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A Deeper Look at Technology Adoption: Moderation and Technology Selection

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ABSTRACT

This study proposes a model of factors that may be driving previously observed gender differences in acceptance decision-making. In particular, a significant effect is found for generalized computer self-efficacy, over and above that of psychological gender role identified in prior related research. However, this study departs from prior work in technology adoption by employing actual choice between competing technologies for an identified need as the criterion variable, which is argued to represent a more realistic context for the application of this research stream.

Keywords

Technology adoption, theory of planned behavior, computer self-efficacy, UTAUT, gender differences, gender roles.

INTRODUCTION

The modern organization is increasingly dependent on information systems with such systems pervasive at all organizational levels. The adoption and introduction of new technologies, once the concern of a small, technical group, is now a frequent activity involving members in a variety of functional areas. Given the large amount of resources typically invested in the development, customization, or acquisition of such technologies, fostering their adoption is of paramount importance.

Technology acceptance has been one of the most researched streams in the information systems literature. Since the introduction of the Technology Acceptance Model (TAM) by Davis (1989), numerous studies have explored and expanded this theory (e.g. Agarwal & Karahanna, 2000; Gefen, Karahanna & Straub, 2003). A recent study has proposed a theory of technology acceptance, the Unified Theory of Acceptance and Usage of Technology (UTAUT) that explains a significant percentage of variance in intention to use new technologies (Venkatesh, Morris, Davis & Davis, 2003, Figure 1).

One topic of relatively recent emergence in technology acceptance research is the moderating influence of gender. Building on previous work (Venkatesh & Morris, 2000), UTAUT presents a moderating effect of gender in the relationships between performance expectancy and behavioral intention, such that it becomes stronger for men; and effort expectancy and behavioral intention, such that it is more significant for women (Venkatesh et al, 2003). Gender differences are useful in that they can impulse research in an area by putting in evidence the existence of an underlying dynamic (Byrnes, Miller & Schafer, 1999 citing Halpern, 1992).

One proposition drawn from the observed gender differences is that sensitivity to these differences could have significant impacts in technology training and marketing, emphasizing the factors that are more salient to each group (Venkatesh & Morris, 2000; Yuen & Ma, 2002). However, without deeper knowledge of the mechanisms by which these differences operate, the design and development of such programs is greatly hampered. Additionally, the usage of gender as a moderator can lead to equivocal results (Ndubisi, 2003). Finally, we need a better understanding of this issue before we can apply our knowledge to actual technology adoption settings. Simply knowing of a gender effect does not allow us to make use of this knowledge. This study proposes a set of variables to account for the observed effect that may further our understanding in this area.

This study is thus concerned with answering the following research question:

What are the underlying factors driving observed gender differences in the context of technology acceptance?

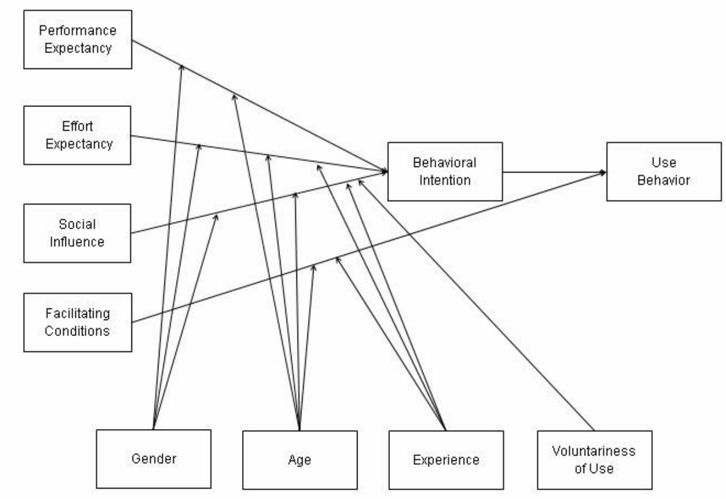

Figure 1. UTAUT (Venkatesh et al, 2003)

Gender Differences

Research on gender differences has received the most extensive focus in sex and gender studies. Comparisons have been conducted in a variety of domains, including verbal and spatial cognitive skills, personality traits and dispositions, and social behaviors (Deaux, 1985). Theories as to the origin of these differences are grouped in three categories: The *biological theories* propose that sex-related differences arise from innate temperamental differences, evolved by natural selection (Costa, Terracciano & McCrae, 2001). Research has suggested there is a strong biological basis underlying differences in personality traits, studying heritability in twins and correlations with hormonal-chemical substances or physiological measures (Feingold, 1994). The *social and cultural* theories suggest that differences arise in the way each sex develops. Finally, both biological and socio-cultural factors are proximal causes of gender differences according to *biosocial theories*. To summarize, perceived and demonstrated sex differences occur on some characteristics and behaviors with overlapping distributions, in cases with gender-differentiated extremes (Stewart & McDermott, 2004). As such, considering gender as a dichotomous "male/female" variable loses the rich within-group variability present in men and women alike.

RESEARCH MODEL & HYPOTHESIS DEVELOPMENT

Figure 2 provides a graphical representation of the research model to be tested in this study. It is based on the empirical results obtained in the formulation of UTAUT (Venkatesh et al, 2003). Hypothesis development for each of the depicted relationships is presented next.

UTAUT Model

The UTAUT model proposed by Venkatesh et al (2003) will be the underlying framework for this research. Because this study is focused on the intention to adopt, and the according decision, actual system usage will not be measured. Further, facilitating conditions and social influence will be controlled for and have thus been removed from the research model. In addition to its main objectives, this study will also provide a replication of the UTAUT as a manipulation check. Thus, the following hypotheses will be tested:

H1: Perceptions of performance and effort expectancy will be significant determinants of the choice of technology.

H2: The relationship between performance and effort expectancy, and choice, will be moderated by biological gender.

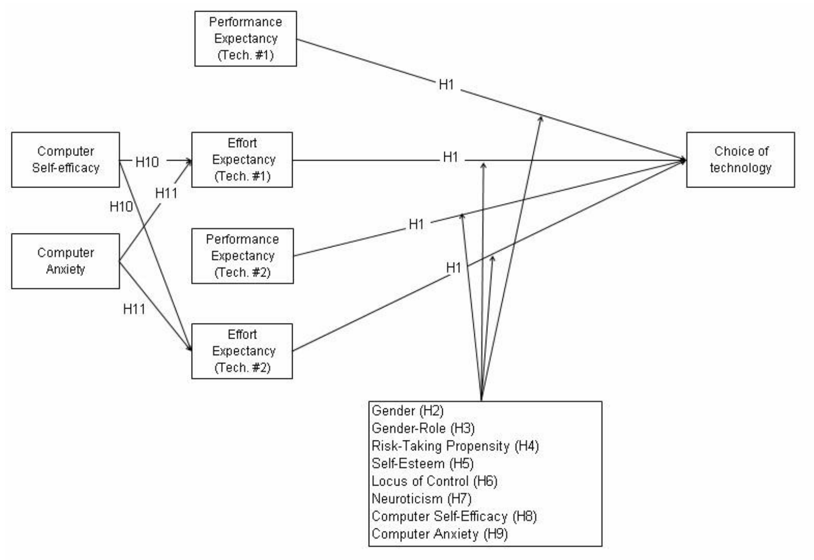

Figure 2. Research Model

Psychological Gender Role

Recent related research (e.g. Venkatesh, Morris, Sykes & Ackerman, 2004) has examined as a psychological construct a set of associations developed throughout human development that are not directly dependent on the natural, or physiological, gender. The authors examined the role of psychological gender in technology acceptance and usage, employing the Theory of Planned Behavior (Ajzen, 1991) as the underlying framework. Their results indicate that masculine individuals were significantly influenced only by attitude, while the opposite was the case for feminine subjects (only subjective norm and perceived behavioral control were significant predictors of behavioral intention). Participants catalogued as androgynous were balanced in their decision-making process. These results, provide support for the role of psychological gender as a moderator of the relationships of interest. Thus, the following is hypothesized:

H3: Psychological gender will moderate the relationship between performance and effort expectancy, and choice.

Risk-Taking Propensity

Another demonstrated difference between men and women is in their attitude toward risk. A meta-analytic review of studies regarding gender and risk-taking found that the majority of reviewed research supported the idea of greater risk-taking on the part of males. Significant differences exist for the means of both self-reported and observed behavior (Byrnes et al, 1999).

Attitude toward risk has been shown to influence decision-making in a variety of contexts. This study proposes that the decision to adopt an information system presents characteristics similar to those existing in the reviewed literature, regarding uncertainty of outcome and consequences. The following hypothesis is thus put forward:

H4: Risk-taking propensity will moderate the relationship between performance and effort expectancy, and choice.

Personality Traits

Gender differences in personality traits have been documented in many empirical studies (Costa, Terracciano & McCrae, 2001). In the late seventies, the popularization of meta-analytic techniques allowed researchers to aggregate research findings. While the number of personality traits that has been researched in the past is significant, two different models have emerged, each presenting a core set of traits that can be used to subsume differences in personality. The first one is the denominated *Big Five*, including the traits of Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness (Langston & Sykes, 1997). An alternative perspective, the *Core Self-Evaluations*, proposes Self-esteem, Generalized Self-efficacy, Locus of Control and Emotional Stability, as determinants of an individual's perspective of oneself and its relationship with his environment (Judge, Locke, Durham & Kluger, 1998). All components of the core self-evaluation set have been shown to present significant differences when evaluated in men and women (Feingold, 1994; Marakas, Yi & Johnson, 1998; Johnson, Marakas & Palmer, 2005).

It is here proposed that core self-evaluations will also be related to the main relationships under study, and thus the following hypotheses are presented:

H5: Self-esteem will moderate the relationship between performance and effort expectancy, and choice.
H6: Locus of control will moderate the relationship between performance and effort expectancy, and choice.
H7: Neuroticism will moderate the relationship between performance and effort expectancy, and choice.

Ease of Use and the Hurdle to User Acceptance

There is strong support in the literature for the notion that women generally exhibit a lower initial level of general computer self-efficacy (Marakas et al, 1998; Hartzel, 2003; Busch, 1995; Venkatesh & Morris, 2000), which can be defined, in general terms, as "an individual's judgment of efficacy across multiple computer application domains" (Marakas et al, 1998). Computer anxiety, a construct related to computer self-efficacy, is also argued to be experienced to a greater extent by women than men (Harrison & Rainer, 1992; Heinsenn, Glass & Knight, 1987). Following from the above exposition and past research (e.g. Venkatesh and Davis, 1996), the following hypotheses are advanced, expressed in terms consistent with the formulation of UTAUT:

H8: Computer self-efficacy will moderate the relationship between performance and effort expectancy, and choice.
H9: Computer anxiety will moderate the relationship between performance and effort expectancy, and choice.
H10: Computer self-efficacy will have a positive effect on effort expectancy.
H11: Computer anxiety will have a negative effect on effort expectancy.

RESEARCH DESIGN

Data for this study were collected through self-report questionnaires presented to participants through sequential screens in a website. Participants were presented with a standard consent form. Following that, basic demographic information (gender, age, etc.) was collected. Participants were then asked to respond to a number of questions that measured the constructs of interest. After this stage was completed, subjects in the study were randomly assigned to one of eight conditions that varied on the two technologies that were presented for comparison. At this time, participants were presented with a hypothetical situation: their organization was undergoing the evaluation and selection process for a new technology, and they had been selected as members of the committee tasked with such endeavor. After prior screening by their Information Technology department, two software packages had been identified as potential candidates. In half of the cells the two technologies were accounts receivable packages, in the remaining, with appropriate modification of the framing, coupon management software.

Participants could then access modified vendor websites for each technology. While the websites included in this research retained the look and feel of the actual vendors of these technologies (including color, layout and logos), they were modified by the authors both to remove elements extraneous to this research, such as contact information, links to other products offered by the same vendor, etc., and to shorten the number of features to reduce the load on the participants. No particular assessment methodology was suggested to the latter. Finally, a set of questions measuring their perception of the functionality and ease of use of each technology were presented, as well as two instances for the subjects to choose their intended course of action. In the first one, they were asked to choose between either one of the two technologies, or neither of them. In the latter case, they were then asked to perform a forced choice between the two software packages under consideration.

Variable Operationalization and Measurement

Gender Role. A shortened version of the Bem Sex-Role Inventory (Bem, 1975, 1981) was used to measure the psychological sex role of individual participants. This instrument asks participants to assess how well the adjectives or statements presented describe them, using a 7-point Likert scale (anchored at "Never or almost never true" and "Always or almost always true"). An important advantage of this form of measurement is that it generates a continuous variable, theoretically ranging between minus and plus sixty. Thus, it is not necessary to categorize individuals in order to analyze the effects of psychological sex-role on the outcomes of interest.

Core Self-Evaluations. These constructs were measured using the Core Self-Evaluation instrument developed by Johnson et al (2005). The measures for locus of control, self-esteem and neuroticism used a seven-point Likert scale anchored at strongly disagree / strongly agree. The general computer self-efficacy measure uses an interval from 0 (cannot do) to 100 (totally confident) with increments of 10 (Johnson & Marakas, 2000).

Computer Anxiety. This construct has been measured in a variety of ways ever since computers were introduced in the workplace. Many implementations of the concept can be traced back to the fear facet of the original rating scale by Heinsenn, Glass & Knight (1987), the Computer Anxiety Rating Scale (CARS), which used a five-point strongly agree / strongly disagree format. The items employed in this study are a subset of those originally developed by Heinsenn, Glass & Knight (1987), after removing items that are no longer representative of the current technological context (such as "I would rather use a typewriter than a computer to write a document"). This resulted in an instrument containing thirteen items, and possible values for this measure ranging from thirteen to ninety one.

UTAUT constructs. The core constructs of UTAUT were measured following the guidelines set in the original study. Intention to adopt was measured by the explicit choice made by the participant as to the technology chosen. Measures of performance and effort expectancy were constructed by modifying those from prior research (i.e. Venkatesh et al, 2003) to adapt the wording to the technologies under consideration. The resulting items were presented to participants along a 7-point Likert scale with strongly agree/disagree anchors.

Risk-Taking Propensity. This research employed a measure constructed following the guidelines set forth by Lauriola & Levin (2000), with one variation. The first five items of the measure reflect those used by the authors in the original research — choosing between a sure thing and a risky option. The last five items present the participant with a decision between two risky choices, one having a higher spread of probability than the other, holding expected value constant across both options. The intention behind this modification was to measure the sensitivity of the measure by including choices of differential risk.

ANALYSIS AND RESULTS

Data were collected from 122 students enrolled in an introductory IS course at a large public midwestern university. 117 usable responses were included in this analysis. The sample was approximately balanced in gender (52:65 M:F) with an age range of 18-25 years. Tables 1 and 2 contain the descriptive statistics and correlations of the different constructs related to the individual subjects, for both the overall sample and categorized by gender of the participant.

	Overall (N=117)		Male (N=52)		Female (N=65)	
	Mean	SD	Mean	SD	Mean	SD
BSRI	6.71	13.05	0.60	11.65	11.60	12.08
Locus of Control	4.83	0.68	4.75	0.66	4.90	0.69
Neuroticism	4.57	1.14	4.68	1.08	4.48	1.18
Self-Esteem	5.75	0.90	5.68	0.98	5.81	0.84
Computer Self-Efficacy	57.66	26.22	63.13	28.42	53.27	23.63
Risk-Propensity	4.66	3.06	4.40	3.13	4.86	3.02
Computer Anxiety	33.13	9.81	32.63	10.18	33.52	9.57

Table 1. Means and Standard Deviations

Table 3 reports the reliability of the different scales employed. While most of the instruments showed acceptable levels of reliability (0.70 and above), the scale for locus of control exhibited only moderate reliability (alpha = 0.622). Since two versions of each of the main constructs in UTAUT were used in the evaluation of the technologies (one Performance and Effort Expectancy measure for each technology), it was of particular interest to consider whether the instruments would emerge as four distinct factors when grouped together, to ensure that differential aspects are being measured. Table 4 reports the positive results obtained using a principal components analysis with varimax rotation (four components were extracted with eigenvalues greater than one, explaining over 68% of the variance).

	Gender	BSRI	Locus of Control	Neuroticism	Self-Esteem	Computer Self-Efficacy	Risk-Propensity	Computer Anxiety
Gender	1							
BSRI	.421**	1						
Locus of Control	.111	.145	1					
Neuroticism	-.090	.083	.485**	1				
Self-Esteem	.075	.059	.598**	.603**	1			
Computer Self-Efficacy	-.188*	-.109	.250**	.318**	.276**	1		
Risk-Propensity	.075	.123	-.352**	-.135	-.237**	-.186*	1	
Computer Anxiety	.045	.032	-.491**	-.346**	-.483**	-.554*	.239**	1

* significant at p<0.05 (two-tailed)
** significant at p<0.01 (two-tailed)

Table 2. Measure Correlations

	Cronbach's α
BSRI	0.813
Locus of Control	0.622
Neuroticism	0.842
Self-Esteem	0.803
Computer Self-Efficacy	0.873
Risk-Propensity (combined)	0.820
Computer Anxiety	0.775

Table 3. Measure Reliabilities

	Component			
	1	2	3	4
PEA1				0.599
PEA2				0.810
PEA3				0.820
PEA4				0.673
EEA1			0.700	
EEA2			0.785	
EEA3			0.885	
EEA4			0.822	
PEB1		0.801		
PEB2		0.859		
PEB3		0.727		
PEB4		0.792		
EEB1	0.670			
EEB2	0.809			
EEB3	0.891			
EEB4	0.895			

PEA = Performance Expectancy - Technology A
EEA = Effort Expectancy - Technology A
PEB = Performance Expectancy - Technology B
EEB = Effort Expectancy - Technology B

Table 4. Factor Analysis of UTAUT Constructs

Replication of Szajna (1994)

The research conducted by Szajna (1994) is the only prior study in technology adoption employing a choice criterion as the dependent variable of interest. While the participants in that study were evaluating competing technologies from the perspective of the direct user, and here the subject is portrayed as making the adoption decision for her department and not for direct, personal benefit, the data collected allowed for a full replication of past results, albeit with a sample size twice as large.

The predictive accuracy of linearly weighted PE/EE combinations was 75 percent, or 72 out of 96 cases, significantly different from the 50 percent one could expect from sheer chance ($z = 4.899$, $p < 0.0001$; see Huberty, 1984). In addition, a discriminant analysis was run employing all four scores obtained for each pair of technologies. Since the distribution of choices was exactly even across the data (48 for each technology, out of a total of 96 cases) no adjustments for priors or maximum chance criterion were needed. The resulting discriminant function for all four elements together was significant (Wilk's lambda = 0.659, $\chi^2_{(4)} = 38.336$, $p < 0.001$), indicating that it did better than chance alone in explaining membership to each group based on perceptions of performance and effort expectancy for both packages under consideration. The correct classification rate was 80.2 percent (78.1 percent using the leave-one-out cross-validation method), also statistically significant ($z = 5.92$, $p < 0.0001$). These results, in summary, replicate and confirm those obtained by Szajna (1994) more than ten years ago, and serve to remark the predictive accuracy of the underlying theoretical model.

Evaluation of hypotheses

Since the dependent variable in this study takes the form of a dichotomous choice between the two alternative technologies, tests of hypotheses were conducted using a logistic regression model. Unlike ordinary least squares regression, logistic regression does not assume linearity between the independent variables and the dependent, relying instead on a link function to determine the likelihood of a certain event, in this case a certain choice, occurring. A pseudo-R^2 measure (Nagelkerke, 1991), scaled to vary between 0 and 1, can be interpreted in the same fashion as traditional R^2 measures, although it tends to be biased downward. This indicator is reported in the tests of the hypotheses requiring the use of binary logistic regression. Tests of moderating effects were performed as prescribed by Baron and Kenny (1986), that is, by entering the predictor first, then the moderator, and finally the interaction term by itself. Results of significance are thus reported only for the inclusion of the interaction term, for the specified hypotheses above.

H1 predicts that perceptions of performance and effort expectancy will predict the choice of a particular technology above its competitor. The results strongly support this contention. The overall model containing the four predictors was significant ($\chi^2_{(4)} = 43.305$, $p < 0.001$; $R^2 = 0.484$; overall classification rate of 81.3%) with all four coefficients large and in the predicted direction, and also individually significant at $p < 0.01$, with the exception of the perception of effort expectancy of one technology ($p = 0.097$).

H2 proposed a moderating effect of gender on these relationships. However, no such effect was found in this case ($\chi^2_{(4)} = 6.294$, $p = 0.178$ for the interaction block). H3, on the other hand, predicted a moderating effect of psychological gender role on the main relationships in the model. The rationale for this proposition stems in past research (Venkatesh et al, 2004) and is supported in the present study ($\chi^2_{(4)} = 14.225$; $R^2 = 0.601$; $p = 0.007$; overall classification rate of 83.3%, for the interaction block).

Contrary to expectations, the data collected provided no support for H4 ($\chi^2_{(4)} = 6.121$; $p = 0.190$) (risk-taking propensity) or H6 ($\chi^2_{(4)} = 5.466$; $p = 0.243$) (locus of control). Support was found for H5 ($\chi^2_{(4)} = 8.648$; $p = 0.071$) (self esteem) and H7 ($\chi^2_{(4)} = 8.199$; $p = 0.085$) (neuroticism) at the more generous 0.10 level.

H8, which posited that generalized computer self-efficacy would moderate the relationships between perceptions of performance and effort expectancy and choice, was strongly supported ($\chi^2_{(4)} = 10.124$; $R^2 = 0.572$; $p = 0.038$; overall classification rate of 80.2%, for the interaction block). As an additional test of the significance of this moderating effect, the interaction block including GCSE was entered after the interaction generated by BSRI (gender role) was already in the model. Results of this analysis indicate that the effect of GCSE stays significant over and above that accounted for BSRI ($\chi^2_{(4)} = 10.452$; $R^2 = 0.685$; $p = 0.033$; overall classification rate of 87.5%, for the interaction block). The sign and magnitude of the coefficients indicate that, as GCSE increases, the effect of performance expectancy on choice becomes stronger and that of effort expectancy weaker. H9, which proposed a similar effect for a related construct, computer anxiety, was not supported by the data in this study ($\chi^2_{(4)}$ = 3.718; p = 0.446).

Also contrary to expectations, and to much published empirical research (i.e. Venkatesh and Davis, 1996; Venkatesh, 2000), neither generalized computer-self efficacy (Hypothesis 10) nor computer anxiety (Hypothesis 11) were significant antecedents of perceptions of effort expectancy, for either technology. This result held when testing each antecedent individually for each effort expectancy perception, and both variables together in a multivariate setting.

CONCLUSION

This research used the UTAUT (Venkatesh et al, 2003) to investigate the moderating effects of psychological gender and other personality traits on the choice of a new technology. We found that psychological gender and other individual-level variables such as self-esteem, neuroticism and generalized computer self efficacy had a moderating effect on the relationship between performance and effort expectancy and the choice of a technology. This research contributes to the existent body of knowledge on individual adoption and usage of IT in several ways.

One contribution of this study is that we empirically tested the UTAUT in the context of two competing technologies. While previous research has investigated adoption and usage of IT in various settings using different theoretical models, the focus has been primarily on one technology. We departed from this body of literature and tested the applicability of existent theoretical models using a more realistic scenario, that of an organization undertaking selection between two potentially feasible technologies. We found support for the claim that performance and effort expectancy of a new technology will determine the choice of that particular technology. This finding is consistent with previous research on technology adoption including Venkatesh et al (2003), that found similar results in the context of adoption and usage of one single technology.

Another contribution of this study stems from investigating the role that psychological gender plays in technology selection. While previous research has investigated the role of biological gender (Gefen & Straub, 1997; Venkatesh & Morris, 2000; Venkatesh et al, 2003), there are very few studies that looked at the role of psychological gender in the context of IT adoption (Venkatesh et al, 2004). Venkatesh et al (2003) called for more research on technology adoption that closely explores the significance of gender roles as a moderating factor on individuals' intentions to use a technology. We found that psychological gender, rather than biological gender, has a moderating impact on the relationship between performance and effort expectancy and the choice of a technology. This result points to the importance of psychological gender role beyond the biological gender in influencing adoption and most importantly, choice between competing alternatives. More research is needed to fully understand the moderating effect of this variable on the latter activity.

One interesting finding from this study is related to the moderating impact of the generalized computing self-efficacy on the relationship between performance and effort expectancy and choice of a technology. This variable has been found to have a stronger effect over and above that of psychological gender role in the context of adoption and choice of a new technology. While not included in the UTAUT, our findings suggest that an individual's generalized computing self-efficacy may be more important than variables such as gender, gender role or age. This finding is important from both a theoretical and practical standpoint. From a theoretical standpoint, our results suggest that models of technology adoption and usage need to be expanded to account for the important role of computer self-efficacy. We expanded the UTAUT and proposed an additional moderator that was found to be highly significant in the context of choosing between two competing technologies. From a practical standpoint, this finding is even more important as an individual's computer self-efficacy can be the object of training programs and thus altered more so than gender roles, which are highly static over time. In this study, as the level of computer self-efficacy increased, more weight in the choice was given to performance, and less to effort expectancy. These results are consistent with what one could expect from subjects who hold a high perception of their ability to deal with matters in the computing domain. In particular, it should be noted that men and women differed markedly on their levels of computer self-efficacy in this sample, with men being higher than women. Future research should more thoroughly investigate the role of generalized computer-self efficacy as a moderator in technology acceptance.

This study is not without limitations. We chose to focus on the moderating role of gender roles and generalized computer-self efficacy and treated them as continuous variables rather than categorical. We followed this venue in order to retain more variance in testing the proposed relationships. This perhaps may limit our full interpretations of the results obtained. However, this limitation is mitigated by the fact that this research has aimed to uncover rather new, undeveloped moderating effects of such variables as they relate to technology adoption and choice. Demographic characteristics of this particular sample may be another source of concern, since it can be expected that young and well-educated individuals may be more familiar with computers and technology and not representative of the population at large. An examination of the means and standard deviations for both computer anxiety and computer self-efficacy, however, reveals an important amount of variation in these two variables. Thus, we do not believe our results were affected by this.

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