowledge workers across multiple industries. Knowledge workers are white collared workers engaged in the production, process, or distribution of information, who represent the majority of the US workforce (Aral et al. 2006; Drury and Farhoomand 1999). We found strong evidence that suggests female knowledge workers perceive technology overload as significantly and negatively linked to their job performance more so than their male counterparts. In light of these findings, there is the new challenge to mitigate technology overload in the workplace and better support both men and women in their careers.

We will first introduce the dimensions of technology overload and technology dependence. We then explore the role of gender as it relates to technology overload and present our hypotheses. Lastly, we explain our study methodology, the results, and discuss the implications of our findings.

BACKGROUND

Technology Overload

Through qualitative and quantitative methods we previously identified three salient dimensions of technology overload: information, system feature, and communication overload (Karr and Lu 2010). In this paper, we examine the impact of gender on this relationship. The next sections review the theoretical basis of the three dimensions included in technology overload.

Information Overload

Information overload occurs when knowledge workers' time constraints and cognitive limits have been reached; O'Reilly (1980) was one of the first researchers to examine the impact of information overload on organizational performance at the individual level of analysis. He found that decision makers tend to seek more information than necessary and that this information overload decreases decision-making performance but paradoxically increases decision-maker confidence and satisfaction in their decisions. Therefore, even though individuals had the belief that "more information is better," this was not in fact the case. Indeed, O'Reilly found that perceived information overload was associated with a decreased in overall performance (1980).

System Feature Overload

System feature overload occurs when a software package becomes too complex for a given task to the point that knowledge workers' productivity is impeded. This is explained by cognitive load theory, which posits that optimal learning occurs when an individual's working memory is minimized so that long term memory can be facilitated (Sweller 1988). The theory of task-technology fit supports cognitive load theory by observing that increased utilization of a system can actually result in poorer individual performance if the technology does not readily support the subset of tasks an individual need to perform (Goodhue and Thompson 1995). The fundamental argument is that a particular technology must fit the task in order to confer benefits to the user. Up to a certain point, adding a new feature increases the marginal utility of the software package.

Communication Overload

Communication overload occurs when a third party *solicits* the attention of the knowledge worker through such means as e-mail, instant messaging, or mobile devices that causes excessive interruptions to the point the worker becomes less productive. A distinction is drawn between information overload and communication overload because knowledge workers *seek* information while communication is initiated by a third party. Cognitive studies suggest that a certain level of interruption can actually improve performance by increasing an individual's focus on the primary task and allowing the individual to multitask. However, they have also shown that excessive interruptions affect human behavior by negatively impacting recall, accuracy, efficiency, stress level, and ultimate performance (Cohen 1980; McFarlane and Latorella 2002; Van-Bergen 1968).

Technology Dependence

Technology dependence is an over-reliance on technology to the point that system failures create loss of productivity. "Over-reliance on the functionality of the system to reap information technology benefits" has been cited as a risk of IT usage within organizations (Dhillon and Backhouse 1996). Although this construct is tied in closely with the hardware and software performance issues, a clear distinction is the observation that knowledge workers did not have alternative means to complete their work. Therefore, when technology became unavailable, knowledge worker productivity came to a halt.

In summary, information, communication, and system feature overload collectively contributed to technology overload. Knowledge workers with high levels of technology dependence are significantly and negatively impacted by technology overload while those less dependent on technology are not significantly impacted (Karr and Lu 2010). However, gender effects of technology overload have yet to be explored. In this paper, we focus specifically on gender and its role between technology overload and knowledge worker productivity.

RESEARCH FRAMEWORK

We are interested in whether gender has any impact on the relationship between technology overload and job performance. Our hypotheses on the role of gender will be discussed for each of the constructs and relationships we have measured, along with the related work that informed them. Research in gender computing has looked at many aspects of gender differences to account for the lack of women in computing fields. One body of research has focused on differences in computing attitudes between men and women. Several studies have identified that women have more computer anxiety, men have more computer self-efficacy, and women have more sex-role stereotypes about computing (Whitley 1997, Jackson et al. 2001). Blackwell et al.'s (2009) study on programming home appliances found that women estimated the task difficulty of programming home appliances as significantly harder than the male study participants. Based on this past research, we expect that women will self-report significantly lower levels of technology-based performance than men.

While women seem to be less confident in their technology-based performance, little research suggests that they would be less confident in their overall performance. Hind and Baruda (1997) looked at differences in men and women and their work performance. The authors found no significant gender differences with the exception of self-appraisal against co-workers, where females rated themselves significantly lower than their co-workers. Blackwell et al.'s (2009) study on programming home appliances found no significant gender effect for task completion, estimated likelihood of success, and actual task success. Since women's performance ratings were the same as men for most measurements, we do not expect to see any significant differences for overall job performance.

> *H1: Women will report significantly lower levels of technology-based performance than men.*
>
> *H2: There are no significant differences between men and women in perceived levels of overall performance.*

Technology overload has several dimensions, each of which may be impacted by gender. For example, research suggests women may be better communicators (Baird & Bradley 1979) and men better problems-solvers (Miller and Bichsel 2004; Silverman 1970). We are also interested if men and women differ in their perceived levels of technology dependence. However, we could not find any past research to suggest one gender leverages technology better or depends on it more than the other. Therefore, we are testing the null hypothesis that there are no gender differences in technology overload and technology dependence.

> *H3: There are no significant differences between men and women in perceived levels of the dimensions of technology overload.*
>
> *H4: There are no significant differences between men and women in perceived levels of technology dependence.*

Technology Overload and Performance

Overall, technology overload is negatively associated with self-reported job performance (Karr and Lu 2010). Since women already reported lower attitude measures in previous studies (Whitley 1997; Jackson 2001; Michie and Nelson 2006), we believe that women will have a stronger negative relationship between technology overload and their job performance than men.

> *H5: Women will perceive a significantly stronger negative relationship between the dimensions of technology overload and their technology-based performance than men.*
>
> *H6: Women will perceive a significantly stronger negative relationship between the dimensions of technology overload and their overall performance than men.*

Technology Dependence and Gender

As stated earlier, technology dependence moderates technology overload and knowledge worker performance; high levels of technology dependence lead to a significant and negative correlation between technology overload and performance (Karr and Lu 2010). We have no reason to expect significant differences between men and women for these relationships. Thus,

> *H7: For low levels of technology dependence, neither men nor women will perceive a significant and negative relationship between the dimensions of technology overload and overall performance.*

H8: For high levels of technology dependence, both men and women will perceive a significant and negative relationship between the dimensions of technology overload and overall performance.

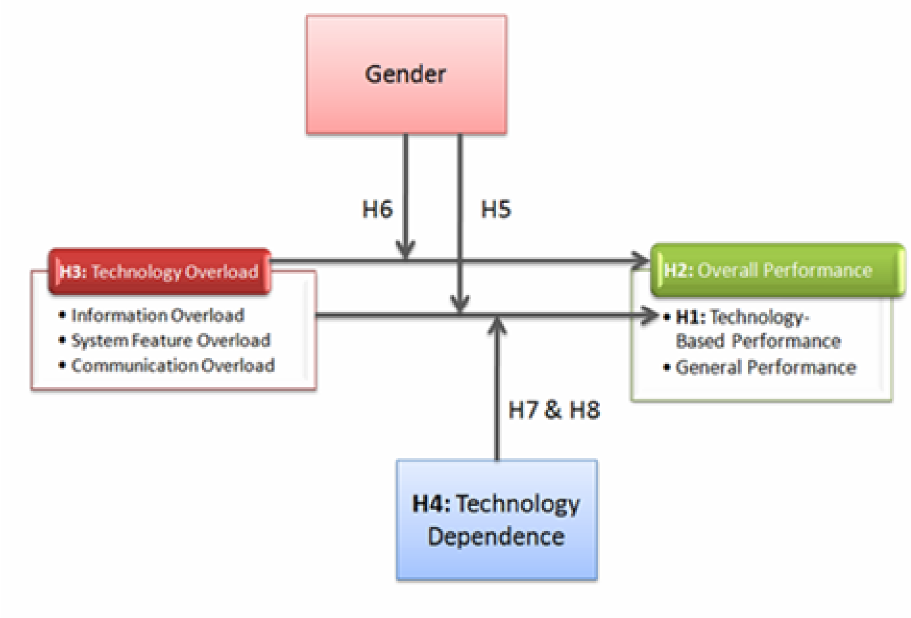

Figure 1. Research Model

METHODOLOGY

Operationalization of Constructs

The constructs of interest are technology overload, technology dependence, technology-based performance, overall performance, and gender. All variables were measured using a pre-existing and validated survey instrument (Karr and Lu 2010). Technology overload was operationalized as a 12-item multidimensional construct comprised of information, system feature, and communication overload. We provided statements where respondents ranked their level of agreement on a 9-point Likert scale. A confirmatory factor analysis using LISREL and structural equation modeling validated the survey instrument (NFI = 0.95, CFI = 0.98, AGFI = 0.84, GFI = 0.90). Information, system feature, and communication overload Cronbach's alphas were 0.72, 0.78, and 0.73 respectively which are considered above the accepted 0.70 cut off for social sciences (Miller 1995). Technology dependence was captured using four survey questions yielding a Cronbach's alpha of 0.75. Technology-based performance was captured using two survey items regarding the efficient and effective use of technology to enhance job performance (Cronbach's alpha = 0.93). Overall performance was measured by incorporating technology-based performance with individual levels of efficiency and effectiveness (Cronbach's alpha = 0.87). All measures were calculated as additive indices of the survey items. Gender was captured as a categorical variable (i.e., male and female). All measures are perceived values studied at the level of analysis for an individual. The complete survey instrument is available upon request.

Data Collection

We constructed a web-based survey of 111 knowledge workers using a "Snowball" sampling procedure (Babbie 2004) to ensure participants were from a wide range of backgrounds. We collected contextual information about the participants, which included gender, age, number of employees, level of education, industry, years with company, and years in industry. Females comprised 50% of the sample. After removing responses that were incomplete, we had a total of 102 participants. Fifty-two females and fifty males participated in the study.

RESULTS

Descriptive Statistics of Sample

Participants between the ages of 25 and 50 represented 75% of our sample, while 11% were under 25 and 14% were over 50. Most of the participants (82%) managed between zero to five employees. The sample was well-educated with approximately 58% of the sample having at least a four year degree and 42% having at least some graduate experience. The knowledge workers came from a variety of industries. The top industry sectors included banking and finance (18%), education (16%), computers and software (14%), and manufacturing (11%). Sixty-seven percent had been with their industry over six years, while only 13% had been in the industry for two years or less.

Statistical Analysis

Our first set of hypotheses test whether or not there are mean differences between genders regarding our constructs of interest: technology-based performance, overall performance, technology overload, and technology dependence. Table 1 summarizes the descriptive statistics for these variables.

		Mean	**Std. Deviation**
Technology-based Performance	Men	14.5400	2.70457
	Women	14.0962	3.00496
Overall Performance	Men	29.2400	4.43805
	Women	28.1154	5.62437
TECHNOLOGY OVERLOAD	Men	60.5600	15.71190
	Women	57.6154	15.49213
Information Overload	Men	15.6800	4.69668
	Women	15.4808	4.48741
System Feature Overload	Men	24.6200	8.02519
	Women	23.0192	6.89555
Communication Overload	Men	20.2600	6.30131
	Women	19.1154	6.49179
Technology Dependence	Men	27.8000	6.10787
	Women	27.5385	6.10837

Table 1. Descriptive Statistics

A simple analysis of variance (ANOVA) was an appropriate statistical test for our hypotheses. Table 2 displays the ANOVA results for each variable of interest.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Technology-based Performance	5.022	1	5.022	.613	.435
Overall Performance	32.239	1	32.239	1.250	.266
TECHNOLOGY OVERLOAD	221.019	1	221.019	.908	.343
Information Overload	1.012	1	1.012	.048	.827
System Feature Overload	65.318	1	65.318	1.170	.282
Communication Overload	33.396	1	33.396	.816	.369
Technology Dependence	1.744	1	1.744	.047	.829
Total	3732.667	101			

Table 2. Analysis of Variance Between Groups (ANOVA)

Although we expected to find significant differences between men and women for technology-based performance, we found no significant differences between men and women for both technology-based and overall performance. Therefore, hypothesis 1 is not supported, and hypothesis 2 is supported. However, it is interesting to note that overall, men reported a higher average performance rating than women for both technology-based and overall performance (though not statistically significant). This may reflect past research that suggested women tend to under-report their own performance (Hind and Baruda 1997) but not to a level that makes their performance ratings significantly different than their male counterparts.

For the remainder of our variables of interest, we tested the null hypothesis that there would be no difference between men and women based on the dimensions of technology overload and technology dependence. In both cases, these hypotheses (3 & 4) were supported. We found no significant differences between men and women for overall technology overload and also for each of the dimensions of technology overload individually. Additionally, there was no significant difference between men and women based on perceived levels of technology dependence. In fact, it is very important that we found no significant differences between men and women based on all the constructs of interest. Since there are no mean differences exhibited between men and women based on technology overload, technology dependence, and performance levels, any significant differences we find in the relationship between these variables for men and women will not be confounded by possible mean differences between genders.

The next group of hypotheses (5 & 6) test whether or not there are significant differences in the relationship between technology overload and performance metrics. Therefore, we chose to test this statistically by calculating Pearson's correlations to examine important relationships. The results were similar with respect to technology-based performance and overall performance. For technology overload, women perceived a significant and negative relationship between technology overload and performance, while men reported a negative but non-significant relationship. Thus, the data supports hypotheses 5 and 6. However, when taking into account the different dimensions of technology overload, the relationship between performance measures and system feature overload for both men and women were negative but not significant. Another interesting result was that men actually perceived a positive relationship between information overload and performance. This suggests that men may have a higher threshold for synthesizing a large amount of information than women. We present these results in Table 3 and graphically represent them in Figure 2.

	Technology-based Performance		**Overall Performance**	
	Men	Women	Men	Women
TECHNOLOGY OVERLOAD	-.157	-.358(**)	-.064	-.356(**)
Information Overload	.040	-.361(**)	.053	-.336(*)
System Feature Overload	-.167	-.247	-.070	-.259
Communication Overload	-.208	-.342(*)	-.110	-.342(*)
N	50	52	50	52

**** Correlation is significant at the 0.01 level (2-tailed).   * Correlation is significant at the 0.05 level (2-tailed).**

Table 3. Pearson's Correlations for Information, System Feature, Communication Overload, and Performance

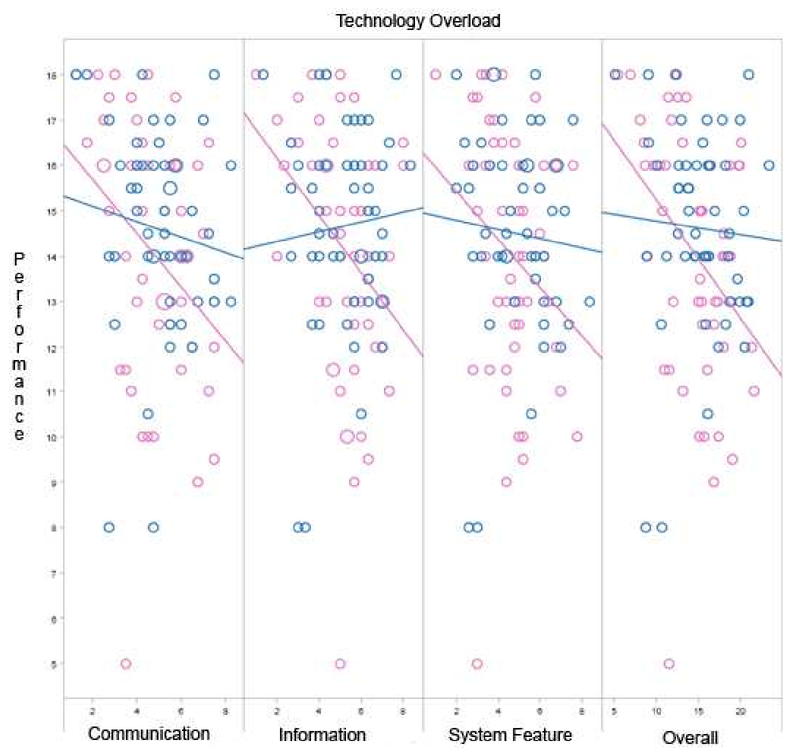

Figure 2. Relationship between overall performance (y-axis) and the dimensions of technology overload (x-axes) for men (blue) and women (pink)

To test hypotheses 7 & 8 we stratified the sample by the mean value of technology dependence (low technology dependence < 27, high technology dependence >=27). Our results for low technology dependence were very surprising (See Table 4 and Figure 3). First, while the correlations for men were not significant, they were actually positive. In other words, there was a direct correlation between technology overload and overall performance for men given low levels of technology dependence. One possible explanation for this is that men prefer leveraging technology to get their work done and have a higher threshold for technology overload than women. Second, the relationship between the dimensions of technology overload and overall performance was actually a statistically significant and negative relationship for information overload, system feature overload, and technology overload overall for women. Thus, the data suggests that even for low levels of technology dependence, women perceive their overall performance to be significantly and negatively impacted by technology overload. Only communication overload was not significantly correlated to performance for women which is consistent with past research that suggests women are considered stronger communicators (Baird & Bradley 1979).

OVERALL PERFORMANCE	Men	Women
TECHNOLOGY OVERLOAD	.382	-.493(*)
Information Overload	.248	-.594(**)
System Feature Overload	.450	-.495(*)
Communication Overload	.261	-.208
N	18	19

Table 4. Pearson's Correlations for Technology Overload and Performance for Low Technology Dependence

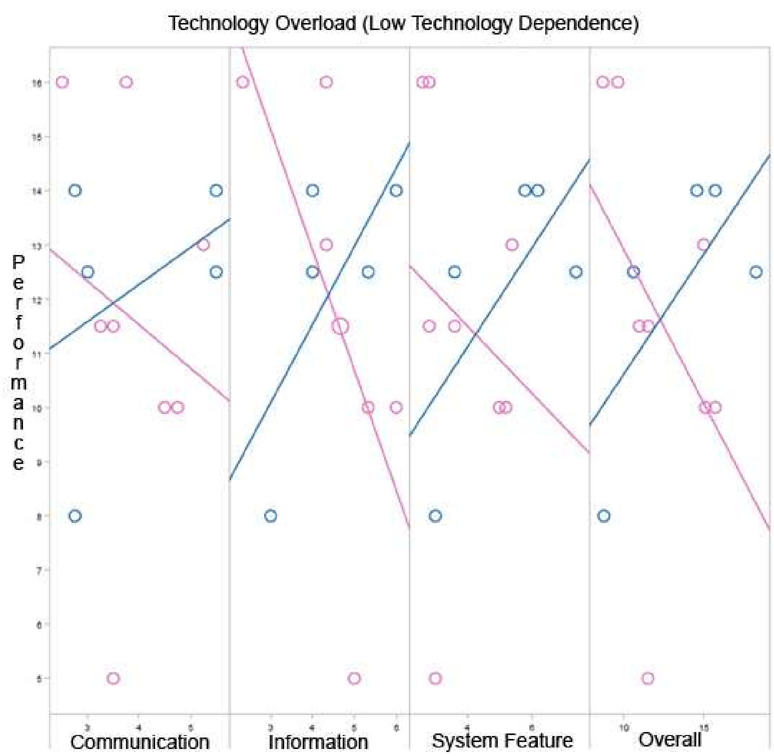

Figure 3. Low Technology Dependence and the Relationship between overall performance (y-axis) and the dimensions of technology overload (x-axes) for men (blue) and women (pink)

For high levels of technology dependence, we also found partial support for our hypothesis (8). The relationship between the dimensions of technology overload and overall performance for men was statistically significant and negative overall, but was not significant for information overload and system feature overload. For women, the relationship between the dimensions of technology overload and overall performance was statistically significant and negative. However, neither men nor women reported a statistically significant correlation between system feature overload and overall performance. One interesting point to note for high levels of technology dependence, the negative impact of the dimensions of technology overload is consistently higher for women than men. For instance, when women are highly dependent on technology to perform their job duties, they perceive the strongest negative impact from communication overload (r = -0.650) related to their overall performance. This contrasts significantly with the results for low technology dependence above.

OVERALL PERFORMANCE	**Men**	**Women**
TECHNOLOGY OVERLOAD	-.439(*)	-.548(**)
Information Overload	-.230	-.442(*)
System Feature Overload	-.325	-.315
Communication Overload	-.490(**)	-.650(**)
N	32	33

**** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).**

Table 5. Pearson's Correlations for Technology Overload and Overall Performance for High Technology Dependence

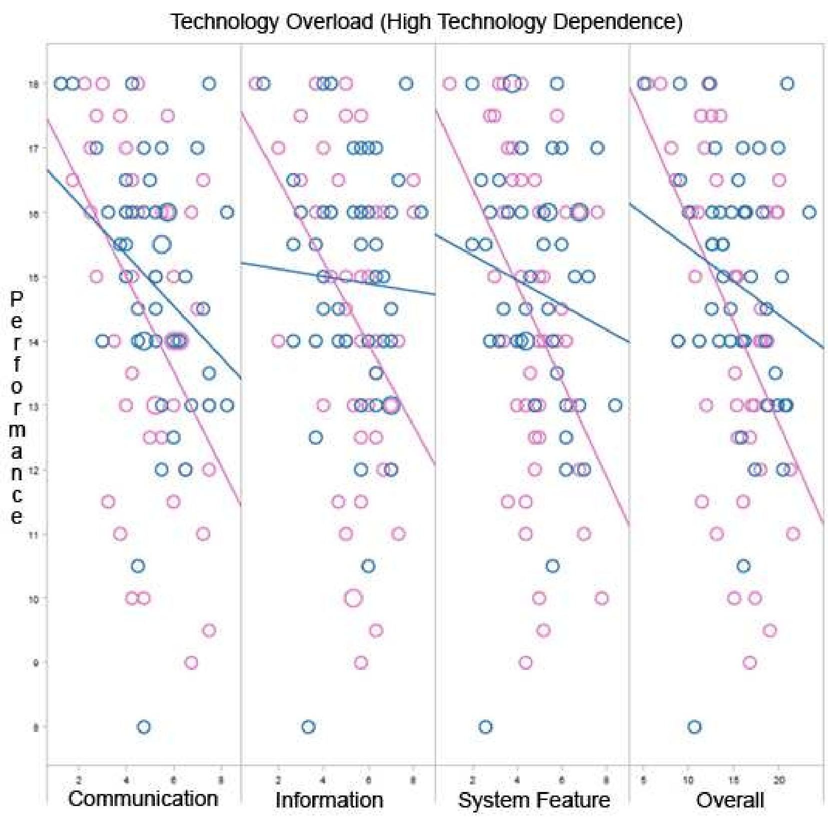

Figure 4. High Technology Dependence and the Relationship between overall performance (y-axis) and the dimensions of technology overload (x-axes) for men (blue) and women (pink)

Table 6 summarizes our hypotheses and findings.

Hypotheses	Results
H1	**Not Supported.** Women did not report significantly lower levels of technology-based performance than men.
H2	**Supported.**
H3	**Supported.**
H4	**Supported.**
H5	**Mostly Supported.** The relationship was not significant for system feature overload.
H6	**Mostly Supported.** The relationship was not significant for system feature overload.
H7	**Partially Supported.** This relationship was significant and negative for women for technology overload overall and each dimension individually except communication overload.
H8	**Partially Supported.** For men the relationship was not significant for information and system feature overload. For women, system feature overload was insignificant.

Table 6. Summary of Hypotheses Testing

DISCUSSION

Implications

While this paper focuses specifically on gender, it is important to note that we tested all control variables in our data set for significant differences in terms of technology overload and its relationship with knowledge worker productivity. This included age, educational level, number of employees managed, and industry. Though some of the results proved insignificant due to sample size, in most cases, we did not find any consistent and significant between group differences for any of the control variables except gender. The results from this study are important for many audiences. First, corporations who are devoted to diversity in the workplace may find ways to provide better support for women to mitigate their levels of perceived technology overload. The key is that organizations must realize that men and women react to technology differently. This is also an important implication for both educators and designers. College-level courses and continuing education could include courses on how to manage technology overload. Techniques could include personal growth strategies, such as time management to tools that can reduce various types of overload such as RSS feeds, aggregators, intelligent agents, personalization, etc. Designers, when developing these tools, also need to keep in mind usability based on gender. The majority of designers, programmers, and quality assurance specialists are male; therefore, the interface design of systems may inadvertently interject a male biased. Finally, women can use the technology overload survey instrument themselves as a prescriptive tool to become aware of their strengths and weaknesses with technology. Closing the loop, women can seek out educators who can help them develop the skills they need and utilize effective tools to reduce their levels of technology overload. As a result, corporations, educators, designers, and female knowledge workers together may be able to increase the retention and success of women in IT-intensive careers.

Limitations and Future Research

The gender differences we found in the relationships between the dimensions of technology overload, technology dependence, and performance are substantiated by our finding of no between-group differences for men and women for technology-based performance, overall performance, dimensions of technology overload, and technology dependence (H1, H2, H3, & H4). Our statistical analysis suggests that women do indeed perceive a greater negative relationship between technology overload and their job performance than men. This exists even for low levels of technology dependence. The first point we must make is that correlation analysis does not imply causality. Therefore, we cannot claim that technology overload negatively impacts women's performance more so than men.

We can only say that there is a significantly stronger negative relationship between the dimensions of perceived technology overload and performance for women. This opens up new research opportunities to explore why this is the case and how it actually affects women in the work place.

Since we used perceived measures, one could also argue that a limitation of this research is a discontinuity between perception and reality. Thus, one explanation is that there truly is a stronger negative correlation between technology overload and performance for women than men. Alternatively, women may simply perceive that they are impacted more negatively. We feel that perception, given the context of this research, is as important as any objective measures. Past researchers have also argued that perceived measures of information overload may be better predictors of pertinent outcomes than objective measures because determinants are affected by situational and individual differences (Eppler and Mengis 2004; O'Reilly 1980). However, a possible area for future research would be to find objective measures for technology overload, technology dependence, and performance metrics. Finally, we acknowledge that being physically male versus female is a superficial characterization for examining technology overload and productivity differences. As researchers, we must continue to delve beyond "gender" for the underlying cognitive processes and behaviors that truly drive these differences.

CONCLUSION

Overall, our results suggest significant differences between men and women regarding the relationship between the dimensions of technology overload and performance. Specifically, women perceive a significantly stronger negative relationship between technology overload and performance (H5 & H6). Even for low levels of technology dependence, women still exhibit strong negative correlations between technology overload and performance, which becomes even stronger when they are highly dependent on technology to perform their job duties (H7 & H8). The implication that women perceive a stronger negative relationship between the dimensions of technology overload and performance in the work place are far reaching. The way individuals leverage technology in their jobs often dictates career success or failure. How an individual perceives their ability to handle technology overload at work can also affect job satisfaction. As more technology enters the work place, both men and women must be able to leverage information technology instead of becoming overwhelmed by it. Thus, we need to identify problematic areas, acknowledge possible gender differences, and to account for them in an equitable way. Identifying statistically significant gender differences based on perceived levels of technology overload and performance is a step towards this goal.

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