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Profiling information technology users: en route to dynamic personalization

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Abstract

This study describes the initial stages in the development of a Technology Profile Inventory (TPI) and its potential use in a variety of contexts, including dynamic personalization. The initial version of the TPI was constructed based on the responses of 318 participants. Factor analysis was used to establish the major components of individuals' attitudes toward information technology. The factors extracted demonstrate the utility of updating measures of computer attitudes to include items related to the Internet and to a broader range of attitudes. The factors of the TPI were correlated with a variety of demographic and usage variables. Gender differences were found for most TPI factors, though not for approval of information technology, and possible explanations of these differences are discussed. Correlations with usage variables provided both convergent and divergent validation, as both past experience and present use of computers and the Internet were associated with more positive TPI attitudes, but cellular phone use was unrelated to all TPI factors.
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1. Introduction

The role of information technology in society is expanding at a remarkable rate. Interactions with computers and the Internet are becoming a standard component of life for a large segment of the population in Western society. So profound is the influence of this technology that the current era has been widely dubbed the "information age." Any phenomenon that gains such influence in our lives is worthy of study, and the methods of psychology may shed some light on our new relationship

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with information technology, particularly with regard to the question of how people respond to this addition to their lives.

A significant body of research on responses to computers has emerged over the last 20 years, as computers have become more and more likely to play a role in daily life. Perhaps because of the universal human tendency to respond to novelty of sufficient magnitude with fear, most of this work has focused on the phenomenon of computer anxiety, which Chua, Chen, and Wong (1999, p. 610) have defined, in a recent meta-analysis, as "a fear for computers when using the computer, or when considering the possibility of computer use." Earlier work on this construct sometimes utilized different labels, such as "computerphobia" (Jay, 1981) and "computer aversion" (Meier, 1985), but the basic sense of a negative emotional response to computers has remained constant. A number of researchers have examined the correlates (e.g. gender, learning style), causes (e.g. lack of computer literacy), and effects (e.g. avoidance of computers) of computer anxiety (e.g. Beckers & Schmidt, 2001, Chua, Chen, & Wong, 1999; Coffin & MacIntyre, 1999).

There is more to human beings than anxiety, however, despite the claims of some existentialist philosophers to the contrary. In the study of personality, anxiety (or, more broadly, negative affect or neuroticism) is considered to be only one of a number of primary domains of human personality in which differences between individuals may be found (e.g. John & Srivastava, 1999). With this in mind, we wondered whether human relationships with computers might reflect some of the complexity of the human personality. Might there be a number of different factors in attitudes toward computers that are differentiable from a mere presence or absence of anxiety? Among those who are comfortable with computers, for example, one encounters people who are very much interested in the complex workings of computer hardware and software—who find computers, as such, interesting. Another group, equally comfortable (perhaps equally low in "computer anxiety"), has no interest whatsoever in *how* computers work, though they enjoy making use of the capabilities which computers provide. These groups appear to differ along a dimension that might be called "computer interest." Such observations prompted us to attempt the design of a psychological instrument that could capture a wider range of responses to computers than simply anxiety.

A few broader measures of computer attitudes have been developed, such as Loyd and Gressard's (1984) Computer Attitude scales, which measure computer-confidence, computer-liking, and computer-anxiety; Nickell and Pinto's (1986) Computer Attitude Scale, which measures positive as well as negative attitudes toward computers; and Popovich, Hyde, Zakrajsek, and Blumer's (1987) Attitudes Toward Computer Usage scale, which also measures positive and negative attitudes toward computers. A factor analysis of several scales measuring these constructs (Whitley, 1996) revealed three general factors: computer anxiety/confidence, positive beliefs about computers, and negative beliefs about computers.

A factor analysis is limited by the content of the scales included in it, however, and cannot reveal psychological constructs that are not differentiated in the items being analyzed. The dimensions reported by Whitley (1996) may not be broad enough to capture the full range of responses to computers, as our example of a dimension of

"computer interest" attempts to indicate by pointing out potential differences even among individuals who like or feel positively about computers. Another difficulty with these measures stems from the speed at which information technology has evolved in the past two decades. In the mid-eighties, when these scales were designed, computers were just coming into widespread personal use, and the Internet was in its infancy, unavailable to the average user. Currently, not only are computers much more thoroughly integrated into the functioning of society, it is also difficult to separate use of computers from use of the Internet. Any reasonably comprehensive measure of computer attitudes must reflect these changes; consequently we have designed our instrument to capture responses to information technology more generally and included items pertaining to Internet use.

A commonly stated goal of the research into computer anxiety has been the development of methods to alleviate that anxiety, thereby improving the lot of people who need or would like to use computers. At the heart of our research program is a similar goal: to facilitate positive experience with information technology. Much as the personality profiles generated by instruments used to measure personality enable predictions of how individuals are likely to respond to various broad classes of life-situations, the technology profiles generated by our instrument are designed to predict how individuals are likely to respond to various aspects of information technology. Genetic makeup and the social environment jointly determine personality, and the same factors partly determine the technology profile. But our predispositions to behave in a technological milieu differ in significant ways because of the novel constraints and demands of the artificial environment. Evolution has not prepared us to interact with information technology as it has prepared us to interact with other people. Knowing a user's technology profile has the potential to confer considerable competitive advantage in the development of user interfaces for complex software.

The ability to profile information technology users quickly and effectively could facilitate the design of software capable of "dynamic personalization." Imagine a web page that conforms itself to suit the technology profile of each user who encounters it, or, more particularly, a program that will display all of its options for someone high in "computer interest" while displaying only the most functional options for someone who just wants to accomplish a task. Dynamic personalization is a realistic goal for today's increasingly sophisticated software, but it requires the ability to assess a broad range of responses to information technology.

In this study we present our initial findings using an instrument designed for this purpose, the Technology Profile Inventory (TPI). Our approach was to generate a broad range of items for assessing responses to information technology, to exam their factor structure in a normal population, and to investigate potential associations between the emergent factors and variables that have, in the past, been associated with responses to computers, including gender, age, experience with information technology, and use of information technology. A well-constructed Technology Profile Inventory (TPI) will have excellent psychometric properties and, furthermore, could form the basis for the construction of reliable, adaptive, efficient, online versions that can be used in a wide variety of contexts.

2. Method

For the initial version of the TPI, several Human–Computer Interaction researchers at the University of Toronto were asked to provide preliminary items concerning responses toward computers and the Internet. The resulting 200 items were narrowed down (by a process of discussion between the authors of this paper) to a set of 49 items that were thought to span a wide range of attitudes in the segment of the population that had at least some experience with information technology. All items were statements, to which participants responded on a 5-point scale ranging from *Strongly Disagree* to *Strongly Agree*.

These 49 items were administered to 323 participants, who responded to posted advertisements or participated for class credit in an introductory psychology class. Data for five participants was unusable due to errors in filling out the response sheets (which were fill-in-the-bubble format for computerized scanning), leaving 318 participants in our sample. Participants included 145 males and 170 females (plus 3 with no gender reported) and ranged in age from 17 to 67 ($M = 22.5$, S.D. = 6.8). Those who did not receive class credit were paid $10. Participants also completed a brief questionnaire requesting demographic information and a series of questions about their information technology usage and experience.

3. Results

3.1. Factor analysis

To ascertain whether the TPI measures multiple distinct factors, as we expected, the responses of 306 participants who responded to every TPI item were subjected to principal components analysis with varimax rotation. Three items were excluded from this analysis because the responses were highly skewed (skewness > 2.0), and one item was excluded due to a typographical error on the administration sheet. Twelve factors with an eigenvalue greater than 1 were extracted, the first seven of which were marked by at least three items and were sensibly interpretable. We have labelled these seven factors, which explained 48% of the total variance, Interest, Approval, Confidence, Anxiety, Internet Transactions, Entertainment, and Complex Design Preference. Two sample items from each factor are listed in Table 1.

The first factor extracted, prior to rotation, was almost 4 times larger than the second (first eigenvalue = 10.60, second eigenvalue = 2.67). This suggests that there is a strong underlying unity to the constructs being assessed by the various factors. A full scale score may, therefore, reflect a generally positive or negative attitude toward information technology. The 38 items that made up the seven primary factors loaded on the first unrotated factor at 0.23 (absolute value) or higher, with the majority over 0.40. After reversing the Anxiety items, so that all items would be keyed in the same direction, Cronbach's Alpha for all 38 items was 0.92, indicating a high degree of reliability as a measure of a single construct. Scores were therefore calculated for the total of all TPI items as well as for the seven individual factors, by

Table 1
Seven factors of the Technology Profile Inventory with sample items

1. Interest	
	"Learning about computers can be fun even when it isn't useful."
	"I don't want to know more about computers than I have to." (Reversed)
2. Approval	
	"Computers are useful educational tools."
	"I don't like to use the Internet." (Reversed)
3. Confidence	
	"I am confident in my ability to master new skills with computers."
	"I am not easily discouraged by problems with computers."
4. Anxiety	
	"I find dealing with computers to be stressful."
	"I find the Internet confusing and disorienting."
5. Internet Transactions	
	"I would prefer to do most of my banking over the Internet."
	"I think that on-line shopping is a good idea."
6. Entertainment	
	"I use the internet to find entertainment, like music, games, or social interactions."
	"I play many computer games, or I did when I was younger."
7. Complex Design Preference	
	"I like web sites to be as simple as possible." (Reversed)
	"I would rather have computers be complex, even if I wasn't going to use all the options."

averaging all available item responses for each factor or for the full scale. Table 2 shows the means, standard deviations, and intercorrelations of the TPI factors and total score. We have left the Anxiety scores reversed, for consistency, and labelled the factor "Lack of Anxiety."

3.2. Gender and age

Table 3 shows a comparison of TPI scores by gender. Men scored higher than women on TPI total score and on all but two factors. There were no significant differences between men and women on Approval and Complex Design Preference. Although the sample was heavily skewed toward the lower end of its age range, we examined the relation of age to TPI scores, as past research has examined relations between computer attitudes and age. Ages were log transformed to reduce the skewness; even so, the skewness of the transformed variable remained greater than 2. Total TPI score and all but two factors were unrelated to age. Entertainment was significantly negatively correlated with age ($r = -0.26$, $P < 0.001$), as was Complex Design Preference, though more weakly ($r = -0.11$, $P < 0.05$). Due to the low number of older participants in the sample, these results should be considered pre-

Table 2
Means, standard deviations, and intercorrelations for factors of the Technology Profile Inventory[a]

	1.	2.	3.	4.	5.	6.	7.	Mean	S.D.
1. TPI total	–							3.50	0.59
2. Interest	0.83	–						3.17	0.90
3. Approval	0.81	0.55	–					3.98	0.65
4. Confidence	0.80	0.60	0.55	–				3.82	0.79
5. Lack of Anxiety	0.69	0.50	0.46	0.60	–			3.51	0.80
6. Internet Transactions	0.58	0.42	0.35	0.34	0.33	–		2.64	0.87
7. Entertainment	0.64	0.49	0.52	0.42	0.30	0.26	–	3.73	0.97
8. Complex Design Preference	0.48	0.27	0.34	0.26	0.30	0.31	0.29	2.84	0.82

[a] All correlations significant at $P < 0.001$.

Table 3
Gender differences in scores on the Technology Profile Inventory

	Male		Female			
	Mean	S.D.	Mean	SD	t (df = 313)	P
TPI total	3.67	0.55	3.35	0.58	5.02	< 0.001
Interest	3.44	0.86	2.94	0.88	5.10	< 0.001
Approval	4.03	0.62	3.94	0.68	1.24[a]	0.22
Confidence	4.06	0.70	3.62	0.81	5.13	< 0.001
Lack of Anxiety	3.64	0.85	3.39	0.74	2.70	< 0.01
Internet Transactions	2.82	0.89	2.48	0.82	3.46	< 0.01
Entertainment	4.14	0.84	3.36	0.94	7.72	< 0.001
Complex Design Preference	2.86	0.82	2.83	0.82	0.34	0.73

[a] Corrected for unequal variances (Levene's test for equality of variances: $F = 5.76$, $P = 0.017$).

liminary until replicated, although they are consistent with a review that suggests that computer anxiety is not strongly related to age (Chua, Chen, & Wong, 1999).

3.3. Information technology use and experience

Participants answered a number of questions about their current use of information technology, including number of hours using computers per week (both in total and divided into personal and work use), number of hours using the internet, and number of hours using a cellular phone. The cellular phone item was included because cellular phones are often considered to be part of the rubric of information technology, and yet they are distinct from computers and the internet in most of their functions. We were interested to determine whether the TPI would discriminate between these different technologies or whether cellular phone use would be related to attitudes similar to other information technology use. Correlations were found between the total TPI score and all usage variables, excluding cellular phone use (Table 4). Interestingly, despite being unrelated to the TPI, cellular phone use was

Table 4
Correlations of TPI scores with information technology usage and experience[a]

	TPI total	Int.	App.	Con.	Anx.	Tran.	Ent.	Des.
1. Total computer time	0.46**	0.43**	0.33**	0.42**	0.33**	0.22**	0.27**	0.21**
2. Personal computer time	0.45**	0.39**	0.36**	0.35**	0.29**	0.21**	0.32**	0.24**
3. Work computer time	0.28**	0.21**	0.19**	0.31**	0.26**	0.15**	0.05	0.14*
4. Internet time	0.41**	0.35**	0.37**	0.28**	0.29**	0.15**	0.26**	0.25**
5. Cell phone time	0.05	0.05	0.06	0.00	0.02	0.04	0.09	0.02
6. Years using computers	0.18**	0.10	0.09	0.27**	0.20**	0.11	0.00	0.08
7. Computer classes taken	0.19**	0.23**	0.11	0.20**	0.05	0.06	0.12	0.11
8. Number of computers owned	0.22**	0.16**	0.26**	0.17**	0.11	0.10	0.20**	0.02

[a] Variables 1–5 reflect the logarithm of hours per week. Variable 7 was log transformed, and variable 8 was squareroot transformed. Int. = Interest, App. = Approval, Con. = Confidence, Anx. = Lack of Anxiety, Tran. = Internet Transactions, Ent. = Entertainment, Des. = Complex Design Preference.

* $P < 0.05$.

** $P < 0.01$.

(weakly) associated with both personal computer use ($r = 0.15$, $P < 0.05$) and Internet use ($r = 0.20$, $P < 0.01$).

Although it is not entirely possible to separate experience with computers from current use, we also asked all but the first 48 of our participants how many years they had been using computers and how many computer classes they had taken. Both of these variables were also correlated with total TPI score (Table 4). Finally, we asked people how many computers they owned, and this was also correlated with TPI score (Table 4). Table 4 shows correlations with the individual TPI factors as well as the total score, and it may be seen that the usage variables correlate with most of the factors. The correlations with experience variables were less numerous, with number of years using computers correlating only with Confidence and Lack of Anxiety, and number of computer classes taken correlating only with Confidence and Interest.

4. Discussion

Our factor analysis supports the hypothesis that responses toward information technology may be more complex than those addressed by existing measures of attitudes toward computers. The Confidence and Anxiety factors are similar to previously identified computer attitudes. The Interest and Approval factors seem to split what has previously been identified as "liking" or a "positive attitude" into two distinct components: a positive attitude toward the functions and uses of information technology (Approval) and a positive attitude toward information technology as interesting in and of itself (Interest). The Internet Transactions, Entertainment, and Complex Design Preference factors have not previously been identified. While the last two of these factors were marked by only three items each, rendering their stability somewhat questionable, they are of interest and will be explored further in

our future research. Such factors could play an important role in the context of dynamic personalization. A preference for more or less complex user interfaces, for example, could strongly influence individuals' behaviors toward information technology or their preferred conformation of web pages and computer programs. Our approach to these smaller factors in our ongoing development of the TPI will be to generate extra items with appropriate face validity and to test for the replicability of the factor structure found in the present study.

With regard to gender, our findings are for the most part consistent with previous findings. In their meta-analysis of computer anxiety and its correlates, Chua, Chen, and Wong (1999) found the effect of gender on computer anxiety to be robust across many studies, with women showing more anxiety than men. Whitley (1996) examined gender differences in a broader range of computer attitudes and found that, while women reported more anxiety and negative beliefs about computers than men, they did not differ from men with regard to their positive beliefs toward computers. An examination of the items Whitley used to assess "positive beliefs" reveals content very similar to the items included in our "Approval" factor, reflecting a positive attitude about the functions and uses of computers. Approval was one of only two TPI factors on which women did not score lower than men. Our findings support Whitley's (1996) assertion of the importance of examining various components of a psychological construct when looking for group differences. Because women score lower than men on the TPI total score, which appears to be a reliable measure of generally positive vs. negative attitudes toward information technology, one might conclude that women felt consistently less positive than men about information technology. However, the finding that women are equally approving of computers highlights the importance of examining the multiple factors encompassed by the general attitude.

That women are more anxious and less confident than men about using computers and the Internet, despite being equally approving, leads us to speculate on the source of these gender differences. Women may not be given as much support as men for developing confidence with information technology, despite being equally convinced of its benefits. Stereotypes of gender-appropriate attitudes and behavior may be hindering women from getting the most out of information technology. Despite the significant differences, it should be noted that both sexes score in the positive range of the Confidence and Lack of Anxiety scales—women may be less comfortable with information technology than men, but on average they are not actively anxious or lacking in confidence. The one major attitudinal factor on which women scored below the midpoint of the scale was Interest; for whatever reason, men appear to be interested in the working of computers, as distinct from their practical uses, while women are not.

The results for technology use and experience are especially promising, providing both convergent and divergent validation for the inventory. TPI scores were positively correlated with all usage statistics for computers and the Internet, but not with cellular phone use, a related technology not explicitly explored in any of the TPI items. The amount of time spent using computers for personal pursuits was found to be more strongly related to TPI score than amount of time using computers for

work, which one might expect given that personal use is likely to be more voluntary. Smaller effects were also found for past experience with computers, in terms of number of years of use and number of computer classes, and these were each only related to two TPI factors. Though correlations cannot establish the mechanism or direction of causation, it seems more likely that years of computer use would contribute to increased confidence and decreased anxiety, rather than that individuals less anxious about computers would be inclined to have started using computers earlier, especially given that Interest and Approval were not associated with years of computer use. Such an effect suggests the utility of early education with information technology, which may help to decrease the gender gap in anxiety and confidence if undertaken appropriately.

5. Future research

One of the next steps in our project will be to refine and expand the TPI subscales, generating additional items relevant to the factors reported in this study, and to determine the stability of the factor structure using other demographic samples. In addition to developing the TPI, we will begin to investigate the behavioral correlates of different technology profiles. Knowledge of the behavioral correlates of the TPI will assist in developing the dynamic delivery of personalized user interfaces that are best suited to a given profile.

One area in which we hope that the TPI will prove to be useful is in the dynamic personalization of web sites. Large enterprises make increasing use of web sites to conduct business and these sites tend to be large, monolithic, complicated, difficult to navigate, and often not easily accessible to a majority of visitors. User-centered design recognizes that information presentation must be driven by the needs of users, and principles of user-centered design (Norman, 2000; Schneiderman, 2000) are generally accepted as essential to the development of effective web pages and other information displays. However, despite an abundance of design guidelines for building usable web sites (e.g. Nielsen, 1999, 2000; Sano, 1996; Shriver, 1997), usability continues to be a pressing problem. Resolution of this incompatibility between client and site requires personalization and all large enterprises are seeking new technologies that will craft the interaction in response to the needs of the individual to create a truly customized experience.

In 1999, Jakob Nielsen estimated that within the following 5 years, 196 million new web sites would be created. However, he also predicted an acute shortage of user interface professionals (Nielsen, 1999) to build usable sites. Although the development of new software tools and methodologies will undoubtedly help to accelerate and improve the design process, without knowing how the user is predisposed to behave, it will be difficult to customize the interaction in a manner that is both pleasant and productive. Without knowing the user's technology profile, and the prevalence of user types in the target population, the designer must configure the site layout, options, and hierarchies using hunches based on past experience. If these guesses are wrong, the user is condemned to a frustrating sequence of trial-and-error

interactions and many will give up in disgust. Our ultimate goal is to develop sound principles for site construction based on an accurate user typology coupled with a better understanding of the online behaviours of each of the major user types. No previous published research has proposed building an accurate typology of users in a technological context to assist in the delivery of personalized content in information technology.

Although a better knowledge of user types is desirable, it is not sufficient. Correlation of user typology with actual online behaviour will be required to develop better web site design guidelines. Click stream behaviour is one important objective measure, but perhaps even more illuminating are the choices that are evaluated and rejected by the user. These cannot be determined unambiguously from click trails alone. We are currently using state-of-the-art high-resolution eye-tracking technology to determine the objects of attention that are associated with click-stream actions and inactions. We hypothesize that different patterns of evaluation and acceptance/rejection will be correlated with the user technology type, as assessed by the TPI. The challenge will be to uncover these links and to use this knowledge to develop effective new methods of dynamic personalization.

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