Journal of the Association for Information Systems

JAIS

Research Article

Examining Two Expectation Disconfirmation Theory Models: Assimilation and Asymmetry Effects

Nancy K. Lankton
Marshall University
lankton@marshall.edu

Harrison D. McKnight
Michigan State University
mcknight@bus.msu.edu

Abstract

Expectation disconfirmation theory (EDT) posits that expectations, disconfirmation, and performance influence customer satisfaction. While information systems researchers have adopted EDT to explain user information technology (IT) satisfaction, they often use various EDT model subsets. Leaving out one or more key variables, or key relationships among the variables, can reduce EDT's explanatory potential. It can also suggest an intervention for practice that is very different from (and inferior to) the intervention suggested by a more complete model. Performance is an especially beneficial but largely neglected EDT construct in IT research. Using EDT theory from the marketing literature, this paper explains and demonstrates the incremental value of using the complete IT EDT model with performance versus the simplified model without it. Studying software users, we find that the complete model with performance both reveals assimilation effects for less experienced users and uncovers asymmetric effects not found in the simplified model. We also find that usefulness performance more strongly influences usage continuance intention than does any other EDT variable. We explain how researchers and practitioners can take full advantage of the predictive and explanatory power of the complete IT EDT model.

Keywords: *Performance, Expectation Disconfirmation Theory, Satisfaction, Usefulness, Continuance Intention.*

* Bernard Tan was the accepting senior editor. This article was submitted on 23rd June 2009 and went through four revisions.

Volume 13, Issue 2, pp. 88-115, February 2012

Examining Two Expectation Disconfirmation Theory Models: Assimilation and Asymmetry Effects

1. Introduction

Information systems researchers have begun to use expectation disconfirmation theory (EDT) to explain user information technology (IT) satisfaction (e.g., Bhattacherjee & Premkumar, 2004). EDT has long been a dominant marketing paradigm for studying customer satisfaction across many products and services (Tse, Nicosia, & Wilton, 1990). In an IT context, EDT explains how technology satisfaction is created as users form initial technology expectations, use the technology, and compare technology performance against initial expectations. According to EDT, expectations are one's pre-usage beliefs about how a technology will perform based upon certain attributes of the technology (Olson & Dover, 1979). Performance is an individual's post-usage belief about how the technology performed on the expectation attributes during the use period (Cadotte, Woodruff, & Jenkins, 1987). Disconfirmation, in turn, is a subjective post-usage comparison that can result in one thinking performance was better, the same as, or worse than expected (Oliver, 1980; Olson & Dover, 1979). EDT posits that expectations, disconfirmation, and performance can all affect satisfaction (Figures 1 and 2). Satisfaction is an important IT-dependent variable that represents a user's emotional state, feelings, or affective attitude about the system following a usage experience (Bhattacherjee & Premkumar, 2004; Doll & Torkzadeh, 1988).

In an EDT literature overview, Oliver (1997) describes two EDT models. The first model is called the simplified expectation disconfirmation model (hereafter called the "simplified model") and includes expectation, disconfirmation, and satisfaction (Figure 1). In this model, expectation is generally predicted to have a negative influence on disconfirmation, as higher expectations are more likely to be negatively disconfirmed (i.e., performance is worse than expected) (Appendix A). Also, both expectations and disconfirmation are predicted to lead to higher satisfaction levels.

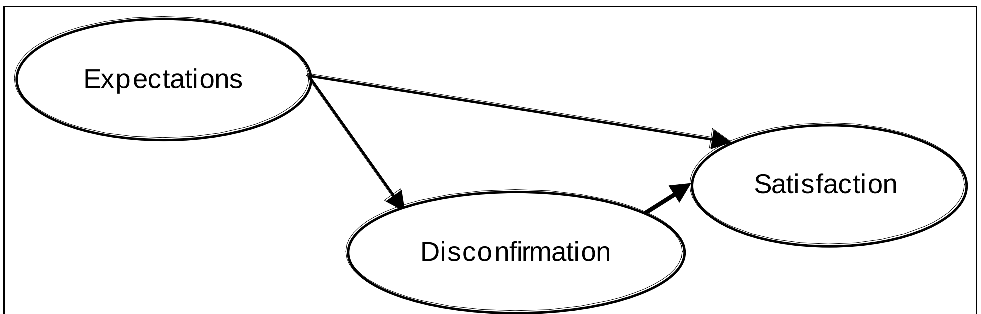

Figure 1. The Simplified Expectation Disconfirmation Model (adopted from Oliver, 1997, p. 110)

The second model is called the complete expectation disconfirmation with performance model (hereafter called the "complete model") (Figure 2 and Appendix A). This model contains performance as an additional variable. It shows that expectations positively influence performance, and performance positively influences disconfirmation and satisfaction. The only difference between the simplified and complete models is the inclusion of performance and its relationships with the other EDT variables. Oliver (1997) claims that the complete model incorporates all the empirical relationships currently recognized by EDT researchers.

We understand that researchers justifiably favor the more parsimonious of two models. For example, the technology acceptance model (TAM) is often favored over other models (e.g., the theory of reasoned action or the theory of planned behavior) for studying IT acceptance because it predicts well with fewer variables. While parsimony is important, an overly parsimonious model may not explain a phenomenon as well as a rival model. We will argue that the simplified EDT model often does not explain as well as the complete EDT model. In the process, we use arguments from the marketing EDT literature, based on such foundations as social judgment theory and prospect theory.

Assessing the use of these models, we find that despite the growing number of IT EDT studies, little IT research to date examines the simplified model, and no IT EDT research to date examines the complete model (see Appendix B for a summary of IT EDT literature). Many IT researchers may leave out expectations and not test the simplified or complete models due to the difficulty of conducting longitudinal studies in which expectations are collected in time 1 and performance and disconfirmation are collected in time 2[1]. Further, IT EDT researchers may not test the complete model or include the complete model's performance variable because performance can correlate highly with disconfirmation, which could distort results through multicollinearity (Bhattacherjee & Premkumar, 2004). Also, in certain circumstances, performance may not add to our understanding of IT satisfaction, making the more parsimonious simplified model the better choice. Studies may also focus on a large number of technology attributes, making it statistically infeasible to test all three variables (expectations, disconfirmation, and performance).

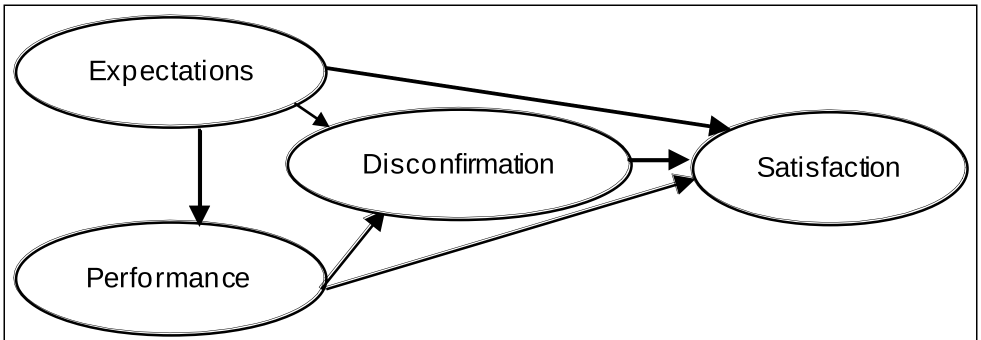

Figure 2. The Complete Expectation Disconfirmation Model (adopted from Oliver, 1997, p. 120)

However, using the simplified and complete models can help researchers better understand how the expectation-disconfirmation process works to form satisfaction. Understanding satisfaction is important because it is a key indicator of IT success (Khalifa & Liu, 2004), an important predictor of IT continuance intentions (Limayem, Hirt, & Cheung, 2007), and a variable that has advantages over other IT success factors in mandatory contexts and online environments (Bhattacherjee, 2001b). While other models have been used to predict satisfaction, such as the IT continuance model (Bhattacherjee, 2001a) and the IT success model (DeLone & McLean, 1992), the simplified and complete models specifically show how satisfaction forms through a disconfirmation process involving both one's initial expectations, and whether initial expectations were met or not (i.e., disconfirmation). This process has been shown to predict satisfaction with consumer products as well as IT (Bhattacherjee & Premkumar, 2004; Spreng & Page, 2003). Further, using the complete model to study the EDT process rather than the simplified or other incomplete models is especially important because it can show whether or not performance is instrumental in explaining satisfaction above and beyond what expectations and disconfirmation explain.

Performance is conceptually and operationally different from modified beliefs, which are included in some IT EDT studies (e.g., Bhattacherjee, 2001a; Brown, Venkatesh, Kuruzovich, & Massey, 2008; Limayem et al., 2007), but which are not a part of mainstream EDT per Oliver (1997). Performance refers to how individuals think a technology performed during the usage experience, and is measured with items referring to this past usage period. For example, to measure usefulness performance, items ask subjects if using the technology enhanced their performance or was useful. Performance is a variable that can be compared with expectations, the earlier forecast or projected beliefs. In contrast, modified beliefs refers to how individuals think a technology currently performs based on the usage experience, and is measured with items asking about current beliefs. For example, to measure modified usefulness beliefs, items ask subjects if using the technology enhances their effectiveness or is useful. Modified beliefs are, therefore, an update of earlier expectations and do not report how the technology did or how it performed, but rather how it is now doing. This difference is important because the theory behind EDT says that disconfirmation is a comparison that the person makes between expectations and performance. Only with the performance variable can this progression of thought be traced. The

[1] While comparing models with and without expectations is beyond our paper's scope, we do show that expectations are important in explaining satisfaction.

modified beliefs variable does not track how the technology performed, but how it is now expected to perform. Thus, it cannot be used to form disconfirmation. This is why performance is modeled as an antecedent of disconfirmation, while modified beliefs are modeled as a consequent.

One way performance can explain how satisfaction forms is by revealing assimilation effects through its mediating role in the expectations-satisfaction link. Assimilation effects point to a stronger reliance on expectations than disconfirmation in forming satisfaction (Oliver, 1997). Assimilation is salient in an IT context because many technologies are complex and not well known. For instance, they are less well known than the consumer products studied in marketing research. This can make it difficult for certain users to evaluate performance and undergo the non-trivial disconfirmation process. Instead, they rely on initial expectations to form satisfaction judgments. In these situations, practitioners should focus on getting initial expectations correct through training and other communications.

Another way performance can help explain satisfaction is through an asymmetric relationship that implies differences between positive and negative perceptions. Asymmetry is relevant to IT because the presence or absence of some system attributes is likely to evoke nonlinear effects. For example, having fast response times may maintain one's satisfaction, but not having them will make one dissatisfied. Unraveling these complexities can help practitioners make better design decisions. Overall, using the complete model that includes performance can help researchers further explore why some ITs succeed and others fail. It can also help IT practitioners make performance enhancement decisions during system design and maintenance.

Because there can be advantages to using the complete model with performance yet little IT research to date has examined it, the first objective of this research is to test the complete model in an IT context and compare the results to those using the simplified model. We investigate the research question: How do the complete model and the simplified model differ in predicting satisfaction and continuance intention? To answer this question, we examine assimilation and asymmetric effects in both models. As a supplemental analysis, we also examine the mediating role of satisfaction. We test these effects using data collected from student users of a database software application.

Our second research objective is to understand when it is better to apply the complete model versus the simplified model. We investigate the question: Do certain conditions exist in which the differences between the simplified and complete models are more prominent? Prior research suggests that performance's role in the EDT process may depend on the attribute examined and user experience. To address this, we explore usefulness and ease-of-use attributes, which, while not as pertinent in the marketing literature, are among the most common attributes associated with technology use. For example, ease of use may not be important for marketing products such as food, CDs, or clothing, but it is often important to satisfaction in an IT context. We also examine users with low versus high prior database software application and related computer experience. Overall, our findings contribute by demonstrating not only how the complete model can explain the EDT process better than the simplified model, but also when IT EDT researchers should apply the complete model versus the simplified model.

The paper proceeds as follows. We first describe performance's additional role in the complete model and develop hypotheses. We then present the methodology, the results, and discuss both the study's implications and its directions for future research.

2. The Complete Model and Performance

In the complete model, performance relates positively to disconfirmation. Holding expectations constant, the higher the performance, the more likely performance will exceed expectations, resulting in positive disconfirmation (Spreng & Page, 2003). Therefore, this relationship explains how performance is converted into a psychological comparison (i.e., disconfirmation) (Oliver, 1989). Performance plays additional explanatory roles in the complete model that are important for IT EDT research.

2.1. Revealing Assimilation Effects

Assimilation is the general process of incorporating new attitudes/beliefs into existing attitudes/beliefs to avoid dissonance (Sherif & Hovland, 1961). Assimilation effects form the basis for certain EDT relationships (Appendix A). In this section, we first explain assimilation effects in more detail, and then we develop hypotheses that can operationally test our research questions about the two EDT Models.

Social judgment theory explains that individuals make judgments and possible changes in attitude by comparing new stimuli to internal reference ranges or latitudes of rejection (new stimuli are different from one's internal reference range), acceptance (new stimuli are similar to one's internal reference range), and non-commitment or indifference (new stimuli are neither similar nor different) (Sherif & Hovland, 1961). Based on this notion, assimilation contrast theory posits that if the comparison falls within the latitude of acceptance, assimilation will occur, meaning that individuals will view the new stimuli as being more similar to their existing beliefs than they actually are, and accept or integrate them into their own beliefs. If the comparison falls within the latitude of rejection, contrast will occur, meaning that individuals will perceive the new stimuli as being more different from their own beliefs than they actually are, and thereby reject them (Sherif & Hovland, 1961). This notion is illustrated by comparing one's position on a social issue with that of another person (Oliver, 1997). If the other's position is not different, such that it falls within one's latitude of acceptance, then one will see the positions as similar, and shift or assimilate the other's position toward one's own. If the other's position is far enough away from one's own, such that it falls within one's zone of rejection, then one will exaggerate the difference and not be swayed by the other's message.

In EDT, expectations and disconfirmation are proxies for assimilation and contrast effects on satisfaction. In this context, assimilation means one relies on expectations in forming satisfaction judgments. One is more likely to assimilate performance perceptions toward expectations if performance is close to initial expectations (i.e., in one's zone of acceptance) (Anderson, 1973; Oliver, 1997; Oliver & Desarbo, 1988; Yi, 1990). Thus, assimilation supports a positive relationship between expectations and satisfaction because individuals respond to performance with satisfaction levels that are similar to their expectations (Oliver & Desarbo, 1988). Contrast means one relies on disconfirmation to form satisfaction judgments. Contrast is more likely to occur when performance is different enough from expectations that it falls into an individual's zone of rejection (Anderson, 1973; Oliver, 1997). Individuals will then magnify the discrepancy when evaluating satisfaction and translate a positive discrepancy (i.e., positive disconfirmation) into higher satisfaction, and a negative discrepancy (i.e., negative disconfirmation) into lower satisfaction (Oliver & Desarbo, 1988; Yi, 1990).

Assimilation effects manifest themselves differently in the simplified and complete EDT models. In the simplified model, a positive relationship between expectations and satisfaction represents assimilation. In the complete model, by including performance, the theoretical assimilation effect is more completely depicted as expectation's indirect effect on satisfaction through performance (Spreng, MacKenzie, & Olshavsky, 1996) (Appendix A). Therefore, it is possible that when testing the simplified model, the direct path from expectations to satisfaction will not be significant, indicating lack of support for an assimilation effect. At the same time, testing the complete model could show that the indirect path from expectations to satisfaction through performance is significant, indicating that there is, indeed, an assimilation effect[2]. To compare the ability of the simplified and complete models to detect assimilation, we test the following hypotheses:

Hypothesis 1a: In the simplified model, expectations will have a significant direct influence on satisfaction, representing an assimilation effect.

Hypothesis 1b: In the complete model, expectations will have a significant indirect influence on satisfaction through performance, representing an assimilation effect.

If our data analysis supports both hypotheses, this would indicate that both models have an equal ability to detect assimilation effects, justifying use of the more parsimonious simplified model. If neither hypothesis is supported, this could mean that assimilation is not present in our data. If,

[2] Even if performance is measured, the assimilation effect might also go undetected if researchers do not test the complete model containing the paths from expectation to performance and performance to satisfaction. This occurred in Premkumar and Bhattacherjee (2008), in which the path from expectation to performance was not tested. We estimated this path by using their correlation matrix and standard deviations. In doing so, we found there is a significant indirect relationship between expectations and satisfaction through performance.

however, H1b is supported and H1a is not supported, this would show the value of using the complete model that includes performance to detect assimilation.

We address the research question of when to use the complete model by predicting that the assimilation effect might be stronger for certain attribute dimensions. Some attributes may be more prone to assimilation, especially if individuals do not attend to the product/technology's performance on that attribute (Oliver, 1997). Other attributes may be more prone to disconfirmation effects, which require an individual to attend to subjective performance judgments and compare these judgments to their earlier expectations.

Marketing researchers have distinguished between technical and functional attributes (Laroche, Kalamas, Cheikhrouhou, & Cézard, 2004). Technical attributes are concerned with outcomes or *what* is delivered or received as a result of product performance (e.g., product reliability). Functional attributes relate to the process itself or how the customer receives the product performance (e.g., responsiveness). Much work in information systems shows that ease of use is an important IT process attribute because it relates to how the IT performance is delivered (i.e., use is easy, not difficult), and usefulness is an important IT outcome attribute because it relates to *what* is received from the IT performance (i.e., enhanced task performance) (Davis, Bagozzi, & Warshaw, 1989; Lankton & Wilson, 2007a; Venkatesh, Morris, Davis, & Davis, 2003). Since ease of use is a functional/process attribute, it may be more difficult for individuals to focus on than the technical/outcome attribute usefulness because process dimensions require more attention and processing of complex stimuli (Venkatesh et al., 2003). Also, usefulness is often more prominent than ease of use in acceptance decisions, making users more likely to attend to it. For example, users are often willing to accept some difficulties with ease of use for an otherwise useful system. While difficulty of use may discourage acceptance of an otherwise useful system, no amount of ease of use can compensate for a system that is not useful (Davis, 1989). Because: (i) assimilation is stronger when users do not attend to performance of an attribute, and (ii) users will attend less to ease of use performance than to usefulness performance, assimilation should be stronger for ease of use than for usefulness. Thus, we predict:

Hypothesis 2a: In the Simplified Model, assimilation (as represented by the direct path from expectations to satisfaction) will be significantly stronger for ease of use than for usefulness.

Hypothesis 2b: In the Complete Model, assimilation (as represented by the indirect path from expectation to satisfaction through performance) will be significantly stronger for ease of use than for usefulness.

We also address the research question of when to use the Complete Model by examining prior user experience, an important individual characteristic in IT research. Research suggests that prior user experience will affect the likelihood of assimilation. For example, Chang (2004) finds that consumers with low product class knowledge are more likely to assimilate performance to expectations in determining their satisfaction with new products. Low-knowledge consumers have less developed product knowledge structures, resulting in a lower cognitive ability to compare their performance beliefs with expectations to form disconfirmation (Chang, 2004). Also, research has shown that direct experiences are less diagnostic when prior knowledge is limited (Kempf & Smith, 1998). Because high-knowledge consumers have more developed product knowledge structures, they have a higher cognitive capacity to compare their initial expectations with their direct experiences (Chang, 2004). These differences in information processing ability result in stronger contrast (disconfirmation) effects for high-experience individuals and stronger assimilation (expectation to performance to satisfaction) effects for low-experience individuals. Oliver (1997) also suggests that individuals with less prior experience may not be able to judge performance as well as individuals with more prior experience. Therefore, they may be more likely to assimilate performance to expectations in forming satisfaction. This same phenomena can apply to IT use where low prior experience with the technology can make one more likely to assimilate performance to expectations in forming satisfaction judgments.

Hypothesis 3a: In the simplified model, assimilation (as represented by the direct path from expectations to satisfaction) will be significantly stronger for individuals with less prior experience than for individuals with more prior experience.

Hypothesis 3b: In the complete model, assimilation (as represented by the indirect path from expectations to satisfaction through performance) will be significantly stronger for individuals with less prior experience than for individuals with more prior experience.

2.2. Uncovering Asymmetric Effects

The performance construct can also uncover asymmetric effects on satisfaction. Asymmetry means that positive and negative values of an independent variable have different impacts on a dependent variable (Cheung & Lee, 2005). Negative asymmetry means one unit of a negative value for a certain variable affects the dependent variable more than one unit of a positive value. Prospect theory forms the basis for the negative asymmetric effect. Prospect theory postulates that, when making judgments, people commonly perceive that the disutility caused by losses is greater than the utility caused by equivalent gains (Kahneman & Tversky, 1979; Mittal, Ross, & Baldasare, 1998). Thus, people prefer avoiding a loss over acquiring a gain (Yi & La, 2003). Negative asymmetry is also supported by the principle that “bad is stronger than good” because individuals will react more strongly to bad things as an adaptive response to their environment (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Cheung & Lee, 2009). Not responding to something that might have positive outcomes has less dire consequences (e.g., mere regret) than not responding to something that might have negative outcomes (e.g., actual harm) (Baumeister et al., 2001; Cheung & Lee, 2009).

Asymmetric effects are important for understanding satisfaction because they can help explain why increasing performance or disconfirmation does not have a corresponding increase in satisfaction (Cheung & Lee, 2005). For example, if negative performance asymmetric effects exist (i.e., negative performance has a significantly larger impact on satisfaction than does positive performance), user satisfaction can drop dramatically with negative performance. Thus, developers should focus more on avoiding negative performance perceptions than on enhancing positive performance perceptions (Cheung & Lee, 2005).

While most EDT research assumes symmetric relationships, some researchers find both negative and positive asymmetric effects (Anderson & Sullivan, 1993; Cheung & Lee, 2005, 2009; Mittal et al., 1998). While this research has enhanced our understanding of how satisfaction forms, it has not yet investigated the joint asymmetric effects of expectations, disconfirmation, and performance on satisfaction. The complete model identifies these variables as the three key drivers of satisfaction (Oliver, 1997). Therefore, it is not enough to examine disconfirmation or performance asymmetric effects in isolation. To understand the full impact of asymmetric effects on satisfaction, the asymmetric effects of all three variables should be examined within the same model. This can only be done by researchers examining the complete model constructs; to our knowledge, this has not yet been done in IT EDT research.

We predict that the types of asymmetric effects (i.e., negative or positive) will depend on attribute type. Anderson and Mittal (2000) call attributes demonstrating negative asymmetry “satisfaction-maintaining attributes” because they represent core attributes individuals take for granted. Satisfaction will drop dramatically if a technology fails in this feature (Cheung & Lee, 2005). To achieve higher satisfaction levels, developers should try to improve these attributes.

On the other hand, positive asymmetry attributes are called “satisfaction-enhancing attributes” because they differ in a good way from what individuals would normally envision (Anderson and Mittal, 2000). Satisfaction will increase significantly if a technology contains these features (Cheung & Lee, 2005). Developers should make sure they maintain these attributes to achieve higher satisfaction levels.

As we explained earlier, usefulness is a necessary condition for future use of a technology. Individuals will not be pleased with technology use if the IT is not useful. Because of this, we predict usefulness is a satisfaction-maintaining or negative asymmetry attribute. In other words, negative usefulness will have more of an effect on satisfaction than positive usefulness, meaning satisfaction will drop more for negative usefulness than it will increase for positive usefulness. Consistent with our earlier discussion that individuals’ usefulness perceptions will be more prone to disconfirmation (i.e., contrast) effects, we also predict that this usefulness negative asymmetry will occur for disconfirmation.

Hypothesis 4a: In the simplified model, usefulness will have a significant negative disconfirmation asymmetry effect on satisfaction (i.e., negative usefulness disconfirmation will have a significantly greater impact on satisfaction than will positive usefulness disconfirmation).

Hypothesis 4b: In the complete model, usefulness will have a significant negative disconfirmation asymmetry effect on satisfaction (i.e., negative usefulness disconfirmation will have a significantly greater impact on satisfaction than will positive usefulness disconfirmation)[3].

Individuals may put up with a technology that is not easy to use as long as it is useful. In this sense, finding that the system is easy to use may come as a surprise or delight to the individual. This implies that ease of use will be a satisfaction-enhancing or positive asymmetry attribute. Satisfaction will increase more for positive ease of use than it will decrease for negative ease of use. We predict that the positive asymmetry for ease of use will exist for performance, because ease of use is more prone to assimilation effects on satisfaction through performance than contrast effects through disconfirmation. Because performance is measured only in studies examining the complete model, we make the following prediction for the complete model only.

Hypothesis 5: In the complete model, ease of use will have a significant positive performance asymmetry effect on satisfaction (i.e., positive ease-of-use performance will have a significantly greater impact on satisfaction than will negative ease-of-use performance).

3. Methodology

We investigate the EDT models in a longitudinal survey of undergraduate business students using Microsoft Access. Access is an appropriate technology to use because it is similar to other technologies for which both ease of use and usefulness beliefs have been examined (e.g., Bhattacherjee & Premkumar, 2004; Davis et al., 1989). EDT is not specific to any product or technology, so it should be applicable to Microsoft Access. The US university students were enrolled in an introductory information systems course. While Access use was required for the course, EDT applies to both mandatory and voluntary contexts because satisfaction (unlike constructs like use and intention) can measure IT's effectiveness or success regardless of any requirements to use the technology (Bhattacherjee & Premkumar, 2004; DeLone & McLean, 2003; Khalifa & Liu, 2004). For example, individuals who are required to use a technology every day for work may still think it is not a success because they are dissatisfied with it. To make continuance intention applicable in this mandatory context, we measured the items after the required coursework and referred to students' continued use after the course (Bhattacherjee & Premkumar, 2004). Students are an appropriate sample because findings from student-based adoption studies have generally been consistent with those done in the field (Lee, Kozar, & Larsen, 2003). Also, student subjects have been used in prior IT EDT studies (e.g., Bhattacherjee & Premkumar, 2004; Spreng & Page, 2003). Participants were 48 percent male with the average age 21. On average, they had used computers for 11 years and their previous Access experience was 2.9 on a scale of 1 (no experience) to 7 (extensive experience).

3.1. Procedure and Measurement Scales

Our procedure generally follows that of Bhattacherjee & Premkumar (2004). We administered the first questionnaire (Appendix C) to assess expectations after students had received a short lecture on Access software, practiced with an Access tutorial CD, and had taken two short Access quizzes with general information about tables and queries. This gave them enough Access knowledge to form initial expectations. Three hundred and fifty students completed the first questionnaire and 296 (85 percent) completed the second (six weeks later). To test for non-response bias, we compared mean expectations and Access experience between those who took and did not take the second questionnaire. We found no significant mean differences.

[3] Because disconfirmation is examined by researchers testing either the simplified or complete model, we test for this effect in both models. However, we note that testing for this effect using all the complete model variables, as in H4b, controls for the effects of performance asymmetry. Therefore, we could find that H4a is supported, but H4b is not, or vice versa. For example, if H4b is supported while H4a is not, this would indicate the incremental value of using the complete model.

Between taking the first and second questionnaires, students completed the remaining Access database assignments, quizzes, and a practical exam [4]. The second questionnaire measured performance, disconfirmation, satisfaction, and continuance intentions. Respondents received extra credit points (1 percent of possible course points) for completing both questionnaires.

We adapted all measures from prior scales demonstrating good psychometric properties (Appendix C). Following common practice (Bhattacherjee & Premkumar, 2004; McKinney, Yoon, & Zahedi, 2002), the usefulness and ease-of-use expectation, performance, and disconfirmation items were worded to reflect expectation's forward-looking nature, performance's backward-looking nature, and disconfirmation's comparative nature. That is, the expectation items asked: "Based on my experience so far, I expect that Microsoft Access will…". The performance items asked: "Based on your experience with Microsoft Access, it was...". The disconfirmation items asked: "Compared to your initial expectations, the ability of Microsoft Access [was better or worse than expected]".

Table 1. SPSS Factor Loadings and Cross Loadings (Using Direct Oblimin Rotation)

Item*	1	2	3	4	5	6	7	8
Disconfirmation Usefulness 1	**.89**	.01	.02	.01	.00	.02	.02	.08
Disconfirmation Usefulness 2	**.81**	.05	.05	.04	.01	.02	.06	.08
Disconfirmation Usefulness 3	**.97**	.02	.04	.02	.02	.01	.00	.04
Disconfirmation Usefulness 4	**.94**	.01	.02	.01	.03	.05	.01	.02
Expectations Usefulness 1	.03	**.97**	.01	.00	.00	.01	.01	.03
Expectations Usefulness 2	.01	**.95**	.02	.02	.03	.00	.02	.01
Expectations Usefulness 3	.00	**.96**	.00	.05	.03	.01	.04	.06
Expectations Usefulness 4	.05	**.91**	.03	.03	.01	.01	.01	.01
Expectations Ease of Use 1	.02	.07	**.85**	.05	.05	.04	.09	.05
Expectations Ease of Use 2	.05	.05	**.95**	.02	.02	.06	.01	.03
Expectations Ease of Use 3	.02	.00	**.90**	.03	.02	.01	.07	.01
Expectations Ease of Use 4	.00	.04	**.90**	.05	.01	.01	.05	.01
Usage Continuance Intention 1	.08	.02	.01	**.94**	.01	.04	.04	.05
Usage Continuance Intention 2	.04	.04	.01	**.94**	.03	.00	.02	.01
Usage Continuance Intention 3	.07	.02	.01	**.95**	.02	.01	.00	.03
Satisfaction 2	.03	.04	.04	.02	**.70**	.26	.04	.02
Satisfaction 3	.03	.01	.00	.03	**.95**	.11	.05	.02
Satisfaction 4	.11	.03	.02	.04	**.80**	.03	.04	.01
Performance Ease of Use 1	.03	.06	.02	.01	.01	**.84**	.01	.05
Performance Ease of Use 2	.08	.01	.01	.00	.02	**.91**	.02	.03
Performance Ease of Use 3	.03	.03	.03	.02	.05	**.88**	.03	.01
Performance Ease of Use 4	.02	.00	.04	.06	.05	**.77**	.08	.09
Disconfirmation Ease of Use 1	.04	.06	.06	.03	.01	.02	**.91**	.02
Disconfirmation Ease of Use 2	.00	.03	.01	.01	.00	.04	**.93**	.04
Disconfirmation Ease of Use 3	.07	.01	.02	.06	.04	.03	**.85**	.09
Disconfirmation Ease of Use 4	.06	.03	.07	.04	.02	.04	**.82**	.01
Performance Usefulness 1	.03	.05	.05	.01	.00	.02	.02	**.96**
Performance Usefulness 2	.01	.00	.02	.03	.00	.01	.06	**.96**
Performance Usefulness 3	.02	.05	.02	.02	.02	.00	.06	**.95**
Performance Usefulness 4	.02	.02	.00	.05	.05	.08	.00	**.81**
Eigenvalue	13.75	4.97	1.99	1.49	1.36	1.16	.90	.78
% Variance	45.84	16.56	6.63	4.97	4.54	3.85	3.01	2.60
Cumulative Variance	45.84	62.40	69.03	74.00	78.54	82.39	85.39	88.00

* The full wording for all items is shown in Appendix C.

[4] To ensure that students' performance on this material did not affect our results, we added their practical exam score as a control variable in the models. Doing so did not significantly change our reported results. We do find that in the simplified model, the practical exam score has a significant influence on usefulness disconfirmation ($\beta = .14$, $p < .01$), ease of use disconfirmation ($\beta = .14$, $p < .01$), and satisfaction ($\beta = .15$, $p < .01$). In the complete model, the score has a significant effect on ease of use performance only ($\beta = .24$, $p < .001$).

We first conducted an initial exploratory factor analysis of all items in SPSS to assess item quality. Using principle components analysis with direct oblimin rotation, we identified six factors with eigenvalues greater than 1 that explain 82 percent of the total variance. Next, a scree test (Cattell, 1966) revealed an eight-factor solution. Because the eight-factor solution is more interpretable than the six-factor solution, we retained the eight factors. We dropped the first satisfaction item because it loaded at less than .60 and had a cross-loading greater than .30. All other items loaded at greater than .70 and had no cross-loadings greater than .30 (see final item loadings in Table 1).

4. Results

4.1. Measurement Model Results

We created a measurement model in EQS, a structural equation modeling software, to assess the latent constructs' psychometric properties. Goodness-of-fit statistics lie within tolerance levels (Bentler & Bonett, 1980; Bollen, 1989; Browne & Cudeck, 1992). The non-normed fit index (NNFI) was .970, the comparative fit index (CFI) was .974, the root mean square error of approximation (RMSEA) was .050, and the χ^2 / degrees of freedom was 1.73 (653.32 / 377). We also find that convergent validity was adequate. The factor loadings were greater than the 0.70 standard, the internal consistency reliabilities (ICRs) were above the .80 standard, and the average variances extracted (AVEs) were above the .50 standard (Fornell & Larcker, 1981) (Table 2). Discriminant validity was also adequate. The square root of the AVE for each construct was greater than the construct's correlation with other constructs (Chin, 1998) (Table 2). Also, there were no cross-loadings greater than .30 (Table 1). Finally, the Lagrange Multiplier χ^2 values were all below 24.52, and were not associated with large standardized parameter change values.

Table 2. Means, ICR's, AVE's and Correlations among Latent Constructs*

Latent Construct	Mean	ICR	AVE	1	2	3	4	5	6	7	8
1. Continuance Intention	4.22	.96	.90	**.95**							
2. Satisfaction	4.11	.88	.71	.59	**.84**						
3. U Disconfirmation	4.55	.97	.88	.64	.63	**.94**					
4. E Disconfirmation	4.31	.94	.80	.51	.66	.73	**.90**				
5. U Performance	4.56	.97	.89	.60	.56	.74	.64	**.94**			
6. E Performance	4.18	.94	.81	.54	.68	.66	.77	.67	**.90**		
7. U Expectations	5.23	.97	.88	.18	.16	.19	.06ns	.24	.13	**.94**	
8. E Expectations	4.91	.93	.76	.19	.16	.20	.19	.18	.27	.57	**.88**

*Diagonal elements are the square root of the average variance extracted by latent constructs from their indicators; off-diagonal elements are correlations between latent constructs. All correlations are significant at p < .05 unless indicated (NS).
U = Usefulness; E = Ease of Use.

We also tested for multicollinearity and common method variance. Condition indices were under 30, ranging from 1 to 22, and no variable had two variance decomposition proportions greater than .50. This test suggests multicollinearity is not a problem (Belsley, Kuh, & Welsch, 1980; Jagpal, 1982). To assess common method variance, we used two tests. First, we used a single-factor confirmatory factor analysis (CFA) approach in which all items are modeled as indicators of a single factor that represents method effects. Method biases are assumed to be substantial if the hypothesized model fits the data (Malhotra, Kim, & Patil, 2006; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). For our data, the hypothesized model with one factor has extremely poor fit (NNFI = .416, CFI = .455, RMSEA = .221, χ^2 / degrees of freedom = 15.40 (6251.14 / 406)). Next, we controlled for the effect of an unmeasured latent methods factor (Podsakoff et al., 2003; Widaman, 1985), and found that doing so only minimally improved model fit (non-normed fit index increased .008) (Bentler & Bonnet, 1980: Elangovan & Xie, 1999; Williams, Cote, & Buckley, 1989). In addition, the original factor loadings are significant even with the method effects taken out[5]. Together these tests indicate that common method variance is not a major problem.

5 While there are some criticisms to using the single factor and the method factor approach to test for common method variance, a method without problems has not yet been identified (Sharma, Yetton, & Crawford, 2009). In addition, we used a longitudinal survey with different endpoints for some scales, both of which can help reduce common method variance (Podsakoff et al., 2003).

4.2. Structural Model Results

We then tested the structural model for the simplified (Figure 3) and complete models (Figure 4) in EQS. To account for any relationships between similar ease of use and usefulness constructs (e.g., ease-of-use and usefulness expectations, ease-of-use and usefulness disconfirmation, and ease-of-use and usefulness performance), we allowed the two expectation constructs and the error terms for the disconfirmation and performance constructs to freely correlate.

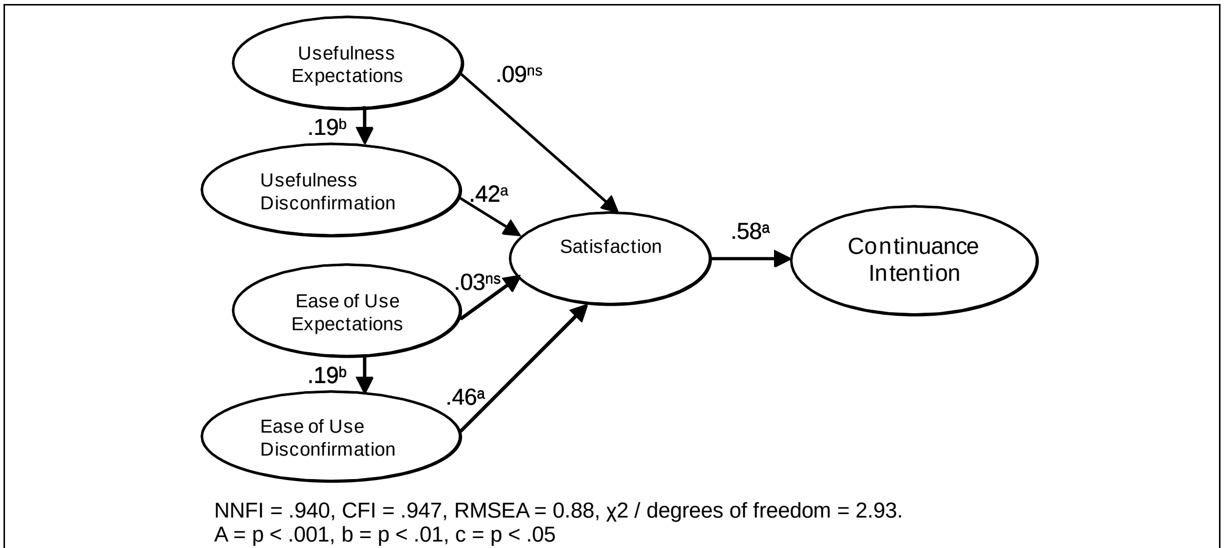

Figure 3. Simplified Model Structural Results

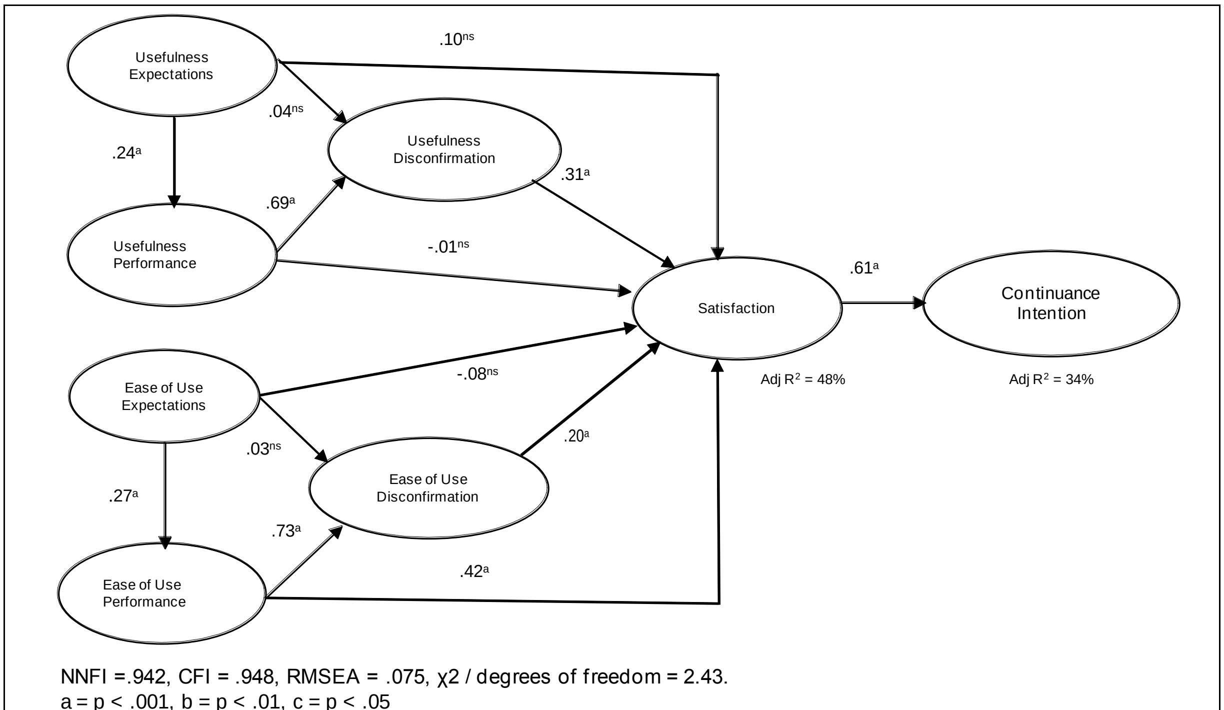

Figure 4. Complete Model Structural Results

For the simplified model, the paths from usefulness and ease of use expectations to usefulness and ease of use disconfirmation, respectively, are significant and positive (Figure 3). Also, in the simplified model, the paths from usefulness and ease of use disconfirmation to satisfaction are significant, and the paths from usefulness and ease of use expectations to satisfaction are not significant. Finally, satisfaction significantly influences usage continuance intentions.

The complete model shows similar results for these relationships, except that usefulness and ease of use expectations no longer directly affect usefulness and ease of use disconfirmation, respectively (Figure 4). For both usefulness and ease of use, expectations significantly influence performance, and performance significantly influences disconfirmation. Performance significantly influences satisfaction for ease of use, but does not significantly influence satisfaction for usefulness[6].

4.3. Testing for Assimilation Effects

As stated above, we find that expectations do not have a significant direct effect on satisfaction in the simplified model (Figure 3). Therefore, the simplified model does not reveal assimilation effects, and H1a is not supported. To test for assimilation effects in the complete model, we analyzed the indirect effects of usefulness and ease of use expectations on satisfaction through performance (Sobel, 1982). We find that while usefulness expectation does not have a significant indirect effect on satisfaction through usefulness performance ($\beta = .01$, $p > .05$), ease of use expectation does have a significant indirect effect on satisfaction through ease of use performance ($\beta = .10$, $p < .01$). Thus, H1b is partially supported[7].

H2a and H2b refer to the assimilation effect being stronger for ease of use than for usefulness. Because significant assimilation effects were not found in the simplified model, H2a is not supported. For the complete model, we tested this hypothesis by analyzing whether the significant ease of use assimilation effect was significantly different from the non-significant usefulness assimilation effect. We found that the 95 percent confidence intervals around the two paths do not overlap, providing assurance that the assimilation effects are stronger for ease of use than for usefulness at $p < .05$. This shows support for H2b.

To test whether assimilation effects are stronger for individuals with less prior experience than for individuals with more prior experience (H3a and H3b), we split our data into low (mean = 1.52, n = 129) and high (mean = 4.04, n = 167) prior Access experience datasets, and into low (mean = 8.96, n = 165) and high (mean = 13.48, n = 131) years of prior computer use (to represent related experience) datasets (see Appendix C for the questionnaire items and scales)[8]. We then ran the structural models for each dataset using the simplified and complete models. The only significant assimilation results for the simplified model are for usefulness expectations for high-experience users in the prior computer use dataset ($\beta = .22$, $p < .05$) (Table 3). However, examining confidence intervals, we find that this effect is not significantly different at $p < .05$ from the non-significant effect for low-experience users ($\beta = .01$, ns). Thus, testing the simplified model shows that assimilation is not significantly different between low and high-experience users, showing a lack of support for H3a.

In the complete model, we find significant assimilation effects for users with low prior Access experience and those with low prior computer use for the ease of use attribute (Table 3). We find that for both experience types, the confidence intervals for the low-experience ease-of-use indirect effects do not overlap with the confidence intervals for the high-experience ease-of-use effects[9]. This provides assurance at $p < .05$ that the low-experience ease-of-use indirect effect is stronger than the high-experience ease-of-use indirect effect, and support for H3b.

---

[6] Usefulness performance does significantly influence satisfaction when the complete model is run with just the usefulness attribute. Our results indicate that when controlling for the effects of ease of use expectation, disconfirmation, and performance, usefulness performance does not significantly influence satisfaction. Hence, for our study, it is important to analyze both usefulness and ease of use in the same model.

[7] We also tested for assimilation by performing a group analysis between users with high/low discrepancies between expectations and performance. Results are similar to those reported.

[8] The high/low groups were split based on means.

[9] To perform this test for the indirect effects between low- and high-experience groups, we used the method suggested by Wolfe and Hanley (2002) that accounts for sample independence.

Table 3. Assimilation Effects based on Prior Experience and Attribute

Prior Access Experience (measured on Likert scale from (1) no experience to (7) extensive experience)				
	Low Experience (mean = 1.52, n = 129)		High Experience (mean = 4.04, n = 167)	
	Usefulness	Ease of Use	Usefulness	Ease of Use
Simplified Model Results				
Expectations → Satisfaction	.14[ns]	.00[ns]	.07[ns]	-.07[ns]
Complete Model Results				
Expectations → Performance	.20[c]	.34[a]	.26[a]	.16[ns]
Performance → Satisfaction	-.20[ns]	.62[a]	.24[c]	.18[ns]
Indirect (Assimilation) Effect	-.04[ns]	.21[b]	.06[ns]	.03[ns]
Prior Computer Experience (measured in number of years)				
	Low Experience (mean = 8.96, n = 165)		High Experience (mean = 13.48, n = 131)	
	Usefulness	Ease of Use	Usefulness	Ease of Use
Simplified Model Results				
Expectations → Satisfaction	.00[ns]	.02[ns]	.22[c]	-.10[ns]
Complete Model Results				
Expectations → Performance	.31[a]	34[a]	.12[ns]	.16[ns]
Performance → Satisfaction	-.11[ns]	.60[a]	.14[ns]	.27[c]
Indirect (Assimilation) Effect	-.03[ns]	.21[b]	.02[ns]	.04[ns]

[a] = p < .001, [b] = p < .01, [c] = p < .05, [ns] = non-significant

4.4. Testing for Asymmetric Effects

To test for asymmetric effects, we follow the dummy variable approach (Cheung & Lee, 2005, 2009; Mittal et al., 1998). This approach is needed to separate an independent variable into two variables: one that indicates when the independent variable's value is positive, and one that indicates when the independent variable's value is negative. Then these positive and negative dummy variables can be tested for their influence on a dependent variable. If the path coefficients between the positive and negative dummy variables are significantly different, this indicates an asymmetric effect (Cheung & Lee, 2005). In our study the goal was to observe differential effects between the positive and negative construct values of expectations, disconfirmation, and performance, on satisfaction. Thus, for each of the six constructs (usefulness expectation, usefulness disconfirmation, usefulness performance, ease of use expectation, ease of use disconfirmation, and ease of use performance) we created two dummy variables. For example, we created a dummy variable called "usefulness positive disconfirmation" based on the usefulness disconfirmation responses. We gave the dummy variable a value of 1 if usefulness disconfirmation ranged from over 4 to 7 (i.e., was positive), and a value of 0 if usefulness disconfirmation ranged from 1 to 4 (i.e., was negative or neutral). Likewise, we also created a dummy variable called "usefulness negative disconfirmation" based on the usefulness disconfirmation responses. We gave this dummy variable a value of 1 if usefulness disconfirmation ranged from 1 to under 4 (i.e., was negative), and a value of 0 if usefulness disconfirmation ranged from 4 to 7 (i.e., was neutral or positive)[10]. We used a similar procedure to create dummy variables for usefulness expectations, usefulness performance, ease of use expectations, ease of use disconfirmation, and ease of use performance.

We then ran two structural models in EQS (Table 4). The first model contains the eight paths from the expectation and disconfirmation dummy variables to satisfaction. This model could be run by researchers examining the simplified model. The second model includes the 12 paths to satisfaction from the expectation, disconfirmation, and performance dummy variables. This model could be run by researchers investigating the complete model.

10 While correlations between the related positive and negative dummy variables (e.g., positive usefulness disconfirmation and negative usefulness disconfirmation) range from -.62 to -.84, the condition index was 20.49 and no two variance proportions were greater than 0.50. Thus, multicollinearity was not a problem in this analysis.

Table 4. Asymmetric Effects on Satisfaction

	Expectation and Disconfirmation	Wald Test	Expectation, Disconfirmation, and Performance	Wald Test
U Expectation (+ neutral)	.07	ns	.07	ns
U Expectation (- neutral)	.08		.07	
E Expectation (+ neutral)	-.04	ns	-.05	ns
E Expectation (- neutral)	-.06		-.07	
U Disconfirmation (+ neutral)	.15[c]	ns	**.07ns**	**F = 8.28, p < .01**
U Disconfirmation (- neutral)	-.22[b]		**-.26[b]**	
E Disconfirmation (+ neutral)	.18[c]	ns	.10ns	ns
E Disconfirmation (- neutral)	-.20[c]		-.15ns	
U Performance (+ neutral)			.14ns	ns
U Performance (- neutral)			.10ns	
E Performance (+ neutral)			**.26[b]**	**F = 6.03, p < .05**
E Performance (- neutral)			**-.01ns**	

[a] = p < .001, [b] = p < .01, [c] = p < .05
U = Usefulness, E = Ease of use

To test H4a and H4b for usefulness negative asymmetric effects, we examined the differences in absolute magnitude between positive and negative usefulness disconfirmation using a Wald test (Cheung & Lee, 2009). For the simplified model (i.e., the model containing only the expectation and disconfirmation dummy variables), there are no significant differences in absolute magnitude between positive and negative effects. Thus, H4a is not supported. However, in the complete model (i.e., the model that examines expectation, disconfirmation, and performance asymmetries), the significant negative usefulness disconfirmation is significantly different in absolute value from the positive usefulness disconfirmation at $p < .01$. This means that usefulness disconfirmation has a negative asymmetric effect on satisfaction with negative usefulness disconfirmation having a significantly larger impact on satisfaction than positive usefulness disconfirmation. This supports H4b.

Finally, in testing H5, we find that the positive ease of use performance effect is significantly greater than the significant negative ease of use performance effect at $p < .05$. This means that positive ease of use performance has a greater impact on satisfaction (i.e., a positive asymmetric effect) and supports H5. No other significant asymmetric effects were found in our analysis of the simplified and complete models.

4.5. Supplemental Analysis

We performed a supplemental analysis to examine any additional role of performance (besides better revealing asymmetric or assimilation effects) that might demonstrate the complete model's value. Marketing research shows that EDT's satisfaction influences re-purchase intentions (e.g., Oliver, 1980). This is based on the notion that a satisfied (or unsatisfied) customer is more (or less) likely to repurchase and reflects the theory of reasoned action's premise that attitudes have a direct influence on intention (Fishbein & Ajzen, 1975; Oliver, 1980). While satisfaction typically fully mediates the effects of both disconfirmation and performance on intentions, there have been some exceptions in the marketing literature. For example, Mittal et al. (1998) find that satisfaction does not fully mediate the performance-intention relationship. These effects have not yet been explored in information systems and have not been examined using the complete model. Direct effects on intentions that are not fully mediated by satisfaction can further demonstrate the importance of including performance in IT EDT models.

Based on this prior research, we tested a model that is similar to the complete model, but that also includes the direct effects of expectations, disconfirmation, and performance on continuance intentions. Table 5 reports each predictor's direct, indirect, and total effects on continuance intentions. We find that in addition to satisfaction, usefulness disconfirmation and performance also have direct effects on continuance intentions. Performing a Sobel test confirms that the direct effect of usefulness performance on continuance intentions is not mediated by satisfaction (mediation p value = .94). Also, usefulness disconfirmation is only partially mediated by satisfaction. Examining the total effects shows that usefulness performance has the largest total effect on continuance intentions. This also evidences the predictive efficacy of performance.

Table 5. Non-Mediated Model Direct, Indirect, and Total Effects

	Satisfaction			Continuance Intentions		
	Direct	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Expectations Usefulness	.10ns	.05[b]	.15[c]	.00ns	.16[a]	.16[c]
Performance Usefulness	-.01ns	.19[a]	.18[b]	.22[b]	.28[a]	.51[a]
Disconfirmation Usefulness	.27[a]	na	.27[a]	.34[a]	.07[c]	.41[a]
Expectations Ease of Use	-.08ns	.15[a]	.06ns	.04ns	.02ns	.06ns
Performance Ease of Use	.40[a]	.16[c]	.56[a]	.09ns	.07ns	.16[b]
Disconfirmation Ease of Use	.22[c]	na	.22[c]	-.12ns	.06[c]	-.05ns
Satisfaction	na	na	na	.27[a]	na	.27[a]
a = p < .001, b = p < .01, c = p<.05						

5. Discussion

Previous IT studies have used various EDT constructs and have tested various EDT models (Appendix B). While Oliver (1997) identifies a complete model that incorporates all the theoretical underpinnings of EDT that are currently recognized, no IT EDT study has examined this model to our knowledge. In fact, many IT EDT studies leave out performance, which, unlike other, similar constructs such as modified beliefs, traces the progression of one's disconfirmation and is critical in identifying assimilation effects. This study compares the simplified and complete models Oliver (1997) proposes to show how and when the complete model provides a better understanding of the EDT process than the simplified model. We discuss our study's main contributions and the related research implications by research objective in the following sections, but first we discuss some overall results.

We find that the variance explained (adjusted R^2) in satisfaction is 42 percent in the simplified model and 48 percent in the complete model. Using a f^2 statistic (Cohen, 1988) and assessing the f^2's significance based on a pseudo F test (Chin, Marcolin, & Newsted, 1996)[11], the increase in satisfaction's adjusted R^2 is significant at $p < .001$. Thus, while the simplified model is more parsimonious, the complete model significantly increases variance explained in satisfaction. This suggests that researchers can explain more about how satisfaction forms by using the complete model. This is important for future research because satisfaction has been a key information systems success indicator for decades (DeLone & McLean, 1992).

5.1. Differences between the Simplified and Complete Models (Research Objective 1)

Our study contributes by uncovering differences between the simplified and complete models. For example, we find differences in the two models relating to assimilation effects. Specifically, we find that using the complete model with performance uncovers assimilation effects not found in the simplified model (H1a is not supported but H1b is supported). Bhattacherjee and Premkumar (2004), who use the simplified model, also show no assimilation effect in one of their tests. However, our study shows that it is important to use the complete model that includes performance when examining assimilation because this effect can be revealed by the indirect effect of expectations on satisfaction through performance.

According to our EDT literature review in Appendix B, there are four IT EDT studies that test models that include all four constructs from the complete model, and hence the models could reveal similar

11 $f^2 = [R^2(\text{Full model}) - R^2(\text{Nested model})]/[1 - R^2(\text{Full model})]$. The pseudo F statistic is calculated as $f^2 * (n-k-1)$, with p, n-(k+p+1) degrees of freedom where n is the sample size, k is the number of constructs in the simplified model, and p is the number of additional constructs in the complete model.

assimilation effects. However, two of these studies (Kim, Ferrin, & Rao, 2009; Susarla, Barua, & Whinston, 2003) did not use the same attributes for expectations, disconfirmation, and performance. Therefore, their models are not a standard EDT representation, and the indirect path of expectations to satisfaction through performance would not represent assimilation effects. Also, the other two studies do not use the complete model and do not test the expectation to performance path (Khalifa & Liu, 2002-3; Premkumar & Bhattacherjee, 2008). Therefore, our research contributes by being the first to show that using a complete IT EDT model reveals an assimilation effect as represented by the indirect path from expectations to satisfaction. It will be important for future research to duplicate these findings in other contexts and with other technologies.

Another difference between the simplified and complete models we find in this study relates to asymmetric effects. Specifically, we contribute to research by showing how using the complete model reveals asymmetric effects on satisfaction, whereas using the simplified model does not (H4b is supported; H4a is not). Most surprising is that while a researcher using both the simplified and complete models can test for disconfirmation asymmetric effects, we find this effect only when we add performance asymmetric effects. Finding that the disconfirmation negative asymmetric effects are not significant in the simplified model, but that they become significant in the complete model illustrates a classic "correlated omitted variable" bias in the simplified model. This supports the additional predictive and explanatory value of using the complete model.

Prior research has not examined the asymmetric effects of all three satisfaction predictors in the same model. For example, while Cheung and Lee (2005) also find usefulness negative asymmetries, they only examine usefulness performance. We find that usefulness performance has no asymmetric effects (this path was not hypothesized), whereas usefulness disconfirmation does have asymmetric effects (H4b). This difference in results provides a different understanding of how satisfaction forms: negative disconfirmation rather than performance will have a larger effect on satisfaction than positive disconfirmation. Also, Cheung and Lee do not find ease-of-use (i.e., usability) asymmetric effects, yet we find that ease-of-use performance has a positive asymmetric effect (H5). Thus, satisfaction is enhanced more by positive performance than negative performance. The differences in results could be because Cheung and Lee (2005) only examine performance and do not include measured disconfirmation or expectations, as we did. In summary, we show that it is beneficial for future researchers to use all three factors, as can be done when using the complete model, to uncover important asymmetric effects.

Our study not only shows that testing the complete model that includes performance increases our understanding of how satisfaction forms, it also shows that including performance can better predict continuance intention. In our supplemental analysis, we find that ease-of-use performance is the most important predictor of satisfaction, and usefulness performance is the most important predictor of continuance intention—even more important than satisfaction. These findings suggest that researchers should include performance as a direct predictor of continuance intentions in their IT EDT models. Future research can examine whether this latter relationship wears off over time as behavior becomes more habitual.

5.2. When it is Better to Use the Complete Model (Research Objective 2)

This study also contributes by determining conditions in which the differences between the simplified and complete models are more prominent. We find that while assimilation effects in the simplified model (or the lack thereof) do not differ based on variable or experience (H2a and H3a are not supported), assimilation effects found in the complete model are greater for ease of use than for usefulness (H2b is supported), and greater for users with lower prior experience than for users with higher prior experience (H3b is supported). In the complete model, assimilation effects are not even significant for either usefulness or high-experience individuals. This means that lower experienced individuals are likely to find only small discrepancies between ease-of-use expectations and performance, perhaps because they do not attend to ease of use performance. Because the discrepancy between ease-of-use expectations and performance is small, these low-experienced individuals assimilate performance to expectations when forming satisfaction judgments.

Overall, these results show that using the complete model to uncover assimilation effects will be beneficial for researchers who are studying the ease-of-use attribute and/or for researchers using less experienced subjects. While Premkumar and Bhattacherjee (2008) do not test all the paths in the complete model, we use the correlations and standard deviations provided to re-test their model. Our re-testing reveals an assimilation effect. Because they use subjects who are inexperienced with the technology, these results appear to coincide with ours regarding experience. However, the authors do not test for assimilation and therefore do not discuss it in their study's implications. By testing for assimilation in future IT EDT research, these results can be confirmed in other contexts. Future research can also build a stronger theory base for other conditions when assimilation is more/less likely to occur. For example, Spreng and Sonmez (2000) find that assimilation is more likely with low involvement consumers. Using the complete model, researchers should investigate whether this finding extends to IT EDT research.

Our study also answers the question about when to use the complete model by showing that researchers interested in examining both usefulness and ease-of-use asymmetric effects should examine all three of the complete model's satisfaction predictors. Our findings imply that researchers should also consider that both the type of asymmetric effect (positive or negative) and how it is manifested (through disconfirmation or performance) can differ by attribute. Researchers could also develop theory relating to these issues. For example, while just examining performance asymmetry on satisfaction with websites, Cheung and Lee (2005, 2009) find that understandability and navigation are satisfaction-enhancing attributes (i.e., they exhibit positive asymmetry) and reliability, appropriateness, up-to-datedness, and accuracy are satisfaction-maintaining attributes (i.e., they exhibit negative asymmetry). It appears that, consistent with our study, the former constructs are more process related and the latter are more outcome related. Cumulative results such as these can help build IT EDT theory. Further, researchers could explore differences in asymmetric affects resulting from use context or technology maturities (Anderson & Mittal, 2000). Our study encourages future research to explore whether these conditions may make it more beneficial to examine asymmetric effects using the complete model constructs.

These conditional results imply that it is sometimes better to use the more parsimonious simplified model, such as when researchers examine assimilation effects for usefulness and/or high-experience users. We find that the simplified model provides similar results regarding assimilation as the complete model does for the ease of use with high-experience users and for usefulness with low-experience users. In these cases, neither model finds assimilation effects. Therefore, using the complete model provides no added explanatory power to detect these effects, and the more parsimonious simplified model could be used. There are significant assimilation effects in the usefulness high-experience group using the simplified model. However, because we do not find these effects for this group using the complete model, using the simplified model in these cases would falsely detect assimilation effects that are not present when performance is added to the model.

5.3. Limitations

This paper has several limitations. Because the subjects were undergraduate students, the results better generalize to entry-level technology users than to experienced users. Other EDT studies, recognizing the difficulty in obtaining use-controlled longitudinal samples from organizations, have used similar subject types (Bhattacherjee & Premkumar, 2004). In addition, because the technology use involved a classroom situation, the students may have been more apt to have high technology expectations of the system because they knew the professor selected it for class use. Our data shows that both mean usefulness expectations (mean 5.23, $t = 19.42$, $p < .001$) and mean ease-of-use expectations (mean = 4.91, $t = 14.16$, $p < .001$) were significantly higher than the neutral point. Still, this is similar to other settings in which someone other than the user picks out specific IT based on performance recommendations from vendors or consultants. Further, mean satisfaction was not significantly different from the neutral point (mean 4.11, $t = 1.720$, $p > .05$), which means this possible upward bias was not consistent in all responses. Another limitation is that we did not assess whether students having different lecturers introduce them to Access created significant differences in initial expectations. Examining how expectations form was not the focus of our study, but could be examined in future research. Finally, we examined only two attribute dimensions; other attribute dimensions may be salient in this and other contexts. Also, usefulness and ease of use may behave differently in business contexts.

5.4. Practical Implications

Based on the differences we find between the simplified and complete models in satisfying our first research objective, our study implies that practitioners and developers should monitor and assess system performance perceptions, which is an important additional component of the Complete Model. Measuring performance perceptions can alert developers to both assimilation (whether performance perceptions are close to initial expectations) and asymmetric effects (whether positive/negative performance has differing effects on satisfaction). Our supplementary findings also indicate that understanding performance levels can help practitioners increase both satisfaction and continuance intentions. For example, we show that increasing ease-of-use performance can increase user satisfaction.

Findings relating to our second research objective (i.e., determining when it is more beneficial to use the complete model) suggest other practical implications.

First, practitioners should note that users with low-experience may not attend to ease-of-use performance. Any feedback from these users on performance might reflect only their initial expectations about the technology's ease of use, which could be based on reputation or other similar experiences, rather than how the technology performed. However, our results about usefulness show that, regardless of experience level, users will be more likely to attend to the technology's usefulness performance and any discrepancies between this performance and initial expectations. Thus, users' usefulness performance judgments may be more accurate or reliable.

Second, in terms of predicting satisfaction, practitioners should realize that performance is sometimes a stronger predictor of satisfaction than disconfirmation is, depending on the attribute of interest and users' experience level. This matters because increasing disconfirmation involves a complex decision about whether to decrease initial expectations or increase performance perceptions. Increasing performance only involves performance perceptions. Understanding when to focus on performance will allow practitioners to understand more easily what effects their targeted actions will have.

Third, we show further that practitioners should employ the correct development and training strategies based on detailed asymmetric effects by attribute type. They will want to improve negative perceptions for attributes with negative asymmetry and maintain positive perceptions for attributes with positive asymmetry (Anderson & Mittal, 2000) (see Table 6). Because ease-of-use performance has a positive asymmetric effect on satisfaction, developers should focus on enhancing its positive qualities. This will have a much greater effect on satisfaction than fixing any negative qualities. For example, developers should continue to improve touch screen technology, as users likely perceive the screens make computers easier to use. On the other hand, because usefulness disconfirmation has a negative asymmetric effect on satisfaction, developers should focus on increasing negative disconfirmation. This could require decreasing users' initial expectations of the technology or increasing performance perceptions. For example, developers could warn users early on that the usefulness of an enterprise resource planning system might take some time to realize, thereby decreasing their expectations and increasing disconfirmation.

Table 6. Managerial Actions for Asymmetry Results

	Negative Asymmetry: Improve Action	**Positive Asymmetry: Maintain Action**
Expectations	Improve negative expectations	Maintain positive expectations
Performance	improve negative performance	Maintain positive performance
Disconfirmation	Improve negative disconfirmation. Make performance greater than expectations by decreasing high expectations or increasing low performance	Maintain positive disconfirmation. Maintain the relationship between expectations and performance such that performance remains greater than expectations.

6. Conclusion

Albert Hirschman (1984) suggests that one way to produce more practice-applicable and explanatory economic models is to slightly reduce their parsimony. We argue in a similar manner for models used to test IT EDT. This paper compares Oliver's simplified and complete models to determine whether there are differences in satisfaction and continuance intention prediction. This comparison reveals the value of using the complete model that includes performance in IT EDT studies. Specifically, it shows that including performance reveals assimilation and asymmetric effects. This paper also answers the question about when it is best to use the Complete Model. Assimilation effects revealed by the complete model are strongest for ease of use and for lower experienced users. Because performance is easy to measure, these gains in predictive power and overall understanding of satisfaction justify measuring it separately and including its relationships with the other EDT variables, as depicted in the complete model.

References

Anderson, E. W., & Mittal, V. (2000). Strengthening the satisfaction-profit chain. *Journal of Service Research, 3*(2), 107-120.
Anderson, E. W., & Sullivan, M. W. (1993). The antecedents and consequences of customer satisfaction for firms. *Marketing Science, 12*(2), 125-143.
Anderson, R. E. (1973). Consumer dissatisfaction: The effect of disconfirmed expectancy on perceived product performance. *Journal of Marketing Research, 10*(1), 38-44.
Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323-370.
Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. New York, NY: John Wiley & Sons.
Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*(3), 588-606.
Bhattacherjee, A. (2001a). Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly, 25*(3), 351-370.
Bhattacherjee, A. (2001b). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, *32*(2), 201-214.
Bhattacherjee, A., & Premkumar, G. (2004). Understanding changes in belief and attitude toward information technology usage: A theoretical model and longitudinal test. *MIS Quarterly, 28*(2), 229-254.
Bhattacherjee, A., Perols, J., & Sanford, C. (2008). Information technology continuance: A theoretic extension and empirical test. *The Journal of Computer Information Systems, 49*(1), 17-26.
Bollen, K. A. (1989). *Structural equations with latent variables*. New York, NY: Wiley.
Brown, S. A., Venkatesh, V., Kuruzovich, J., & Massey, A. P. (2008). Expectation confirmation: An examination of three competing models. *Organizational Behavior and Human Decision Processes, 105*(1), 52-66.
Browne, M. W., & Cudeck, R. (1992). Alternative ways of assessing model fit. *Sociological Methods and Research, 21*(2), 230-258.
Cadotte, E. R., Woodruff, R. B., & Jenkins, R. L. (1987). Expectations and norms in models of consumer satisfaction. *Journal of Marketing Research, 24*(3), 305-314.
Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*(2), 245-276.
Chang, C. (2004). The interplay of product class knowledge and trial experience in attitude formation. *Journal of Advertising, 33*(1), 83-92.
Cheung, C. M. K., & Lee, M. K. O. (2005). The asymmetric effect of web site attribute performance on web satisfaction: An empirical study. *E-Service Journal, 3*(3), 65-86.
Cheung, C. M. K., & Lee, M. K. O. (2009). User satisfaction with an Internet-based portal: An asymmetric and nonlinear approach. *Journal of the American Society for Information Science and Technology, 60*(1), 111-122.
Chin, W. (1998). The partial least squares approach to structural equation modeling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295-336). Mahwah, NJ: Lawrence Erlbaum Associates.
Chin, W. W., Marcolin, B. L., & Newsted, P. R. (1996). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and voice mail emotion/adoption study. In J. I. DeGross, A. Srinivasan, & S. L. Jarvenpaa (Eds.), *Proceedings of the Seventeenth International Conference on Information Systems* (pp. 21-41). Cleveland, OH.
Cohen, J. (1988). *Statistical power analysis for the behavioral sciences, 2nd ed.* Hillsdale, NJ: Lawrence Erlbaum.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.
Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man Machine Studies, 38*(3), 475-487.
Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60-95.
DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9-30.
Deng, L, Turner, D. E., Gehling, R., & Prince, B. (2010). User experience, satisfaction, and continual usage intention of IT. *European Journal of Information Systems, 19*(1), 60-75.
Doll, W. J., & Torkzadeh, G. (1988). The measurement of end-user computing satisfaction. *MIS Quarterly*, 12(2), 259-274.
Doong, H.-S., & Lai, H. (2008). Exploring usage continuance of e-negotiation systems: Expectation and disconfirmation approach. *Group Decision and Negotiation, 17*(2), 111-126.
Elangovan, A. R., & Xie, J. L. (1999). Effects of perceived power of supervisor on subordinate stress and motivation: The moderating role of subordinate characteristics. *Journal of Organizational Behavior, 20*(3), 359-373.
Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishing Company.
Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.
Hirschman, A. O. (1984). Against parsimony: Three easy ways of complicating some categories of economic discourse. *American Economic Review, 74*(2), 89-96.
Ho, C-H. (2010). Continuance intention of e-learning platform: Toward an integrated model. *International of Journal of Electronic Business Management, 8*(3), 206-215.
Hsu, M. H., Chiu, C. M., & Ju, T. L. (2004). Determinants of continued use of the WWW: An integration of two theoretical models. *Industrial Management & Data Systems, 104*(9), 766-775.
Hsu, M.-H., Yen, C.-H., Chiu, C.-M., & Chang, C.-M. (2006). A longitudinal investigation of continued online shopping behavior: An extension of the theory of planned behavior. *International Journal of Human-Computer Studies, 64*(9), 889-904.
Jagpal, H. S. (1982). Multicollinearity in structural equation models with unobservable variables. *Journal of Marketing Research, 19*(4), 431-439.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-292.
Kempf, D. S., & Smith, R. E. (1998). Consumer processing of product trial and the influence of prior advertising: A structural modeling approach. *Journal of Marketing Research, 35*(3), 325-338.
Khalifa, M., & Liu, V. (2002-3). Satisfaction with internet-based services: The role of expectations and desires. *International Journal of Electronic Commerce, 7*(2), 31-49.
Khalifa, M., & Liu, V. (2003). Determinants of satisfaction at different adoption stages of Internet-based services. *Journal of the Association for Information Systems, 4*(5), 206-232.
Khalifa, M., & Liu, V. (2004). The state of research on information systems satisfaction. *Journal of Information Technology Theory and Application, 5*(4), 37-49.
Kim, B. (2010). An empirical investigation of mobile data service continuance: Incorporating the theory of planned behavior into the expectation–confirmation model. *Expert Systems with Applications, 37*(10), 7033-7039.
Kim, D. J., Ferrin, D. L., & Rao, H. R. (2009). Trust and satisfaction, two stepping stones for successful e-commerce relationships: A longitudinal exploration. *Information Systems Research*, *20*(2), 237-257.
Lankton, N. K., & Wilson, E. V. (2007a). Antecedents and dimensions of online service expectations. *IEEE Transactions on Engineering Management*, *54*(4), 776-788.
Lankton, N. K., & Wilson, E. V. (2007b). Factors influencing expectations of e-health services within a direct-effects model of user satisfaction. *E-Service Journal, 5*(2), 85-111.
Laroche, M., Kalamas, M., Cheikhrouhou, S., & Cézard, A. (2004). An assessment of the dimensionality of should and will service expectations. *Canadian Journal of Administrative Sciences*, *21*(4), 361-375.
LaTour, S. A., & Peat, N. C. (1979). Conceptual and methodological issues in consumer satisfaction research. *Advances in Consumer Research, 6*, 431-437.
Lee, M.-C.. (2010). Explaining and predicting users' continuance intention toward e-learning: An extension of the expectation-confirmation model. *Computers & Education, 54*(2), 506-516.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems, 12*(1), 752-780.
Liao, C., Chen, J.-L., & Yen, D. C. (2007). Theory of planned behavior (TPB) and customer satisfaction in the continued use of e-service: An integrated model. *Computers in Human Behavior, 23*(6), 2804-2822.
Limayem, M., Hirt, S. G., & Cheung, C. M. K. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS Quarterly, 31*(4), 705-737.
Lin, C. S., Wu, S., & Tsai, R. J. (2005). Integrating perceived playfulness into expectation-confirmation model for web portal context. *Information & Management, 42*(5), 683-693.
Malhotra, N. K., Kim, S. S., & Patil, A. (2006). Common method variance in IS research: A comparison of alternative approaches and a reanalysis of past research. *Management Science, 52*(12), 1865-1883.
McKinney, V., Yoon, K., & Zahedi, F. (2002). The measurement of web-customer satisfaction: An expectation and disconfirmation approach. *Information Systems Research, 13*(3), 296-315.
Mittal, V., Ross, W. T., Jr., & Baldasare, P. M. (1998). The asymmetric impact of negative and positive attribute-level performance on overall satisfaction and repurchase intentions. *Journal of Marketing, 62*(1), 33-47.
Oliver, R. L. (1980). A cognitive model of the antecedents and consequences of satisfaction decisions. *Journal of Marketing Research, 17*(4), 460-469.
Oliver, R. L. (1989). Processing of the satisfaction response in consumption: A suggested framework and research propositions. *Journal of Consumer Satisfaction, Dissatisfaction, and Complaining Behavior, 2*, 1-16.
Oliver, R. L. (1997). *Satisfaction: A behavioral perspective on the consumer*. New York, NY: McGraw-Hill.
Oliver, R. L., & DeSarbo, W. S. (1988). Response determinants in satisfaction judgments. *Journal of Consumer Research, 14*(4), 495-507.
Olson, J. C., & Dover, P. A. (1979). Disconfirmation of consumer expectations through product trial. *Journal of Applied Psychology, 64*(2), 179-189.
Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903.
Premkumar, G., & Bhattacherjee, A. (2008). Explaining information technology usage: A test of competing models. *Omega, 36*(1), 64-75.
Sharma, R., Yetton, P., & Crawford, J. (2009). Estimating the effect of common method variance: The method-method pair technique with an illustration from TAM research. *MIS Quarterly, 33*(3), 473-490.
Sherif, M., & Hovland, C. I. (1961). *Social judgment: Assimilation and contrast effects in communication and attitude change*. New Haven, CT: Yale University Press.
Sobel, M.E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. In S. Leinhart (Ed.), *Sociological methodology 1982* (pp. 290-312), San Francisco, CA: Jossey-Bass.
Spreng, R. A., MacKenzie, S. B., & Olshavsky, R. W. (1996). A reexamination of the determinants of consumer satisfaction. *Journal of Marketing, 60*(3), 15-32.
Spreng, R. A., & Page, T. J., Jr. (2003). A test of alternative measures of disconfirmation. *Decision Sciences, 34*(1), 31-62.
Spreng, R. A., & Sonmez, E. (2000). The moderating effect of involvement on the consumer satisfaction formation process. *Proceedings of the American Marketing Association Conference* (pp. 168-174).
Suh, K., Kim, S., & Lee, J. (1994). End-user's disconfirmed expectations and the success of information systems. *Information Resources Management Journal, 7*(4), 30-39.
Susarla, A., Barua, A., & Whinston, A. B. (2003). Understanding the service component of application service provision: An empirical analysis of satisfaction with ASP services. *MIS Quarterly, 27*(1), 91-123.
Szajna, B., & Scamell, R. W. (1993). The effects of information system user expectations on their performance and perceptions. *MIS Quarterly, 17*(4), 493-516.
Tang, J. E., & Chiang, C.-H. (2010). Integrating experiential value of blog use into the expectation-confirmation theory model. *Social Behavior and Personality, 38*(10), 1377-1389.

Thong, J. Y. L., Hong, S.-J., & Tam, K. Y. (2006). The effects of post-adoption beliefs on the expectation-confirmation model for information technology continuance. *International Journal of Human-Computer Studies, 64*(9), 799-810.

Tse, D. K., & Wilton, P. C. (1988). Models of consumer satisfaction formation: An extension. *Journal of Marketing Research, 25*(2), 204-212.

Tse, D. K., Nicosia, M., & Wilton, P. C. (1990). Consumer satisfaction as a process. *Psychology & Marketing, 7*(3), 177-193.

Venkatesh, V., & Goyal, S. (2010). Expectation disconfirmation and technology adoption: Polynomial modeling and response surface analysis. *MIS Quarterly, 34*(2), 281-303.

Venkatesh, V., Morris, M., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478.

Widaman, K. (1985). Hierarchically nested covariance structure models for multitrait-multimethod data. *Applied Psychological Measurement, 9*(1), 1-26

Williams, L. J., Cote, J. A., & Buckley, M. R. (1989). Lack of method variance in self-reported affect and perceptions at work: Reality or artifact? *Journal of Applied Psychology, 74*(3), 462-468.

Wolfe, R., & Hanley, J. (2002). If we're so different, why do we keep overlapping? When 1 plus 1 doesn't make 2. *Canadian Medical Association Journal, 166*(1), 65-66.

Yen, C.-H., & Lu, H.-P. (2008). Factors influencing online auction repurchase intention. *Internet Research, 18*(1), 7-25.

Yi, Y. (1990). A critical review of consumer satisfaction. In V. A. Zeithaml (Ed.), *Review of marketing* (pp. 68-123). Chicago, IL: American Marketing Association.

Yi, Y., & La, S. (2003). The moderating role of confidence in expectations and the asymmetric influence of disconfirmation on customer satisfaction. *The Service Industries Journal, 23*(5), 20-47.

Appendices

Appendix A. Expectation Disconfirmation Theory Hypothesized Relationships

Table A-1. Expectation Disconfirmation Theory Hypothesized Relationships

Hypothesized Relationship	Predicted Sign	Underlying Theory/Justification
Expectation → Disconfirmation[1]	Negative, none, or positive	Expectation disconfirmation theory generally supports a negative relationship. High expectations should be negatively disconfirmed because performance usually does not meet or exceed these high expectations. Likewise, low expectations are likely to be positively disconfirmed because performance typically does not fall below these low expectations (Yi, 1990; Oliver, 1997). However, individuals may adjust or forget expectations, which can result in no relationship between expectations and disconfirmation. Also, the halo effect may cause individuals with high expectations to only see high, better than expected outcomes and individuals with low expectations to only see low, worse than expected outcomes, thus creating a positive relationship between expectations and disconfirmation (Oliver, 1997).
Disconfirmation → Satisfaction[1]	Positive	Contrast theory accounts for discrepancies between expectations and performance that are large enough to fall into an individual's zone of rejection (Yi, 1990). Contrast theory predicts that individuals will magnify large discrepancies when evaluating satisfaction. Individuals will translate a positive discrepancy (i.e., positive disconfirmation) into high satisfaction, and a negative discrepancy (i.e., negative disconfirmation) into low satisfaction (Oliver ,1997; Oliver & DeSarbo, 1988; Yi, 1990).
Expectations → Satisfaction, [1], and Expectations → Performance → Satisfaction[2]	Positive	Assimilation theory postulates that if individuals perceive that the disparity between expectations and performance is small enough, they will accept the discrepancy and assimilate their performance evaluations toward their expectations (Yi, 1990). Thus, assimilation reduces cognitive dissonance between expectation and performance perceptions. Assimilation theory supports a positive relationship between expectations and satisfaction as individuals respond to performance with satisfaction levels that are similar to their expectations (Oliver & Desarbo, 1988).
Performance → Disconfirmation[2]	Positive	Holding expectations constant, the higher the performance, the more likely performance will exceed expectations, resulting in positive disconfirmation (Spreng & Page, 2003). This relationship explains how performance is converted into a psychological comparison (i.e., a disconfirmation) (Oliver, 1989).
Performance → Satisfaction[2]	Positive	This relationship captures certain consumer experiences better than the disconfirmation-satisfaction or expectation-satisfaction links (LaTour & Peat, 1979; Tse & Wilton, 1988). For example, if performance is extremely good or bad, it may be easier for individuals to adjust current expectations rather than performance (Tse & Wilton, 1988). Also, individuals who are motivated to learn from their experiences may be satisfied with good performance regardless of their expectations or disconfirmation (Tse & Wilton, 1988).

1 = Simplified Model Relationships; 2 = Additional Complete Model Relationships

Appendix B.

The following table lists IT EDT studies through 2010 found by searching for journal articles in the ProQuest research library by keywords (expectation, disconfirmation, confirmation, information system, information technology) and by specific author names. The table below shows the EDT relationships tested in each study.

Table B-1.

	EDT Relationships					
	E → D	E → S	D → S	E→ P	P → D	P → S
Expectations Only Models						
Brown et al. (2008)		■				
Lankton and Wilson (2007a)		■				
Szajna and Scarnell (1993)		■				
Venkatesh and Goyal (2010)		■				
Disconfirmation Only Models						
Bhattacherjee (2001a)*			■			
Bhattacherjee (2001b)*			■			
Bhattacherjee, Perols, and Sanford (2008)*			■			
Doong and Lai (2008)*			■			
Ho (2010)*			■			
Hsu, Yen, Chiu, and Chang (2006)*			■			
Hsu, Chiu, and Ju (2004)*			■			
Kim (2010)*			■			
Lee (2010)*			■			
Liao, Chen, and Yen (2007)*			■			
Limayem et al. (2007)*			■			
Lin, Wu, and Tsai (2005)*			■			
Tang and Chiang (2010)*			■			
Thong, Hong, and Tam (2006)*			■			
Yen and Lu (2008)*			■			
Expectations and Disconfirmation Models (Simplified Model)						
Bhattacherjee and Premkumar (2004)	■	■	■			
Disconfirmation and Performance Models						
Deng, Turner, Gehling, and Prince (2010)*			■			■
Khalifa and Liu (2003)			■		■	■
Suh, Kim, and Lee (1994)			■			■
Expectations and Performance Models						
Lankton and Wilson (2007b)		■		■		■
Expectation, Disconfirmation, and Performance Models						
Khalifa and Liu (2002-3)	■		■		■	■
Susarla et al. (2003)		■	■	■		■
Premkumar and Bhattacherjee (2008)*	■	■	■		■	■
Kim et al. (2009)	■	■	■		■	
(Complete Model)	■	■	■	■	■	■

Note: The shaded (black) boxes represent the relationships tested in each study.
*These studies also examine the satisfaction to continuance intention relationship.
E = Expectations, D = Disconfirmation, P = Performance, S = Satisfaction.

Appendix C. Measurement Items

Questionnaire Time 1

Expectations

Based on my experience so far, I expect that Microsoft Access will:
Usefulness *(adapted from Bhattacherjee & Premkumar, 2004)*

1. increase my productivity.
2. improve my performance.
3. enhance my effectiveness.
4. be useful.

Ease of Use *(adapted from Davis, 1993)*

1. be easy to get to do what I want it to do.
2. be easy for me to learn to use.
3. be easy for me to become skillful at.
4. be easy to use.

Prior Access Experience

1. I would rate my level of experience with Microsoft Access as (circle one): *(7-pt Likert scale from (1) no experience to (7) extensive experience)*

Prior Computer Use

1. I have been using a computer for ________ years. (measured as number of years)

Questionnaire Time 2

Performance

Based on your experience with Microsoft Access, it:
Usefulness *(adapted from Bhattacherjee & Premkumar, 2004)*

1. increased my productivity.
2. improved my performance.
3. enhanced my effectiveness.
4. was useful.

Ease of Use *(adapted from Davis, 1993)*

1. was easy to get to do what I want it to do.
2. was easy for me to learn to use.
3. was easy for me to become skillful at.
4. was easy to use.

Disconfirmation *(7-point Likert Scale from (1) Much worse than expected to (7) Much better than expected)*

Compared to your initial expectations, the ability of Microsoft Access:
Usefulness *(adapted from Bhattacherjee & Premkumar, 2004)*

1. to increase my productivity was . . .
2. to improve my performance was . . .
3. to enhance my effectiveness was . . .
4. to be useful was . . .

Ease of Use *(adapted from Davis, 1993)*

1. to be easy to get to do what I want it to do was . . .
2. to be easy for me to learn to use was . . .
3. to be easy for me to become skillful at was . . .
4. to be easy to use was . . .

Satisfaction *(7-pt. Likert Scale, endpoints shown) (adapted from Bhattacherjee & Premkumar, 2004)*

1. I am ______ with my use of Microsoft Access. Extremely displeased/Extremely pleased
2. I am ______ with my use of Microsoft Access. Extremely frustrated/Extremely contented
3. I am ______ with my use of Microsoft Access. Extremely miserable/Extremely delighted
4. I am ______ with my use of Microsoft Access. Extremely dissatisfied/Extremely satisfied

Continuance Intention *(adapted from Bhattacherjee & Premkumar, 2004)*

1. In the near future, I intend to continue using Microsoft Access.
2. I intend to continue using Microsoft Access to create databases.
3. I plan to continue using Microsoft Access after this class.

Items measured on a 7-point Likert Scale from (1) Strongly disagree to (7) Strongly agree unless otherwise indicated.

About the Authors

Nancy LANKTON is an assistant professor in the College of Business at Marshall University. She received her B.S. in Accounting, M.B.A., M.S. in Computer Information Systems, and Ph.D. in Business Administration from Arizona State University. She teaches accounting information systems and information systems auditing. Nancy's main research interests include trust's impacts on individual and organizational use of information technology, e-health, and privacy behaviors related to social networking websites. She has published in journals such as Contemporary Accounting Research, IEEE Transactions on Engineering Management, Journal of Management Information Systems, and the Journal of the American Medical Informatics Association. She is a member of the Association for Information Systems, and the Information Systems Auditor and Control Association, and currently serves as an Associate Editor for Communications of the AIS.

D. Harrison MCKNIGHT is an associate professor in the Eli Broad College of Business at Michigan State University. He received his Ph.D. in management information systems from the University of Minnesota. Before pursuing a doctorate, he earned bachelors and MBA degrees from Brigham Young University and worked for ten years at American Airlines' SABRE Computer Systems division. Dr. McKnight currently serves as an Associate Editor at MIS Quarterly. His research interests include trust within technology and electronic commerce settings and the retention and motivation of technical professionals. His work has appeared in such journals as MIS Quarterly, Information Systems Research, Journal of Management Information Systems, IEEE Transactions on Engineering Management, and the Academy of Management Review.