Toward a Unified Theory of Consumer Acceptance Technology

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ABSTRACT

In the last few decades, scholars and practitioners have increasingly tried to understand the factors that influence technology acceptance. Theories and models developed by scholars have tended to focus on the role of cognition and have rarely included affect. The few studies that have incorporated affect have tended to measure a single emotion rather than modeling it comprehensively. This research addresses that inadequacy in our understanding of technology adoption by merging two previously unrelated models: TAM (the Technology Acceptance Model) and PAD (the Pleasure, Arousal, and Dominance paradigm of affect). This study also examines an enhanced view of cognition. The product of this unified theoretical framework is referred to as the Consumer Acceptance of Technology (CAT) model. The results of a test using structural equation modeling provide empirical support for the model. Overall, the CAT model explains over 50% of the variance in consumer adoption intentions, a considerable increase compared to TAM. These findings suggest that

substantial improvement in the prediction of technology adoption decisions is possible by use of this model with its integration of affect and cognition. © 2007 Wiley Periodicals, Inc.

Consumers may adopt high-technology products not only to obtain useful benefits but also to *enjoy* the experience of using them. At other times, consumers reject innovations despite their potential usefulness because of a *fear* of being overwhelmed by the technology. Mick and Fournier (1998) vividly described this "technology paradox," the conflicting emotional reactions consumers experience as they respond to innovations. They argued that the more marketers take emotions into account, the more successful they will be in designing and marketing high tech products.

Despite the potential role played by affect, most prior technology adoption research has focused on cognition. Specifically, the theories have highlighted what people *believe* about an innovation (Rogers, 2003; Davis, 1989). Although a few studies have included a limited form of affect, integrating a comprehensive representation of affect with cognition in a model has yet to occur.

The purpose of this research is to develop and empirically test a unified theory of consumer acceptance of technology. Specifically, the primary objective is to incorporate the well-known PAD paradigm of affect (Mehrabian & Russell, 1974) into the Technology Acceptance Model (Davis, 1989), the most popular model used for predicting technology adoption. An additional goal is to improve the conceptualization of cognition by adding a key belief, relative advantage, which involves the extent to which an innovation is superior to the alternatives. This unified theoretical framework, called the *Consumer Acceptance of Technology* (CAT), is comprehensive yet parsimonious and, thereby, more powerful in describing and predicting consumer adoption of technology.

THEORY OF TECHNOLOGY ACCEPTANCE

The Technology Acceptance Model (TAM)

TAM, a widely used model in management of information systems (e.g., Davis, 1989), was an adaptation of the theory of reasoned action (TRA by Fishbein & Ajzen, 1975). The goal of TAM was to offer a parsimonious explanation of the determinants of adoption that would be general enough for application to usage behavior across a wide range of technology innovations (Davis, Bagozzi, & Warshaw, 1989). TAM theorized that an individual's behavioral intention to adopt a particular piece of technology is determined by the person's attitude toward the use of the technology. Attitude, in turn, is determined by two beliefs: perceived usefulness and perceived ease of use.

TAM was developed to understand employee acceptance of new technology and most research using the model has focused on cognition rather than affect.[1] The emphasis on cognition might be appropriate for an organizational context where adoption is mandated and users have little choice regarding the decision. But it is an insufficient explanation for consumer contexts in which potential users are free to adopt or reject new technology based on how they *feel* as well as how they *think*.

To date, however, there has been little integration of affect into applications of TAM with ultimate consumers. One of the exceptions is Childers et al. (2001), who proposed that both hedonic and utilitarian motivations are relevant as consumers engage in online retail shopping. In addition to a utilitarian motivation, they found that enjoyment is a strong predictor of attitude toward interactive shopping. This is consistent with Dabholkar and Bagozzi's (2002) study in which an intrinsic motivation, fun, was used with TAM and found to have a significant effect on technology-based self-service acceptance. However, neither of these studies tested the full TAM model. The adoption intention construct was not included in the study by Childers et al. (2001) and perceived usefulness was not explicitly examined by Dabholkar and Bagozzi's (2002). More recently, Bruner and Kumar (2005) incorporated a measure of fun along with all of the original TAM components. They found that fun had a direct effect on attitude and this effect was more than one and a half times the effect of cognition on attitude toward the use of a technology product.

Yet, as important as fun and enjoyment may be, there are many other emotions that consumers can experience as they consider adopting high-tech innovations. Mick and Fournier (1998) argued that technology may trigger both positive and negative feelings. For example, on the positive side, consumers can be pleasantly surprised, excited, and confident as they consider the adoption of technology, whereas on the negative side people can be annoyed, worried, or scared. The specific emotion(s) that may be relevant for consumer adoption of technology may vary with the person and context in which adoption occurs.

Despite the variety of emotions that could influence consumer adoption, the studies discussed earlier only incorporated a *single* emotion into their respective models, and just positive ones at that. This means that affect, in its most comprehensive sense, has not been incorporated into TAM up to this point. Hence, there is a need for a model that covers the wide variety of affective reactions consumers may experience when developing their adoption intentions. To keep the model as parsimonious as possible, the dozens of possible emotions that exist can not be

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[1] Although Davis did some limited exploration of a form of affect regarding workers' acceptance of technology (e.g., Davis et al., 1992), he did not consider it to be important or relevant enough to be part of TAM. This view was reinforced more recently when he and his coauthors deliberately choose to *exclude* affect as part of any of the five models they were comparing, saying that including affect "did not appear to be appropriate" in the organizational context (Riemenschneider, Hardgrave, & Davis, 2002, p. 1139).

individually modeled within TAM. Therefore, a theory of affect is needed that covers the broad range of emotions that consumers may experience and yet does not unnecessarily complicate the model. A paradigm that fits these constraints is discussed next.

Mehrabian-Russell's (1974) PAD Theory

Based on environmental psychology, Mehrabian and Russell's (1974) theory asserts that all emotional responses to physical and social environments can be captured with three dimensions of affect: pleasure, arousal, and dominance (PAD). The authors argued that any emotional state may be regarded as positions on these three dimensions, that is, the various combinations of pleasure, arousal, and dominance can adequately represent all of the diverse human emotional reactions to environments. These three dimensions define a person's feelings that, in turn, influence behavior.

The first dimension, pleasure, refers to the degree to which a person experiences an enjoyable reaction to some stimulus. Examples of positive emotions strongly associated with this dimension are happiness, enjoyment, and satisfaction. The second dimension, arousal, is defined as a combination of mental alertness and physical activity which a person feels in response to some stimulus. Excitement is a key emotion related to this dimension. Dominance is the third dimension and refers to the extent to which the individual feels in control of, or controlled by, a stimulus. Emotions can range from boldness and courage at one extreme to anger and fear at the other.

PAD has been employed in marketing research to measure emotional responses to environmental stimuli. It has been used to study consumers' responses to store atmosphere in retail settings (Donovan & Rossiter, 1982; Donovan, Marcoolyn, & Nesdale, 1994), emotions evoked by television ads (Holbrook & Batra, 1987), product-consumption experiences (Oliver, 1993), services (Hui & Bateson, 1991), online shopping enjoyment (Koufaris, 2002), and other marketing contexts (e.g., Halvena & Holbrook, 1986).

Although the pleasure and arousal dimensions of affect have been examined in many marketing studies, the dominance dimension has frequently been left out (e.g., Baker, Levy, & Grewal, 1992; Mummalaneni, 2005; Sherman, Mathur, & Smith, 1997). The decision to exclude dominance appears to have been heavily based on Russell's two-dimensional view of affect (1980) as well as the lack of significance of dominance in a key marketing study (Donovan & Rossiter, 1982). However, there are several recent studies where dominance has played a significant role (e.g., Brengman, 2004; Fontaine et al., 2002; Foxall & Yani-de-Soriano 2005). Additionally, empirical comparisons of the two- and three-dimensional models have shown that the latter provided the more "informative" representation of emotions (Morgan & Heise, 1988; Shaver et al., 1987).

As for Mehrabian himself, he has continued to argue for the three-dimensional model and has performed more studies confirming it (1995). He also has demonstrated that the PAD paradigm can be extended to describing personality temperament (1996, 2000). Most recently, Yani-de-Soriano and Foxall (2006) made a strong case for the continuing relevance of dominance to marketing studies. Hence, although it is tempting to eliminate the dominance dimension to produce a simpler model, the complete PAD paradigm is employed in the proposed model of technology acceptance because of its greater potential to capture the full breadth of affect.

CONSUMER ACCEPTANCE OF TECHNOLOGY (CAT)

The CAT model is proposed as a replacement for TAM. The relationships among the model's core constructs are discussed later and the study's hypotheses are presented. Figure 1 illustrates the model as tested in this study.

Perceived Usefulness. Perceived usefulness is defined as the extent to which persons believe that technology will enhance their productivity or job performance (Davis, Bagozzi, & Warshaw, 1989). In the consumer context, it is the perceived likelihood that the technology will benefit the person in performance of some task. It is concerned mainly with perceptions of the functional outcome as a consequence of technology usage.

A significant body of TAM research has shown that perceived usefulness is a strong determinant of user acceptance, adoption, and usage behavior (Davis, 1989; Mathieson, 1991; Taylor & Todd, 1995). In fact, perceived usefulness has been found to be the most significant factor in acceptance of technology in the workplace, even more important than perceived ease of use (Davis, 1989; Hu et al., 1999).

In the consumer context, significant positive relationships have been found between the perceived usefulness of new Internet services and attitudes toward these services (Childers et al., 2001; Gentry & Calantone, 2002). Similarly, perceived usefulness has been found to have a positive impact on attitude toward using mobile Internet products (Bruner & Kumar, 2005; Lee, Kim, & Chung, 2003). Thus,

> **Hypothesis 1:** The higher the perceived usefulness of a high technology innovation, the more positive the attitude toward the act of adopting the innovation.

Perceived Ease of Use. In TAM, perceived ease of use is defined as the extent to which a person believes that using a technology will be simple (Davis, Bagozzi, & Warshaw, 1989). It is a construct tied to an individual's assessment of the effort involved in learning and using a technology.
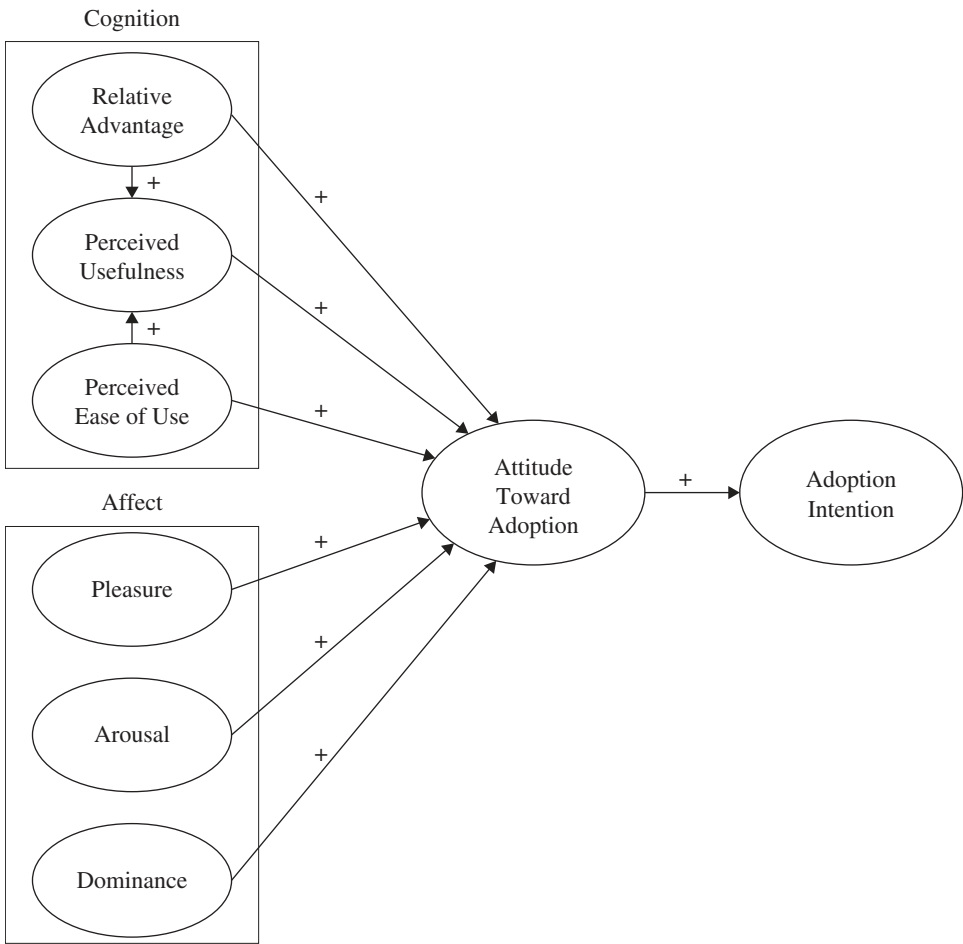
Figure 1. Proposed Consumer Acceptance of Technology (CAT) model.

Perceived ease of use is beneficial for initial acceptance of an innovation and is essential for adoption and continued use (Davis, Bagozzi, & Warshaw, 1989).

Perceived ease-of-use has been examined extensively in understanding user acceptance of technology (Venkatesh, 2000). Like perceived usefulness, perceived ease of use has been empirically shown to be a critical component of the adoption process (e.g., Lin, Shih, & Sher, 2007; Venkatesh, 1999). The effects of this construct within TAM, however, are less clear. Sometimes ease of use has been shown to have both a direct effect on attitude, whereas in other cases only an indirect effect (via perceived usefulness) has been found (Davis, Bagozzi, & Warshaw, 1989; Venkatesh, 1999). The direct effect suggests that perceived ease of use could improve attitude toward adoption regardless of the product's usefulness. By contrast, the indirect effect stems from the situation where, other things being equal, the easier a technology is to use, the more

useful it is perceived to be, thus, the more positive one's attitude and intention toward using the technology (Davis, Bagozzi, & Warshaw, 1989). Both direct and indirect effects have been tested and found to be positive and significant in the workplace context (Adams, Nelson, & Todd, 1992; Davis, Bagozzi, & Warshaw, 1989). Similarly, in the consumer context, ease of use was found to have a direct and positive effect on attitude toward use of technological innovations (Childers et al., 2001; Dabholkar & Bagozzi, 2002; Gentry & Calantone, 2002). Thus,

Hypothesis 2a: The higher the perceived ease of use of a high technology innovation, the greater the perceived usefulness of the innovation.

Hypothesis 2b: The higher the perceived ease of use of a high technology innovation, the more positive the attitude toward the act of adopting the innovation.

Relative Advantage. Individuals are more likely to adopt innovations that have perceived advantages than they are to buy products which have little or no additional benefits over the alternatives. As described by Rogers (2003), relative advantage means that the innovation is believed by the adopter to be superior in some way to what it is intended to supersede. In an effort to operationalize the characteristics of innovation acceptance proposed by Rogers (2003), Moore and Benbasat (1991) developed the PCI model (Perceived Components of Innovation). A test of PCI by Plouffe, Hulland, and Vandenbosch (2001) showed that relative advantage is the model's most powerful predictor of adoption intention. In fact, in a meta-analysis of work on innovation characteristics, relative advantage was one of just a few constructs found to be consistently related to adoption (Tornatzky & Klein, 1982).

Comparing perceived usefulness with relative advantage, the former reflects the belief that a technology helps perform a function while the latter is focused on the degree to which an innovation is perceived to be *better* than its precursor. Although the two concepts are related, they are distinct and may play complementary roles in shaping adoption attitudes (e.g., Karahanna et al., 2002; Moore & Benbasat, 1991). Despite their conceptual distinctions, direct empirical examination of their relative roles has not been conducted. Plouffe, Hulland, and Vandenbosch (2001) included both constructs in their study but not in the same model, meaning their roles could not be directly compared. Furthermore, attitude toward adoption was not included in the study; thus, the extent to which attitude simultaneously mediates the effects of usefulness and relative advantage on adoption intentions is unknown.

In organizational settings, individual employees often do not have the freedom to compare technology innovations and choose which one to

adopt. Instead, someone else in the organization makes the decision to adopt a certain innovation and employees are expected to use it. This is in great contrast to the consumer context in which consumers are relatively free to compare the characteristics of one or more options and to decide which option is most advantageous compared to what they have previously used. Hence, in consumer contexts, relative advantage is anticipated to influence attitude toward adoption. Because the construct is not explicitly captured in TAM, the position taken here is that the explanatory power of the model could be improved if it were added, particularly when trying to describe what ultimate consumers (rather than employees) routinely do.

With regard to the flow of effects from relative advantage to attitude toward adoption, both direct and indirect effects are expected. Relative advantage is posited to influence perceived usefulness, and thereby adoption attitude, in much the same way as explained earlier regarding perceived ease of use; that is, consumers are likely to judge an innovation to be useful to the extent that it is believed to have advantages over the alternative(s). This is the indirect effect. However, not all advantages are necessarily considered useful by consumers. Often, firms tout the advantages a product has over the competition or previous technology, which may not be considered "useful" from the consumer's perspective. Yet, these advantages may still influence their attitudes toward the new product. This is the direct effect. For example, an aesthetically pleasing design for a new product may be touted as an advantage by the firm over drab precursors, as in the case of iPods. Although this does not enhance perceptions of product usefulness, it may influence consumer attitudes toward the product. In other words, it is possible for some apparent "advantages" to be considered not very useful from a functional perspective. Hence, usefulness is posited to partially mediate the effect of relative advantage on attitude toward adoption.

Hypothesis 3a: The higher the perceived relative advantage of a high-technology innovation, the greater the perceived usefulness of the innovation.

Hypothesis 3b: The higher the perceived relative advantage of a high-technology innovation, the more positive the attitude toward adopting the innovation.

Pleasure. For over two decades, marketing scholars have argued that an intrinsically motivated hedonic feeling may play an important role in the consumption decision (Holbrook & Hirschman, 1982; Hartman et al., 2006). In the context of technology, the entertainment potential of these high-technology products is expected to have a strong influence on the adoption decision (Childers et al., 2001). Recently, pleasure was found to have a direct and strong positive effect on attitude toward Internet

shopping (Lee, Suh, & Whang, 2003) and, when operationalized as "fun," it had a direct effect on attitude toward the use of handheld internet devices (Bruner & Kumar, 2005).

Arousal. Research has shown that arousal can influence behavior and the formation of attitudes in marketing contexts. For instance, Donovan, Marcoolyn, and Nesdale (1994) found a positive relationship between the feelings of shoppers who had been aroused in a store and their attitudes toward in-store shopping. Similarly, LaTour and Rotfeld (1997) found that an excited feeling (arousal) is conducive to a positive attitude about an advertisement. In a technology adoption context, Lee, Suh, and Wang (2003) found that arousal had a positive influence on attitude toward use of an Internet shopping mall.

Dominance. Feelings related to being in control are a major facet of the dominance dimension. Studies have shown that control, or lack thereof, is related to adoption and use of technology (e.g., Parasuraman & Colby, 2001; Trevino & Webster, 1992). Submissiveness, the opposite pole of dominance, is reflected in several anxiety-related feelings such as frustration, confusion, and fear (Russell & Mehrabian, 1977). Harris (1999) found that anxiety strongly predicted negative attitudes regarding computer technology usage. Moreover, Igbaria and Parasuraman (1989) found that anxiety was the strongest predictor of negative attitude toward technology. In fact, the effect was even greater than that of the demographic and cognitive style variables examined.

Hypotheses 4 through 6 address the affective components of CAT.

Hypothesis 4: The higher the level of pleasure consumers feel toward a high-technology innovation, the more positive their attitude toward the act of adopting the innovation.

Hypothesis 5: The higher the arousal induced in consumers by a high-technology innovation, the more positive their attitude toward the act of adopting the innovation.

Hypothesis 6: The higher the level of dominance consumers feel regarding a high-technology innovation, the more positive their attitude toward the act of adopting the innovation.

Attitude and Intention. In the context of TAM, attitude toward the act refers to the evaluative judgment of adopting a piece of technology. It is viewed as the result of a set of cognitions as well as a set of affective responses to the behavior (Cohen & Areni, 1991; Triandis, 1971). Logically, therefore, the adoption of a high-technology innovation is not only influenced by cognitions about the technology but also by affect.

The effect of attitude toward adoption in TAM is unclear because the empirical support for its effect on behavioral intention has been inconsistent. Some studies have excluded the attitude component from TAM because it did not fully mediate the effect of perceived usefulness and perceived ease of use (Venkatesh, 1999; Venkatesh & Davis, 2000). In contrast, a meta-analysis of attitudinal research related to the theory of reasoned action found strong support for using attitude to predict intentions (Sheppard, Hartwick, & Warshaw 1988). For example, some have found that attitude plays a key mediating role (Chang & Cheung, 2001) or is a partial mediator (Davis, Bagozzi, & Warshaw, 1989). Because of these inconsistent findings in the literature, there is a need to identify the conditions under which attitude appears to mediate the belief-intention link.

Attitude toward adoption has been found to play a key role in technology acceptance within the consumer context. Bruner and Kumar (2005) showed that attitude mediated the effects of perceived usefulness, ease of use, and an emotion (fun) on intention. One possible reason attitude was found to be a significant part of the model in this consumer study is that affect was included, though in limited form. This finding is not surprising because attitudes have for a long time been theorized to be influenced both by cognition and affect, and, in turn, directly influence behavioral intentions (Ajzen, 2001). However, studies of technology acceptance in the MIS and IT literatures usually predict attitude solely in terms of cognition.

After a review of the relevant literature, particularly as it pertains to the consumer context, attitude toward adoption is retained for use in the model and is hypothesized to be influenced by both cognition and affect.

Hypothesis 7a: Attitude toward the act of adopting an innovation mediates the effects of cognition and affect on adoption intention.

Hypothesis 7b: Attitude toward the act of adopting an innovation has a direct and positive effect on consumer intention to adopt the innovation.

Comparing CAT to the Original TAM

The final hypothesis involves an explicit comparison of the CAT model versus the original TAM. The test of this hypothesis will determine whether or not CAT, with its multidimensional operationalization of affect as well as the addition of relative advantage, provides a significant improvement in predicting adoption intention compared to TAM, which does not incorporate these constructs.

Hypothesis 8: The CAT model explains more variance in consumer adoption intentions than the original TAM.

RESEARCH METHODOLOGY

Pretest

The focal innovation used in the study was a PDA (personal digital assistant). This product was selected for a variety of reasons. The type of PDA used was a relatively new, prototype model (not generally available to the public) at the time of the study. It had Microsoft's *Pocket PC* operating system, the newest type with multitasking and multimedia capabilities. Furthermore, PDAs were one of six product categories on which the technologically sophisticated of the American population had been identified as focusing their spending (Horrigan, 2003). Of those six categories, the "personal organizer" group was the most amenable for obtaining multiple units and providing them to several subjects simultaneously in an experimental setting.

To confirm the expectations that the *Pocket PCs* would be viewed as innovative, high tech products, a pretest was carried out with 40 subjects similar to those in the main study. PDAs were provided to subjects and they evaluated them using 7-point Likert scales (1 = *strongly disagree* to 7 = *strongly agree*). The results indicated that the PDA was viewed not only as a high-technology product (mean = 5.48, S.D. = 1.01) but that it was an innovative as well (mean = 5.53, S.D. = 1.08).

Main Study Sample and Procedures

According to a study by the Pew Internet & American Life Project (Horrigan, 2003), the "young, tech elite" should be one of the most attractive segments to marketers of innovative technology because their adoption and usage of tech products influence what the majority eventually do. The Pew study provided evidence that this group spends more than average on all sorts of technology goods and services. The members were more likely to be college educated than usual and have an average age of 22 years. Thus, college students were considered a particularly relevant and appropriate segment to use in a study of technology acceptance.

Data were collected from 260 undergraduate students at a large Midwestern U.S. university.[2] One hundred twenty-one (52.6%) of the respondents were women and 109 (47.4%) were men. Although the majority of the respondents (59.1%) were between the ages of 21 and 25 years, their ages ranged from less than 20 to more than 36. Most subjects indicated having little or no experience with PDAs (mean = 1.45, S.D. = .81).[3]

[2]   Extra credit was given to those who voluntarily completed the study. An alternative task was offered to students to earn the same amount of extra credit and amounted to writing a three-page paper on a marketing topic of their choice.

[3]   Participants indicated their experience level with PDAs on a 4-point scale ranging from 1 (none-at-all) to 4 (several hours per week). The sample was limited to those for whom a PDA, particularly a *Pocket PC*, was relatively unfamiliar because CAT was most relevant for contexts in which the products were viewed by consumers as technological innovations.

Thirty questionnaires were excluded from analysis because the participants either owned a PDA or did not perceive a PDA to be a high-technology and innovative product.

The procedure followed in the main study consisted of three phases. First, participants were asked to fill out a portion of the questionnaire having to do with general demographics. Second, subjects were instructed to engage in two tasks in order to gain some familiarity with the device. The tasks were two typical but different consumer activities involving the PDA: a utilitarian (cognition-evoking) task and a hedonic (affect-evoking) task. The utilitarian task required subjects to use the PDA's calendar and schedule feature. Participants were instructed to find a single meeting time that fit several coworkers' schedules. Subsequently, subjects searched the PDA's contact feature to obtain some information (e.g., telephone number and e-mail address) from the address book. In contrast, the hedonic task involved the subjects engaging in an entertainment activity using the PDA (accessing and running a movie clip). The main reason for having these two different tasks was to make sure that all subjects had cognitive and affective experiences they could draw on when completing the rest of the survey form. The order of these two tasks was counterbalanced to minimize any potential order effects. Thus, half of the subjects were randomly assigned to perform hedonic task first, and the other half were assigned to perform the utilitarian task first. Finally, they completed the primary dependent measures.

Measures

All theoretical constructs were operationalized using previously developed multi-item scales (Appendix). The scales to measure perceived usefulness and perceived ease of use were from Lund (2001). The measure of relative advantage was borrowed from Moore and Benbasat (1991). Scales to measure emotion (PAD) were taken from the original work by Mehrabian and Russell (1974). Measures of attitude (A_{act}) and adoption intention were adapted from Bagozzi, Baumgartner, and Yi (1992) and MacKenzie, Lutz, and Belch (1986), respectively.

RESULTS

The proposed model (see Figure 1) was examined using structural equation modeling (SEM). The data were analyzed using EQS and a two-step structural equation modeling approach (Anderson & Gerbing, 1988). First, the measurement model was assessed using confirmatory factor analysis (CFA) to verify that each scale uniquely measured its associated factor. The model was refined to create a "best" measurement model by eliminating scale items that did not have good item reliability or had high cross-loadings on two constructs. Second, the structural model

was evaluated by testing the hypotheses and performing the model comparisons.

The Measurement Model

CFA was used to test the unidimensionality, reliability, and validity of the constructs in the model. Construct validity was examined via the assessment of each measure's convergent and discriminant validity. Furthermore, several goodness of fit indices (both absolute and incremental fit indices) were used because there is no consensus on any single measure (Hu & Bentler, 1999).

Overall goodness-of-fit indices for the initial model suggested that the fit was acceptable, with the chi-square/df ratio of 1.53, root-mean-squared error of approximation (RMSEA = .05), standardized root-mean-squared residual (SRMR = .06), comparative fit index (CFI = .93), nonnormed fit index (NNFI = .93) all having acceptable fit levels. An examination of the standardized residual matrix, along with modification indices and Wald test, suggested that some of the indicators of the pleasure, arousal, and dominance constructs cross-loaded and needed slight modification. After some items were dropped the measurement model was again tested. The goodness of fit indices for the final measurement model indicated a better fit than those obtained for the initial model. Other indices also suggested a better fit for the final model (chi-square/df ratio = 1.52, RMSEA = .04, SRMR = .04, CFI = .96, and NNFI = .95).

Internal consistency reliability (Cronbach's alpha) greater than 0.8 is typically considered to be good and levels of 0.7 to 0.8 are considered acceptable (Nunnally & Bernstein, 1994). The Appendix provides the alpha coefficients estimated from the revised scales for each construct in the proposed model. The internal consistency reliabilities of the different measures included in the model ranged from .76 to .93. Moreover, all of the composite (construct) reliabilities were greater than 0.7 and, hence, were considered very good (Hair et al., 1998). Furthermore, all items had large and significant loadings on their corresponding factors ($p < .01$), which is evidence of unidimensionality and convergent validity (Bollen, 1989). The correlations, means, and standard deviations for the scales are provided in Table 1.

The discriminant validity of the constructs was supported by comparing the χ^2 difference of the original proposed model to other constrained models with the correlation between that pair of constructs fixed to unity. A significant chi-square difference implies that the original model is a better fit for the data, thereby providing evidence of discriminant validity (Bagozzi & Phillips, 1982). The results of the chi-square difference tests showed that in every case the χ^2 of the original models were significantly better than unions of any two latent variables, thus supporting the discriminant validity for every one of the scales (Table 2).

Table 1. Correlation Matrix and Descriptive Statistics.

Construct	PU	RA	PEU	PL	ARO	DOM	A_{act}	AI	Mean	S.D.
Perceived usefulness	1								3.95	.76
Relative advantage	.96	1							3.74	.88
Perceived ease-of-use	.50	.46	1						4.33	.63
Pleasure	.49	.42	.52	1					3.28	.74
Arousal	.32	.29	.28	.54	1				3.87	.84
Dominance	.49	.47	.49	.58	.55	1			3.64	.87
Attitude toward adoption	.65	.58	.48	.68	.51	.47	1		4.42	.70
Adoption intention	.57	.52	.45	.47	.31	.40	.66	1	4.29	.86

Structural Model Analyses

Structural equation modeling (SEM) using EQS was implemented to test the research model and hypotheses. The CAT model was examined using multiple fit indices. The overall model fit was adequate and the standardized path estimates indicated significant relationships among the constructs. The chi-square/df ratio was less than 2. The incremental fit indices (CFI and NNFI) were all above 0.91 and absolute fit indices, RMSEA and SRMR, were less than 0.06 and 0.09, respectively.

Hypotheses 1 through 3 related to cognition. Perceived usefulness was a significant determinant of A_{act} ($\beta = 0.80, p < .05$), thus supporting Hypothesis 1. Likewise, the direct effect of perceived ease of use on perceived usefulness was statistically significant ($\beta = 0.14, p < .01$), thus supporting Hypothesis 2a. Perceived ease of use was not a significant direct predictor of A_{act} ($\beta = 0.04, p =$ n.s.), hence, failing to support Hypothesis 2b. Hypothesis 3a and 3b related to perceived relative advantage of an innovation. Hypothesis 3a was supported ($\beta = 0.95, p < .01$), indicating that perceived relative advantage has a strong positive relationship with perceived usefulness. Hypothesis 3b was not supported ($\beta = -0.35, p =$ n.s.) meaning that perceived relative advantage was not found to have a significant direct effect on A_{act}.

Hypotheses 4 through 6 pertained to affect. Both pleasure ($\beta = 0.41$, $p < .01$) and arousal ($\beta = 0.19, p < .01$) had strong direct effects on A_{act}, thus supporting Hypotheses 4 and 5. Dominance did not demonstrate a direct relationship with A_{act} ($\beta = -0.01, p =$ n.s.). Thus, Hypothesis 6 was not supported.

In summary, the results of these tests showed that attitude had three direct antecedents: perceived usefulness, pleasure, and arousal. Perceived usefulness had the strongest direct effect on A_{act} ($\beta = 0.80, p < .01$), followed by pleasure ($\beta = 0.41, p < .01$), and then arousal ($\beta = 0.19, p < .01$). Both perceived ease of use and relative advantage had indirect effects on A_{act} via perceived usefulness, and dominance had no direct effect.

Table 2. Pairwise Discriminant Analyses.

Model	χ^2_{df}
Original model	$\chi^2_{467} = 871.63$
Combining attitude with adoption intention	$\chi^2_{474} = 1543.63$
Combining attitude with relative advantage	$\chi^2_{474} = 1813.50$
Combining attitude with perceived usefulness	$\chi^2_{474} = 1805.07$
Combining attitude with perceived ease-of-use	$\chi^2_{474} = 2079.43$
Combining attitude with pleasure	$\chi^2_{474} = 1205.05$
Combining attitude with arousal	$\chi^2_{474} = 1167.85$
Combining attitude with dominance	$\chi^2_{474} = 1256.03$
Combining adoption intention with relative advantage	$\chi^2_{474} = 2107.81$
Combining adoption intention with perceived usefulness	$\chi^2_{474} = 1725.83$
Combining adoption intention with perceived ease-of-use	$\chi^2_{474} = 1901.71$
Combining adoption intention with pleasure	$\chi^2_{474} = 1472.06$
Combining adoption intention with arousal	$\chi^2_{474} = 1304.70$
Combining adoption intention with dominance	$\chi^2_{474} = 1323.69$
Combining relative advantage with perceived usefulness	$\chi^2_{474} = 892.99$
Combining relative advantage with perceived ease-of-use	$\chi^2_{474} = 2013.51$
Combining relative advantage with pleasure	$\chi^2_{474} = 1489.04$
Combining relative advantage with arousal	$\chi^2_{474} = 1305.01$
Combining relative advantage with dominance	$\chi^2_{474} = 1266.03$
Combining perceived usefulness with perceived ease-of-use	$\chi^2_{474} = 2025.72$
Combining perceived usefulness with pleasure	$\chi^2_{474} = 1443.95$
Combining perceived usefulness with arousal	$\chi^2_{474} = 1286.58$
Combining perceived usefulness with dominance	$\chi^2_{474} = 1245.44$
Combining perceived ease-of-use with pleasure	$\chi^2_{474} = 1418.79$
Combining perceived ease-of-use with arousal	$\chi^2_{474} = 1346.76$
Combining perceived ease-of-use with dominance	$\chi^2_{474} = 1251.45$
Combining pleasure with arousal	$\chi^2_{474} = 1084.88$
Combining pleasure with dominance	$\chi^2_{474} = 1102.46$
Combining arousal with dominance	$\chi^2_{474} = 1071.70$

To examine the mediational role of attitude (Hypotheses 7a), two models were estimated for comparison. Although the first model positioned attitude in a fully mediational role between cognition (perceived usefulness, ease of use, and relative advantage) as well as affect (pleasure, arousal, and dominance) and adoption intention, the second model allowed for the cognitive and affective constructs to have both direct and indirect (mediated through attitude) effects on adoption intention. The first model was nested within the second model. A chi-square (χ^2) difference test was performed to determine whether A_{act} fully mediated or only partially mediated the influence of cognition and affect on adoption intention of high-technology innovations. Table 3 presents the results for the full and

Table 3. Full Mediation and Partial Mediation Models of Attitude.

Path	Full mediation		Partial mediation	
	Standardized path coefficients	t-value	Standardized path coefficients	t-value
RA → AI	–	–	.02	.06
PU → AI	–	–	.18	2.00*
PEU → AI	–	–	.12	.52
PL → AI	–	–	.01	.14
ARO → AI	–	–	−.06	−1.06
DOM → AI	–	–	.07	1.60
RA → A_{act}	−.35	−1.07	−.36	−1.09
PU → A_{act}	.80	2.42*	.80	2.39*
PEU → A_{act}	.04	0.68	.03	0.55
PL → A_{act}	.41	6.87**	.41	6.86**
ARO → A_{act}	.19	3.44**	.20	3.55**
DOM → A_{act}	−.01	−.05	−.02	−.32
RA → PU	.95	16.37**	.95	16.43**
PEU → PU	.14	4.92**	.14	4.90**
A_{act} → AI	.63	13.21**	.49	6.68**
Chi-square with df	$\chi^2_{(485)} = 1184.29$		Chi-square with df $\quad \chi^2_{(479)} = 1156.73$	

* $p < .05$; ** $p < .01$

partial mediation models. The test suggests that the partial mediation model proved the best fit for the data ($\Delta\chi^2_{(5)} = 27.56, p < .05$), thus, supporting Hypothesis 7a.

The data also showed a strong positive relationship between Aact and adoption intention ($\beta = .63, p < .01$), thus supporting Hypothesis 7b. This confirms that individuals who have high positive attitude toward adopting a high technology product were likely to have intentions to buy that product. Figure 2 depicts the path coefficients, t-values, and the significant (and nonsignificant) paths of the research model.

Finally, to test Hypothesis 8, the proposed model (CAT) was compared to the original TAM in terms of explaining variance in adoption intention. CAT was estimated first and accounted for 53% of the variance in behavioral intention to adopt the high-technology product. Next, the relative advantage and affective components were dropped and the model (now in the form of the original TAM) was reestimated. This model accounted for only 38% of the variance in behavioral intention. The test indicates that CAT provided a substantially better fit to the data than the original TAM ($\Delta\chi^2_{(3)} = 97.53, p < .001$), with an almost 40% improvement in variance explanation. Given this, Hypothesis 8 was clearly supported.

DISCUSSION

The results of this study have provided strong evidence in support of a unified theory of consumer technology acceptance in which affect is
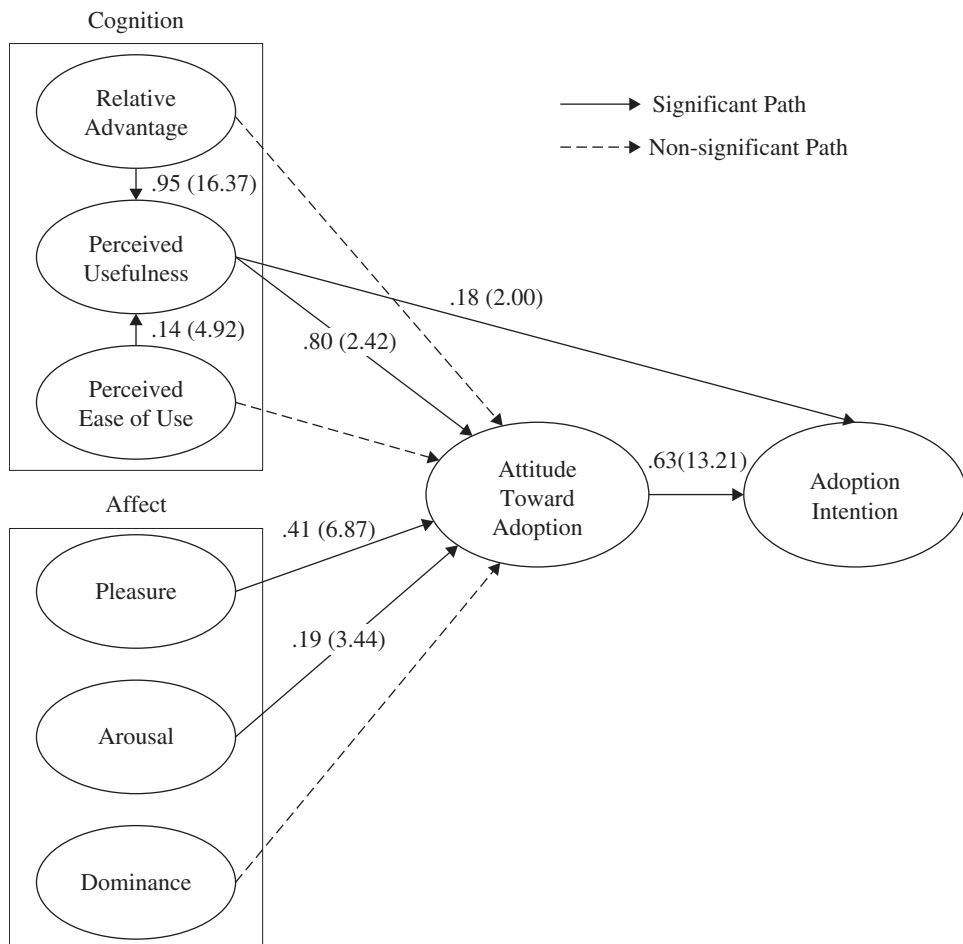
Figure 2. Path coefficients for Consumer Acceptance of Technology Model.

comprehensively integrated with cognition. Specifically, strong empirical support was found for eight of the study's eleven research hypotheses. The ultimate consequence was that the unified model (CAT) explained over 50 percent of the variance in adoption intention. Previous uses of TAM tended to only explain between 17% and 33% of variance in behavioral intention (Davis 1989; Davis, Bagozzi, & Warshaw, 1989; Chau & Hu 2001).

In addition to the model enhancement provided by this research, several key findings of previous TAM studies were replicated. The results supported most of the individual causal paths postulated by TAM. The positive effect of perceived ease of use on usefulness found in this study is consistent with previous TAM research. This confirms that in a consumer context, judgments about a technology's usefulness are affected by an individual's sense of the simplicity and convenience with which it can be used. Although perceived usefulness was found to have a direct and positive effect on attitude, perceived ease of use only had an indirect

effect on attitude via perceived usefulness. Although that result failed to support H2b, it was not totally unexpected because most prior TAM research has found that perceived usefulness contributes more in predicting attitude than perceived ease of use (e.g., Davis, 1989; Hu et al., 1999; Childers et al., 2001).

Unexpectedly, perceived usefulness had a direct effect on adoption intention. Although not typical, this finding has been found before (e.g., Gentry & Calantone, 2002). A possible explanation is that perceived usefulness has the potential to induce dual effects by influencing individual's attitude as well as his or her intention to adopt technology. This finding suggests that perceived usefulness can directly influence one's adoption intentions regardless of one's attitude. In other words, a consumer might have a mixed attitude about adopting a piece of technology and yet intend to adopt the product anyway because it is considered to be so useful and necessary. As a practical example, there is the well documented love/hate relationship many consumers have with their cell phones (e.g., Lemelson-MIT Program, 2004; Swanbrow, 2005). On a scholarly level, this may help understand why TAM has been used in some studies without attitude at all.

Another insight gained by this study involves the roles of relative advantage and perceived usefulness. No known previous study directly compared their effects on adoption attitude and intention. Although relative advantage was expected to have an effect on attitude toward adoption, it was not clear if it would be a direct effect, an indirect effect (through perceived usefulness), or both. Ultimately, the results provided support only for the indirect effect. The direct effect may still be found in some cases, however. As has been found over time with TAM and PCI constructs, a degree of context dependency exists (Plouffe, Hulland, & Vandenbosch, 2001). For example, it could be that when subjects are provided with multiple product options, the perceived relative advantage of the focal innovation can be primed more than what occurred in the present study where subjects had only one product to use and no explicit comparisons to make.

As anticipated, several of the individual paths postulated from the PAD paradigm were also significant predictors of attitude toward adoption. The results showed that pleasure and arousal were significant predictors of attitude, suggesting that being pleased and excited about a new high-tech device positively influences the consumer's attitude toward adoption. In contrast, dominance was not found to be significantly related to attitude. In retrospect, it is possible that the nature of the setting did not evoke the type of emotions most representative of the dominance dimension. Yani-de-Soriano and Foxall (2006) have recently examined this issue and concluded that the significance of dominance's role depends on what they referred to as "the scope of the setting." Their review of multiple studies shows that dominance is the primary affective discriminator between closed (little choice) and open (free choice) settings.

Perhaps manipulation of the setting or the product choice would have evoked more dominance-related feelings. In this study, there were no other products for subjects to choose from nor were there time, money, or social pressures on them to respond a certain way with respect to the focal product. Considering all of this, the role of dominance should not be viewed as a closed issue; it is still worthy of exploration.

These findings have implications for both scholars as well as managers concerned with technology adoption. As for theory, most studies based on innovation diffusion literature from sociology or technology acceptance literature from management information systems have, with few exceptions, focused on cognition as the sole driver of adoption. This study built on the few others in recent years that have provided strong evidence that a more complete picture of adoption intention is possible by including affect into models of technology acceptance (Bruner & Kumar, 2005; Childers et al., 2001; Dabholkar & Bagozzi, 2002; Wood & Moreau, 2006). By integrating PAD with TAM to produce a unified theoretical model, CAT improves the prediction of technology adoption while retaining a parsimonious structure. More specifically, results from this study suggest that affect, in the form of pleasure and arousal, can greatly improve the predictive power of TAM.

As for managerial implications, the present study offers practitioners several valuable findings. First and foremost, the results are clearly of interest to the management of new product development, particularly the implementation of strategies with respect to product design. The CAT model is useful for predicting the extent to which a target market intends to adopt a particular technological innovation. High-technology products often have a high degree of technological uncertainty marked by complicated product functions. This research shows that for products with low usefulness, ease of use is unlikely by itself to influence consumer attitudes and intentions to adopt. Firms should keep this in mind, especially during the product design stage. Furthermore, CAT forces marketing managers in the high-technology industry to acknowledge that emotional reactions can play a significant role in determining consumers' adoption of such products, above and beyond how useful the product is thought to be. Of special interest to managers is the finding that feelings of pleasantness and arousal have powerful effects on consumer attitude. Not only should products be designed with pleasure and arousal in mind but those affective dimensions should be assessed with the product's target market during concept and market testing to more accurately assess the innovation's acceptance level.

The findings also have important implications for managers involved in promotional activities intended to inform and persuade consumers to accept high technology innovations. Advertising professionals should tailor their campaigns to communicate not only the technology's usefulness and ease of use, but also the enjoyment and fun that comes from using the product. Fun, a mixture of pleasure and arousal, seems

to be a particularly potent emotion to evoke. Other mixtures of pleasure and arousal that may be appropriate to promote are playfulness (intrinsically motivating, self-oriented, and active) and coolness (concepts of artistic expression, uniqueness-seeking, and ideal self) (Solomon, 2003; O'Donnell & Wardlow, 2000). Although managers should try to elicit and maximize positive affect (joy, excitement, fun, cool, etc.), reducing negative affective responses (e.g., dullness, unhappiness, annoyance) also could contribute to increasing positive attitude, especially with some segments.

This study raises several questions that suggest topics for future research. First, even though cognition played the dominant role in this study, it seems possible that in some situations affect could be the more powerful predictor of adoption intentions (e.g., Bruner & Kumar, 2005; Scarabis, Florack, & Gosejohann, 2006). Future studies could investigate the conditions under which that flow of effects tends to occur. Second, one of the goals of CAT was parsimonious integration of affect and that led to use of the PAD paradigm. Other paradigms exist, although not as parsimonious. It is worthy of studying under what conditions another representation of affect would be useful, such as when depth (knowledge about a few specific emotions) is more important than breadth. Third, as suggested already, it is premature to treat dominance as irrelevant to technology acceptance. Instead, its effects appear to be more difficult to detect and less direct than those of the pleasure and arousal dimensions. Examination of effects beyond the single one tested in this study (H6) is suggested for future research. For example, interaction effects between dominance and the cognitive components of CAT or dominance and constructs not currently included (e.g., nature of the task, social influence) deserve scrutiny. Finally, the measures of relative advantage and perceived usefulness used in the current study were highly correlated. Although that is expected given the nature of the constructs, it is suggested that measures be developed for these two constructs that are more distinct. For example, by explicitly identifying what alternative(s) the focal innovation is supposed to be better than (e.g., a particular precursor or a competing new product), a scale may be produced for relative advantage that has greater discriminability from the measure of perceived usefulness.

In conclusion, this research, in conjunction with other studies examining the role of affect in predicting adoption intention (Bruner & Kumar, 2005; Childers et al., 2001; Dabholkar & Bagozzi, 2002), should serve as a caution to other consumer researchers that basing their behavioral predictions on cognition alone, as in the original TAM, may lead to significantly deteriorated prediction ability. This study has provided strong evidence that comprehensive and integrative models of cognition and affect such as CAT provide superior explanations of technology acceptance.

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APPENDIX

Questionnaire Items and Reliabilities*

Usefulness (α = .90; construct reliability = .85)

1. It helped me be more effective.
2. It helped me be more productive.
3. It saved me time to use it.
4. It required the fewest steps to accomplish what I wanted to do with it.
5. It made the task I wanted to accomplish easier to get done.

Ease of Use (α = .91; construct reliability = .86)

1. It was easy to use.
2. I learned to use it quickly.
3. It was simple to use.
4. I easily remember how to use it.
5. It was easy to learn to use it.

Pleasure (α = .80; construct reliability = .75)

1. Happy/Unhappy
2. Pleased/Annoyed
3. Satisfied/Unsatisfied
4. Contented/Melancholic**
5. Hopeful/Despairing
6. Relaxed/Bored**

Arousal (α = .78; construct reliability = .72)

1. Stimulated/Relaxed
2. Excited/Calm
3. Frenzied/Sluggish**
4. Jittery/Dull**
5. Wide-awake/Sleepy
6. Aroused/Unaroused

Dominance (α = .76; construct reliability = .70)

1. In Control/Cared For
2. Controlling/Controlled
3. Dominant/Submissive
4. Influential/Influenced
5. Autonomous/Guided**
6. Important/Awed**

Attitude-Toward-the-Act (α = .93; construct reliability = .85)

Overall, how would you describe your experience? For me, using the _____ to _____ is:

1. bad/good
2. negative/positive
3. unfavorable/favorable
4. unpleasant/pleasant

Adoption Intention (α = .93; construct reliability = .85)

Assuming you have access to such a device in the future, what is the probability that you would use it?

1. unlikely/likely
2. improbable/probable
3. impossible/possible

* All scales used a 5-point response format. Items followed by ** were deleted after the first round of the CFA.