Received 30 May 2017
Revised 21 September 2017
Accepted 14 December 2017

Wearable health information systems intermittent discontinuance

A revised expectation-disconfirmation model

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Abstract

Purpose – Wearable health information systems (IS) open up a new era for personal health self-management, and bring about disruptive changes to individual lives. However, prior studies on IS post-adoptive behavior primarily focused on either continuance or discontinuance, neglecting the mutual transformation process between IS usage and rejection behavior. This behavior is expressed as intermittent discontinuance in the current study. By revising and extending the expectation-disconfirmation model, the purpose of this paper is to understand the factors affecting information system intermittent discontinuance in the context of wearable eHealth.

Design/methodology/approach – This study proposes a revised expectation-disconfirmation model by incorporating four new theoretical constructs, i.e. neutral disconfirmation, attitudinal ambivalence, neutral satisfaction, and intermittent discontinuance. An online survey was used to validate the research model, and 428 wearable health device users were recruited in this study.

Findings – Empirical results demonstrate that neutral disconfirmation exerts positive effects on neutral satisfaction and attitudinal ambivalence, both of which further have positive effects on intermittent discontinuance. In addition, attitudinal ambivalence also has a positive and significant effect on neutral satisfaction.

Originality/value – This study extends the current understanding on IS post-adoption usage behavior by introducing a new concept, i.e., intermittent discontinuance. In particular, post-adoption usage behavior is viewed as a dynamic process within a changing environment in this study. Some unique features specific to intermittent discontinuance are also identified. In this regard, neutral and conflicting constructs further add new values to IS adoption and diffusion literature. In addition, the integration of eHealth and wearable devices provides a fruitful research context for future research, and this study represents one of the first attempts to empirically explore the intermittent usage problems encountered within this emerging phenomenon.

Keywords Attitudinal ambivalence, Expectation-disconfirmation theory, Intermittent discontinuance, Neutral disconfirmation, Neutral satisfaction, Wearable health information systems

Paper type Research paper

Introduction

Recent remarkable advancements in sensor and semiconductor technology have allowed traditional medical devices used in the hospitals to evolve into different types of wearable health information systems (IS). Compared with hospital medical devices, wearable health devices are smaller in size, have lower power consumption, and can be worn comfortably. These wearable health devices include wrist bands, smart watches and glasses, and wearable body metric textile, and can track personal heart rate, steps, blood pressure, body temperature, and sleep condition (Swan, 2013). It thus becomes easy for people to monitor their fitness and health indicators anytime and anywhere, using wearable health IS. As such, wearable health devices open up a new era of personal health self-monitoring and self-management, and these devices greatly change the way people know about themselves

Industrial Management & Data Systems
Vol. 118 No. 3, 2018
pp. 506-523

0263-5577
DOI 10.1108/IMDS-05-2017-0222

and improve their quality of life (Swan, 2013; Lazar *et al.*, 2015; Gilmore, 2016). In this regard, some leading companies in the consumer electronic market such as Apple, Google, SumSung, and XiaoMi, as well as start-ups, such as Jawbone and Pebble, have launched their own wearable health devices and started to establish business ecosystems around these devices. It is reported that wearable health device shipments will grow consistently from less than 20 million units in 2014 to more than 100 million units in 2019 (IDC, 2015).

IS scholars also have started to investigate wearable health device users' adoption and usage behavior (Sun *et al.*, 2013; Gao *et al.*, 2015; Buchwald *et al.*, 2015; Lunney *et al.*, 2016; Hong *et al.*, 2017). Following prior understanding on information technology adoption and diffusion in IS field, these studies implicitly assumed that users' decisions on wearable health device adoption and usage were permanent and unchanged. However, this is not the common case for wearable health IS. In the eHealth context, although wearable health device market has grown exponentially, the attractions of these information technologies to users are decreasing and the usage trend often shows a significant drop after a period of time (Lazar *et al.*, 2015). Epstein *et al.* (2016) also indicated that people often reuse the abandoned wearable health devices because they might feel guilty for not making self-tracking as a habit or for the high sunk costs of the smart devices. In this regard, we believe that users' decisions to reject or discontinue the use of wearable health information technology do not necessarily mean the end of the decision-making process. Instead, users' engagement with wearable health IS often include a series of dynamic and coherent decision-making process, and people are more likely to reuse these technologies even though they have decided to discontinue using them before.

We conceptualize this new phenomenon as intermittent discontinuance in this study, and it refers to a state where people neither continuously use the focal information technology nor entirely abandon it. In this state, people may discontinue using it temporarily for a period of time, and reuse/readopt it later, and a cycle of "discontinuance-readoption" will be observed. Intermittent discontinuance would bring some consequential damages to the utility of wearable health IS because people can effectively evaluate their health status and get timely intervention only when personal health information is continuously monitored for a long period (Swan, 2013; Choe *et al.*, 2014). In this regard, it is necessary to understand how intermittent discontinuance is conceptualized and formed. This study presents an initial attempt to revise the expectation-disconfirmation theory (EDT) (Bhattacherjee, 2001), which is one of the most widely used theories in IS discontinuance, to explain users' intermittent discontinuance intention of wearable health IS. In particular, three new concepts to IS field, i.e. neutral disconfirmation, attitudinal ambivalence, and neutral satisfaction, are incorporated in the revised model to better meet the unique concerns of intermittent discontinuance.

The remainder of the paper is organized as follows. The theoretical background and related work are reviewed in the next section, which is followed by the research model and hypotheses. In the subsequent sections, the research methodology is introduced and the data analysis results are reported. This study is concluded with a discussion of the key findings and the implications for research and practice.

Theoretical background and literature review

Discontinuance and intermittent discontinuance

Discontinuance refers to users' decision to stop their use of an information technology (Parthasarathy and Bhattacherjee, 1998), and has been regarded as an important post-adoption behavior in IS research (Bhattacherjee, 2001; Fan and Suh, 2014; Buchwald *et al.*, 2015). In particular, IS discontinuance includes two situations: one is replacement discontinuance, which occurs when users replace the inferior IS with a superior one, and the other is disenchantment discontinuance, which results from dissatisfaction with experiences of

IS use (Parthasarathy and Bhattacherjee, 1998; York and Turcotte, 2015). These types of IS discontinuance assume that users will abandon the use of IS completely.

However, some recent evidences have demonstrated that users' decisions on IS adoption and usage may not always be permanent and unchanged. For example, York and Turcotte (2015) have found that people might discontinue using Facebook temporarily, and they would re-adopt it after a few days of discontinuance. Crandell (2011) also presented some interesting anecdotal evidence for this. As shown in his work, Facebook users would shut down their accounts for a while, and come back soon because they felt that it was impossible to leave Facebook forever. This phenomenon was called as "Facebook vacation" by Crandell (2011). Moreover, Ravindran *et al.* (2014) have conducted an in-depth interview and found that Facebook users would take a self-imposed rest break from social networking, and temporarily deactivated their Facebook accounts because of social network fatigue. Nonetheless, all of the articles discussed above just examine this phenomenon using a qualitative research method, without comparing the differences between discontinuance and intermittent discontinuance, and lacking a rigorous empirical understanding of how intermittent discontinuance is conceptualized and formed.

Except for social networking, intermittent discontinuance also occurs in the context of mobile internet. For example, a recent study by Xu *et al.* (2017) proposed a technology readoption model, and demonstrated that people were less likely to completely abandon the use of a mobile internet services. As a result, technical firms could win disadopters back by addressing the drivers of readoption. This is also the case for wearable health information technologies. Epstein *et al.* (2016) found that people tended to blame themselves for failing to continue the use of wearable health devices, and for the high costs they have paid for the abandoned devices. In this sense, wearable health information technology users are very likely to reuse/readopt these abandoned devices to alleviate their guilt (Epstein *et al.*, 2016). A further examination of the dynamic usage behavior of wearable health devices was thus also strongly suggested by Clawson *et al.* (2015).

On the basis of this considerable evidence and literature, intermittent discontinuance can be defined as a kind of IS post-adoption usage behavior through temporarily discontinuing the use of information technology, and readopting it later. The cycle of discontinuance and readoption is more likely to be repeated, and a dynamic adoption and usage process is embodied in intermittent discontinuance. According to Ravindran *et al.* (2014), there are three possible usage behaviors associated with intermittent discontinuance, including controlled use, short breaks in use, and suspended use. In particular, controlled use characterizes that users have a downward moderation in technology use with a lower usage frequency. Breaks in use represents that users will take a short break between two periods of use, and suspended use indicates a most serious situation of intermittent discontinuance, but users' disengagement with an information technology in suspended use is not a final discontinuance decision. The three types of intermittent discontinuance imply that people would not permanently continue or discontinue using information technology, and instead they tend to use the technology intermittently. Based on the four criteria proposed by Jarvis *et al.* (2003), intermittent discontinuance concept is considered as a formative construct with three components, i.e. controlled use, breaks in use, and suspended use in this study. A spectrum from IS continuance to discontinuance, and the positions for the three components of intermittent discontinuance, are depicted in Figure 1.

EDT

The EDT originated from consumer behavior research, and has been widely used to examine customer satisfaction and post-purchase behavior such as repurchase and complaining behavior (Oliver, 1980; Hsu *et al.*, 2016). The EDT involves four major constructs, namely, expectation, performance, confirmation, and satisfaction. These constructs and their

relationships are illustrated in Figure 2. In general, if the actual performance of a product is superior to users' original expectation, it will lead to users' confirmation of their prior expectations and bring satisfaction toward the product, which further determines repurchase decision. Based on the EDT, Bhattacherjee (2001) further proposed a post-acceptance model of IS continuance, and the constructs and associated relationships were presented in Figure 3. In particular, the IS continuance model has significantly broadened IS adoption and usage research, and has been validated in different contexts (e.g. Fan and Suh, 2014; Susanto *et al.*, 2016).

It is important to notice that both EDT and IS continuance model conceptualize expectation as an evaluative judgment about a focal product or an information technology

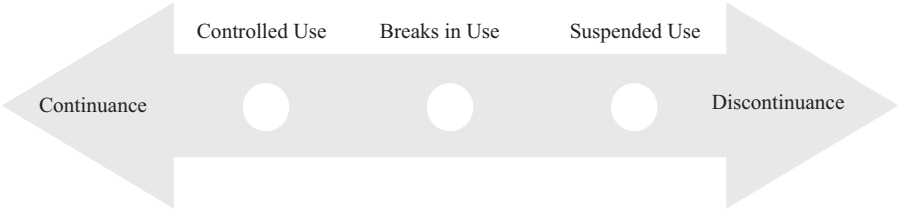
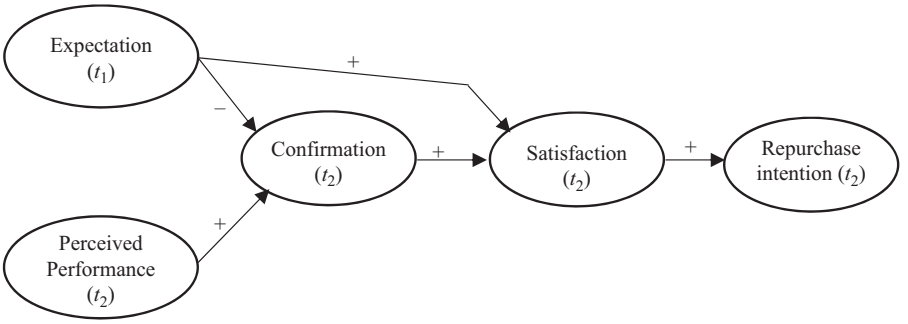
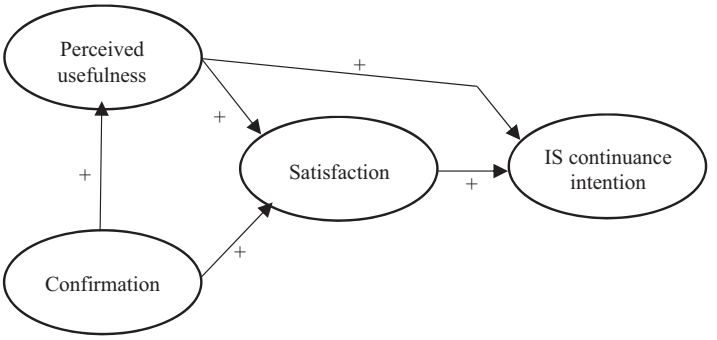


Figure 1.
A continuous spectrum from continuance to discontinuance



Notes: t_1 = pre-consumption variable; t_2 = post-consumption variable
Source: Oliver (1980)

Figure 2.
Expectation-confirmation theory



Source: Bhattacherjee (2001)

Figure 3.
A post-acceptance model of IS continuance

with reference to a single level, i.e. higher or lower than one's expectation (Oliver, 1980; Bhattacherjee, 2001). However, there are some concerns and criticisms regarding the ambiguity of the variable "expectation" in IS and marketing discipline, and there are increasing numbers of studies claiming that expectation should be conceptualized by including two different levels, that is, adequate and desired expectations (Zeithaml *et al.*, 1993; Kettinger and Lee, 2005; Gorla and Somers, 2014). Specifically, the desired level of expectation refers to the level of performance users expect to receive. In other words, the desired expectation is what users believe the performance can be and should be. The adequate level of expectation refers to the minimum level of performance users expect, that is, the threshold of acceptable performance. When the actual performance falls above the desired level of expectation, users' expectation is believed to be positively confirmed, and in this case, users will form a positive perception of IS use and feel satisfied when using such IS (Woodruff *et al.*, 1983; Bhattacherjee, 2001). When the actual performance falls below the adequate level of expectation, users' expectation is believed to be negatively disconfirmed, and in this case, users will lower their initial positive perception of IS use and feel dissatisfied when using such IS (Oliver, 1980; Woodruff *et al.,* 1983). When the actual performance falls below the desired expectation, but above the adequate expectation, a neutral result will be achieved (Oliver, 1980; Woodruff *et al.*, 1983). In particular, such a neutral situation has been conceptualized as a "zone of indifference" (Woodruff *et al.*, 1983) or a "zone of tolerance" (Kettinger and Lee, 2005; Gorla and Somers, 2014).

In general, positive and negative confirmation can be conceptualized to be theoretically consistent with confirmation and disconfirmation in EDT, respectively. In this regard, positive confirmation will enhance users' positive perceptions and satisfaction with IS use, thereby leading to IS continuance. On the contrary, negative disconfirmation will lower users' positive perceptions and evoke dissatisfaction with IS use, thereby resulting in IS discontinuance (Bhattacherjee, 2001). As such, positive and negative disconfirmation can only explain why users continue or discontinue using the IS, but fail to explain their intermittent discontinuance usage behavior. In this regard, intermittent discontinuance represents a situation of the above-mentioned "zone of indifference," and users' expectation levels fall between desired and adequate levels. In the current study, if users intermittently discontinue using the wearable health devices, the performance of the devices should be acceptable for them, namely, above the adequate expectation, but does not surpass the desired level of expectation, namely, below the desired expectation. In other words, they can tolerate the performance of the devices to some extent, but they are not entirely satisfied with the devices. Therefore, users' intermittent discontinuance of wearable health devices is attributable to the neutral disconfirmation and users' neutral satisfaction. This study thus presents an initial attempt to revise the expectation-disconfirmation model by focusing on the specificity of the context, and incorporates neutral disconfirmation, neutral satisfaction, and users' attitudinal ambivalence to better investigate users' intermittent discontinuance intention toward wearable health devices.

Model development and hypothesis

Built on the expectation-disconfirmation model and previous studies on intermittent behavior, this study develops a research model as shown in Figure 4.

Role of neutral satisfaction

Satisfaction can be considered as a psychological or affective state associated with or resulting from a pleasurable experience of prior expectation confirmation (Bhattacherjee, 2001). As such, personal satisfaction can be conceptualized as an affective arousal with a specific valence (Briggs *et al.*, 2008). This definitions distinguish satisfaction from the judgment or attitude, and it has been widely accepted in prior research (Oliver, 1980; Bhattacherjee, 2001; Briggs *et al.*, 2008; Cheung *et al.*, 2015; Shen *et al.*, 2018). Thus, neutral

satisfaction can be defined as an affective arousal with a neutral valence resulting from neither a pleasurable nor a disagreeable level of usage experience of a technology or a product. Based on the EDT and the IS continuance model, users' discontinuance mainly results from their dissatisfaction with the IS performance, whereas continuance is determined by their satisfied experience with IS use. This view has also been widely demonstrated in IS research (Fan and Suh, 2014; Susanto *et al.*, 2016; Sun *et al.*, 2016). However, if people are neutrally satisfied with the IS, they will experience an affective arousal without any valence (Briggs *et al.*, 2008). In this case, people will neither stop using the IS entirely, nor will they use it continuously, because they are motivated by neither dissatisfaction nor satisfaction. As such, it is possible to assume that a neutral level of satisfaction may be difficult for the users of wearable health IS to make a decision to continue or discontinue the devices in a permanent manner. Instead, users are likely to sway between continuance and discontinuance, and thus change their system usage behavior intermittently. Thus, the following hypothesis is proposed:

H1. Neutral satisfaction with wearable health IS is positively associated with intermittent discontinuance intention to use the systems.

Antecedents of neutral satisfaction

The EDT and Bhattacherjee (2001) indicated that confirmation would lead to users' satisfaction with IS use because the expected benefits of IS use were realized, whereas disconfirmation would result in users' dissatisfaction with IS use because the expectations and values of IS use were not fulfilled. In particular, users' expectation can be further conceptualized as desired level and adequate level as noted previously (Zeithaml *et al.*, 1993; Kettinger and Lee, 2005). When the desired expectations on IS use are confirmed, a positive disconfirmation (i.e. confirmation in the EDT) occurs, and users tend to be satisfied with IS use (Woodruff *et al.,* 1983; Gorla and Somers, 2014). When the adequate expectations are disconfirmed, a negative disconfirmation (i.e. disconfirmation in the EDT) occurs, and users will be dissatisfied with IS use (Woodruff *et al.,* 1983; Gorla and Somers, 2014). When the adequate expectations on IS use are fulfilled but the desired expectations remain unfulfilled, a "zone of indifference" (Woodruff *et al.*, 1983) or a "zone of tolerance" (Kettinger and Lee, 2005) occurs, which is conceptualized as a neutral disconfirmation in this study. Neutral disconfirmation is thus defined as the realization of the minimum expectation and the failure to achieve the desired expectation.

In particular, when users' minimum expectations toward the wearable health IS are confirmed, they will consider the performance of the system as acceptable, and thus they will not be dissatisfied with the system use (Kettinger and Lee, 2005). However, it does not necessarily mean that users will be satisfied with the system if their desired expectations are

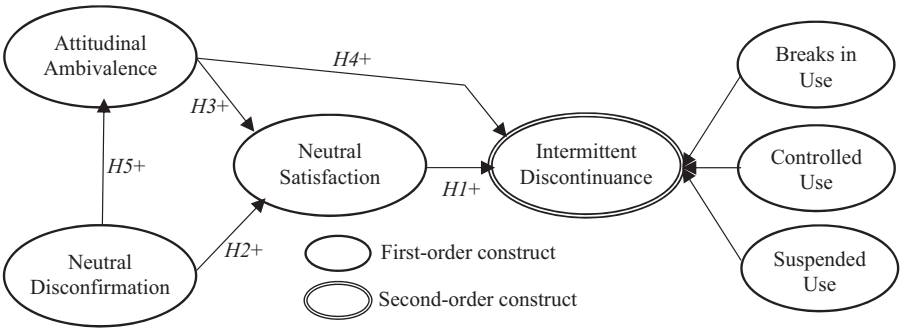


Figure 4.
A revised model of intermittent discontinuance

not confirmed yet (Behling *et al.*, 1968). In this case, users' neutral disconfirmation of the focal system will neither affect satisfaction nor dissatisfaction, and they will be more likely to feel a sense of satisfaction without any valence, that is, a neutral satisfaction in this study.

Based on these arguments, we predict that when users' expectations on the use of wearable health IS are neutrally disconfirmed, they will exhibit a feeling of neutral satisfaction with the system. Thus, the following hypothesis is proposed:

H2. Neutral disconfirmation of the performance of wearable health IS is positively associated with neutral satisfaction with the systems.

Moreover, Bhattacherjee (2001) further argued that *ex post* expectation (usefulness belief in particular) would exert a significant effect on users' post-adoption affect (satisfaction in particular) as well. In particular, positive beliefs about IS use will increase users' satisfaction, whereas negative beliefs will result in users' dissatisfaction (Gorla and Somers, 2014; Zhang *et al.*, 2016). Since neutral satisfaction indicates that users are neither satisfied nor dissatisfied with IS use, a bipolar belief perspective will be inappropriate to explain neutral satisfaction in this study. Therefore, attitudinal ambivalence, which refers to the extent to which the attitude object is evaluated both positively and negatively at the same time (Jonas *et al.*, 2000), is included in the revised expectation-disconfirmation model as the *ex post* expectation beliefs. Attitudinal ambivalence implies that conflicting beliefs (positive vs negative) co-exist in users' evaluations of system use, and in this case, users will find it difficult to estimate their satisfaction level with a clear valence (Olsen *et al.*, 2005; Ziegler *et al.*, 2012). As a result, users will attempt to form a compromising affective arousal to deal with the conflicting cognitive beliefs (Pratt and Doucet, 2000; Stein *et al.*, 2015). In this regard, it will be more likely that a neutral satisfaction toward the focal system would be induced by users' attitudinal ambivalence. Therefore, we predict that when users have ambivalent attitudes to the use of wearable health IS, they tend to be neutrally satisfied with the devices. Therefore, the following hypothesis is proposed:

H3. Attitudinal ambivalence toward wearable health IS is positively associated with neutral satisfaction with the systems.

Role of attitudinal ambivalence

Most attitude research has argued that attitude can be accepted as a key factor in evoking human behavioral intention in IS research (Shen *et al.*, 2010; Park *et al.*, 2016). Attitude is regarded as a bipolar construct, which is defined as a tendency to assign a certain degree of positive or negative evaluation to a given attitude object. Accordingly, attitude in these studies is merely conceptualized as an evaluation of either positive or negative beliefs. However, prior studies on the social cognitive theory have demonstrated that people's cognitive beliefs are not always consistent, and may even be conflicting (Thompson and Zanna, 1995). For example, one person may dislike fast food because it is considered to be unhealthy, but he or she may also love eating it because it is time saving or delicious. Thus, conflicting beliefs are likely to exist simultaneously in people's evaluation of an attitude object (Jonas *et al.*, 2000), which is defined as attitudinal ambivalence in this study.

In accordance with the EDT and Bhattacherjee's (2001) work, attitudinal ambivalence (as an *ex post* expectation) may have a direct effect on users' behavioral intention. In particular, positive beliefs will facilitate human behavioral intention, whereas negative beliefs will lower it (Shen *et al.*, 2012; Chen and Shen, 2015; Park *et al.*, 2016). However, users having attitudinal ambivalence are more likely to face difficulty in clearly labeling their positive or negative evaluations of the attitude objects, i.e. wearable health IS in this study (Stein *et al.*, 2015). As a result, users may cope with their attitudinal ambivalence toward the focal system by not making a permanent or clear usage, for example, continuance or discontinuance (Bala *et al.*, 2017).

Instead, they may combine the two different types of usage behavior and use the health devices dynamically (Pratt and Doucet, 2000; Stein *et al.*, 2015). Therefore, users will intermittently discontinue using wearable health devices, indicating a cycle of temporary discontinuance and readoption of these devices. Therefore, the following hypothesis is proposed:

H4. Attitudinal ambivalence toward wearable health IS is positively associated with intermittent discontinuance intention to use the systems.

Role of neutral disconfirmation

Furthermore, Bhattacherjee (2001) indicated that confirmation would enhance positive beliefs about an IS, and disconfirmation would reduce such positive beliefs and generate negative beliefs. Based on Bhattacherjee's (2001) work, neutral disconfirmation is assumed to significantly affect attitudinal ambivalence toward wearable health IS in the current study. Specifically, when users' expectations on IS use are neutrally disconfirmed, users will not necessarily develop negative beliefs toward the focal system because the minimum expectations are confirmed and they can tolerate the performance of the system. However, they will not necessarily form an evaluation with positive beliefs because their desired expectations remain unfulfilled (Woodruff *et al.* 1983; Kettinger and Lee, 2005). This situation implies that users may have a contradictory and ambivalent attitude toward the system, and both pure positive and negative evaluations are hard to be triggered. Therefore, neutral disconfirmation of users' expectations on the use of wearable health device will lead the users to be inclined to ambivalently evaluate the systems. The following hypothesis is proposed:

H5. Neutral disconfirmation of the performance of wearable health IS is positively associated with attitudinal ambivalence toward the systems.

Methodology

Data collection and samples

This study targets the users of wearable health IS, and an online survey method is used for data collection because of its merits in quick access to the unique populations (Wright, 2005). Before initiating data collection, ten wearable health device users were invited to complete a pre-test, and the primary objective of conducting a pre-test is to evaluate the clarity, understandability, logic, and organization of all questionnaire items. According to their feedback, the problematic items were re-worded in the revised questionnaire.

Online survey participants were recruited using a paid service supported by Sojump.com, which is the largest professional online survey service provider in Mainland China and has more than 2.6 million active members with diversified experience and backgrounds. The advantage of employing a professional online survey company lies in its ability to quickly reach the potential respondents, and its expansive sample bank will help us obtain the data from a random sample of potential users, instead of a convenience sample, such as student sample. The online survey company is responsible for inviting eligible participants from the sample bank to take our survey, and the IP address restriction ensures that an individual can complete the questionnaire only once, avoiding the repeated answers. Each successful respondents will be rewarded with certain points, which can be used to redeem different prizes offered by the company. To ensure that the respondents have used wearable health IS such as smart watches, smart wristbands, smart sphygmomanometer, or body intelligent scales before, a screening question was added at the front of the questionnaire. The reason why we included the screening question is that this study intends to understand users' post-adoptive behavior, and thus people who had not used wearable health IS before should not be incorporated into this survey. Finally, 428 valid responses were received, and their demographic characteristics are presented in Table I.

Table I.
Demographic characteristics of respondents

Variables	Types	Frequency	%	Variables	Types	Frequency	%
Gender	Male	211	49.30	Monthly income (RMB)	< 5,000	111	25.94
	Female	217	50.70		5,000-7,999	168	39.25
Education	< Undergraduate	75	17.52		8,000-11,999	119	27.80
	Undergraduate	319	74.53		⩾12,000	30	7.01
	> Undergraduate	34	7.95	Age	18~25	63	14.72
Experience of usage	< 6 months	121	28.27		26~30	107	25.00
	6-12 months	188	43.93		31~40	180	42.06
	> 12 months	119	27.80		> 40	78	18.22

Note: $n = 428$

Measures

Although some of the variables in this study are relatively new to the IS field, we adapted the measurement items from previous studies as much as possible. There are two reasons for this. First, IS reference disciplines, such as social psychology, management, marketing, and information science, provide a solid theoretical basis and a broad range of measurement which can be used for items adaption. Second, measurement items from the literature have been well evaluated for their reliability and validity, thereby reducing the measurement risk of this study. In this regard, constructs in the model were measured using multi-item scales adapted from established instruments with good reliability and validity, and the selected measurement items have been frequently used in the literature, demonstrating the wide acceptance of these measurement items. Specifically, neutral satisfaction was measured with three items adapted from Behling *et al.* (1968), and neutral disconfirmation was measured with three items from Bhattacherjee (2001) and Kettinger and Lee (2005). Intermittent discontinuance was measured with items adapted from Ravindran *et al.* (2014) and Shen and Li (2017). All the measurement items of neutral satisfaction, neutral disconfirmation, and intermittent discontinuance were phrased in a seven-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). In addition, with regard to attitudinal ambivalence, we used six unidimensional seven-point scales to capture the positive or negative ratings of the stimulus products (Kaplan, 1972), and the six seven-point scales also have shown acceptable psychometric properties in the literature (e.g. Cornil *et al.*, 2014). Furthermore, the degree of ambivalence was evaluated using a formula-based approach proposed by Thompson and Zanna (1995). The computation equation of attitudinal ambivalence value is: $A = [P+N]/2-|P-,N|$, where A represents attitudinal ambivalence; P represents the reactions to the positive evaluation; and N represents the reactions to the negative evaluations. In particular, this formula has been widely used and has been proven to be a validated method to measure attitudinal ambivalence in social science research (Jonas *et al.*, 2000; Luttrell *et al.*, 2016). To fit the specific investigation context of this study, changes in the wording were made to highlight the keywords of the context, for example, wearable health device. All the items are presented in Appendix.

Data analysis and results

We used the partial least-squares-based structural equation modeling (PLS-SEM) approach to analyze the empirical data to validate our research model. Compared with covariance-based structural equation modeling approach, PLS-SEM is found to be more appropriate to handle theoretical models with second-order constructs (Hair *et al.*, 2010). Following the

two-step procedure, we first assessed the construct reliability and validity in the measurement model analysis, and examined the structural model to test the hypothesized relationships then. In particular, the data analysis was performed using SmartPLS 2.0.

Measurement model

Measurement model of reflective and formative constructs should be assessed following different guidelines (Petter *et al.*, 2007; Sun *et al.*, 2012). Specifically, the reliability and validity of reflective constructs are generally determined by construct reliability, convergent validity, and discriminant validity. In this study, we examine the composite reliability (CR) and Cronbach's α (CA) to assess the construct reliability, and examine the average variance extracted (AVE) to assess the convergent validity. In particular, CR and CA values greater than 0.7 and an AVE value greater than 0.5 are recommended (Fornell and Bookstein, 1982). Discriminant validity can be evaluated by comparing the square root of the AVE of a construct and the correlation coefficients between that construct and all other constructs. If the square root of the AVE of a construct is greater than all of its correlation coefficients with other constructs, then discriminant validity is satisfied (Fornell and Bookstein, 1982). As shown in Table II, CR and CA values range from 0.912 to 0.948 and from 0.822 to 0.917, respectively, indicating a good reliability for the reflective constructs. The AVE value ranges from 0.776 to 0.899, and the square root of the AVEs for all the constructs are higher than the correlation coefficients between the particular constructs and any other constructs, suggesting acceptable convergent and discriminant validity for the reflective constructs.

Moreover, convergent and discriminant validity of reflective constructs can be also evaluated by checking the item loadings. In particular, when the item loadings are greater than 0.7, convergent validity can be achieved. When the item loadings on its theory-related construct are greater than those on other constructs, discriminant validity can be achieved. Table III shows that all reflective constructs present good convergent and discriminant validity.

Furthermore, this study follows the established procedure to assess the construct validity and reliability of the formative constructs (Petter *et al.*, 2007; Sun *et al.*, 2012; Wang *et al.*, 2013). In particular, construct validity of formative constructs is assessed by examining the item weights, which should be significant in the statistic level. The reliability of formative constructs is assessed by examining the possible multicollinearity among indicators, and variance inflation factor values are recommended to be lower than 3.00. As shown in Table IV, the validity and reliability of the formative constructs are confirmed.

Structural model

Figure 5 depicts the PLS analysis results. The results show that neutral disconfirmation exerts positive effects on neutral satisfaction ($\beta = 0.280$, $t = 5.329$) and attitudinal ambivalence ($\beta = 0.378$, $t = 8.784$), leading the support to *H2* and *H5*. Moreover, the results further show that neutral satisfaction and attitudinal ambivalence both exert a positive effect on

Construct	AVE	CR	CA	Mean	SD	NS	ND	AA	BU	CU	SU
NS	0.858	0.948	0.917	3.674	1.502	*0.926*					
ND	0.840	0.940	0.904	3.588	1.569	0.403	*0.917*				
AA	0.776	0.912	0.856	0.657	1.682	0.438	0.377	*0.881*			
BU	0.899	0.947	0.888	2.652	1.349	0.404	0.322	0.371	*0.948*		
CU	0.877	0.934	0.860	2.633	1.417	0.492	0.411	0.553	0.480	*0.936*	
SU	0.848	0.918	0.822	2.818	1.483	0.437	0.418	0.523	0.528	0.635	*0.921*

Notes: NS, neutral satisfaction; ND, neutral disconfirmation; AA, attitudinal ambivalence; BU, breaks in use; CU, controlled use; SU, suspended use. The square root of AVE is reported along the diagonal in italics

Table II. Construct reliability and validity of reflective constructs

Items	NS	ND	AA	BU	CU	SU
NS1	*0.909*	0.379	0.382	0.364	0.462	0.409
NS2	*0.941*	0.401	0.411	0.409	0.454	0.410
NS3	*0.928*	0.345	0.422	0.351	0.450	0.399
ND1	0.394	*0.892*	0.343	0.266	0.388	0.379
ND2	0.360	*0.929*	0.322	0.307	0.367	0.371
ND3	0.358	*0.928*	0.371	0.311	0.375	0.403
AA1	0.393	0.348	*0.870*	0.324	0.506	0.450
AA2	0.398	0.347	*0.904*	0.343	0.500	0.485
AA3	0.364	0.301	*0.869*	0.314	0.458	0.464
BU1	0.395	0.322	0.353	*0.950*	0.464	0.512
BU2	0.373	0.288	0.351	*0.946*	0.446	0.491
CU1	0.465	0.399	0.486	0.456	*0.932*	0.592
CU2	0.456	0.372	0.550	0.443	*0.941*	0.613
SU1	0.412	0.392	0.522	0.494	0.641	*0.930*
SU2	0.396	0.382	0.450	0.481	0.540	*0.912*

Table III.
Cross loadings of items of reflective constructs

Note: The item loadings on its theory-related construct are reported along the diagonal in italics

Formative construct	Subconstructs	Weights	*t*-values	VIF values
Intermittent discontinuance	Controlled use	0.720	15.936	1.762
	Breaks in use	0.413	8.318	1.458
	Suspended use	0.557	11.868	1.880

Table IV.
Construct reliability and validity of formative constructs

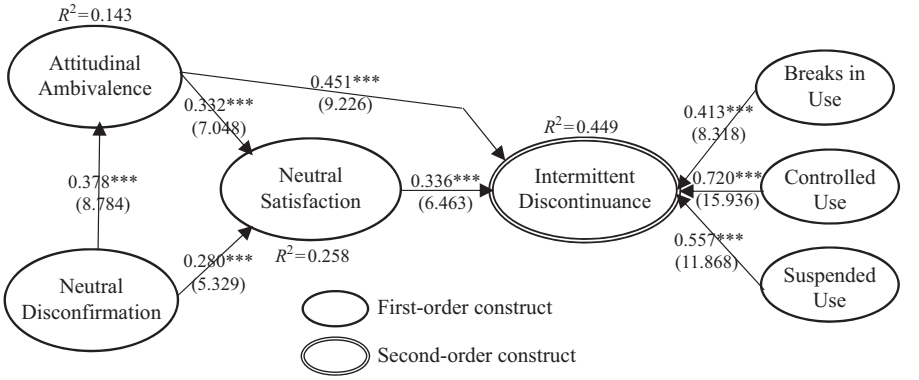


Figure 5.
Structural model

Notes: *t* value is in parentheses. *$p<0.05$; **$p<0.01$; ***$p<0.001$

intermittent discontinuance, with path coefficients at 0.336 ($t=6.463$) and 0.451 ($t=9.226$), respectively. As such, *H1* and *H4* are supported. In addition, the path from attitudinal ambivalence to neutral satisfaction is positive and significant ($\beta=0.332$, $t=7.048$), suggesting that *H3* is supported. In this regard, all the hypothesized relationships in the revised expectation-disconfirmation model are supported. Furthermore, exogenous variables explain 44.9 percent of the variance in intermittent discontinuance, 25.8 percent of the variance in neutral satisfaction, and 14.3 percent of the variance in attitudinal ambivalence.

Conclusions and discussions

This study aims to investigate how intermittent discontinuance is conceptualized and formed for wearable health IS. The underresearched phenomenon of intermittent discontinuance is relatively common in IS post-adoption stage, but it has been rarely systematically explored by IS scholars. Drawing upon the EDT, this study developed a model by incorporating new concepts specific to IS intermittent discontinuance. Consistent with the hypotheses (i.e. *H2* and *H5*), the results demonstrated that neutral disconfirmation exerts positive effects on both neutral satisfaction and attitudinal ambivalence. Different from confirmation and disconfirmation of expectations in EDT, neutral disconfirmation represents a state that users' adequate expectations are fulfilled, but desired expectations remain unfulfilled. In this regard, a "zone of indifference" or "zone of tolerance" will occur, and despite the fact that people can tolerate the possible deficiency of an information technology, they will be neither satisfied nor dissatisfied with the system. The results of this study also confirmed the assumption that people will be more likely to develop a mixed evaluation of the information system if their expectations are neutrally disconfirmed. Another observation from the results is that if people perceive conflicting evaluations of an information system, they will try to seek a compromising solution to respond to their conflicting cognitive beliefs, thereby expressing the neutral satisfaction with the focal system, as the mechanism proposed by *H3*. Furthermore, both attitudinal ambivalence and neutral satisfaction exert positive and significant effects on IS intermittent discontinuance, and together explain 44.9 percent of the variance in users' intermittent discontinuance. The support for the *H1* and *H4* suggests that if users' evaluation toward an information system is neutral and ambivalent, system usage behavior will also show the characteristic of intermittence, rather than some very clear usage decisions, such as continuance or discontinuance in the literature. In this study, the revised expectation-disconfirmation model incorporates four novel constructs specific to meet the unique concerns of IS intermittent discontinuance, which has been determined by attitudinal ambivalence and neutral satisfaction, with a large explained variance. As such, the proposed model provides a timely, parsimonious, and valid reference to explain information technology intermittent discontinuance, and, in particular, offers new insights to the field of post-adoptive IT usage behavior and wearable health-tech industry. We will further discuss the implications for both research and practice in the following sections.

Theoretical implications

Theoretical implications of this study can be understood in three ways. First of all, this study examines users' post-adoptive usage behavior of wearable health IS. The growing popularity of smart wearable device has provided a fruitful research context for IS scholar, and, in particular, smart wearables offer unprecedented opportunities for eHealth research. For example, people often use smart band, which is one of the most popular wearables, in health monitoring activities. However, research around this emerging phenomenon is limited and largely relies on our understanding of traditional IS. It is thus important and necessary to understand what is new for wearable healthcare device users' behavior, what really matters to them, and whether existing theories of IS adoption and diffusion can explain this phenomenon well. This study delves into the context, and focuses on a frequently observed phenomenon where people may stop using wearable healthcare device temporarily for a period of time, and reuse/readopt it later. Such intermittent discontinuance behavior will undermine the utility of wearable health devices because people can effectively evaluate their health status and get timely intervention only when their health information is continuously monitored for a long enough period of time. Due to the fact that intermittent discontinuance is a relative common phenomenon for the use of wearable IS, this study makes an initial attempt to grasp this issue, and extends the EDT model by

integrating new perspectives from related fields. In this regard, we believe that this study contributes to our current understanding toward wearable IS in general, and wearable eHealth devices in particular.

Second, this study contributes to our current understanding about the post-adoptive usage behavior. This study breaks out of the dichotomy of continuance and discontinuance, and points out that a series of possible states will be constructed before an individual completely drops an information technology. In this regard, post-adoption usage behavior is viewed as a dynamic process within a changing environment in this study, and this view is believed to be a more realistic assumption toward actual human decision-making behavior. We have clarified some key issues involved in the rarely investigated intermittent discontinuance, such as its definition, dimensions, and measurements, in the current study. As such, this study will add some new knowledge to IS post-adoption behavior research area by shifting permanent discontinuance to intermittent discontinuance. Instead of considering IS post-adoptive behavior as a black-and-white issue, intermittent discontinuance provides new research opportunities for IS scholars, and we strongly call for future research to pay more attention to this new concept.

Third, this study contributes to the IS discontinuance theory by incorporating neutral and conflicting constructs to identify the antecedents of intermittent discontinuance. Intermittent discontinuance implies that users may not permanently abandon an information technology when the performance of the technology is at an acceptable level for the users. As such, positive or negative disconfirmation can only explain why people continue or discontinue using a technology, but fail to explain the intermittent discontinuance usage behavior. In this regard, neutral disconfirmation, neutral satisfaction, and attitudinal ambivalence are considered in the revised expectation-disconfirmation model to better capture the core tenet of intermittent discontinuance. As we discussed above, the three variables reflect the specific conditions that lead to users' intermittent discontinuance behavior. The results also demonstrate that our model accounts for 44.9 percent of the variance in intermittent discontinuance, indicating the explanatory power of the research model. Therefore, this study justifies the incorporation of ambivalent and neutral constructs in understanding users' intermittent behavior, and thus provides a solid theoretical framework that would guide future research to further explore the IS intermittent discontinuance behavior.

Practical implications

Except for the theoretical implications, there are some managerial implications emerged from this study. First of all, as described above, the performance of wearable health devices heavily depends on the continued usage of these devices. Only in this way can wearable health devices be used to keep track of users' health status and efficiently provide health advice. However, intermittent discontinuance is common for the users of wearable health devices, and the underlying reason, as demonstrated in this study, is that users have conflicting or ambivalent evaluation toward the devices when they actually use the systems. This is a serious issue for the device vendors because a service-based, instead of product-based, business model becomes increasingly important. As a result, the focus of wearable health device vendors should shift from simply attracting new customers to establishing business ecosystems around wearable health devices to promote the continuous usage behavior. Specifically, practitioners can launch various activities, for example, telling the device users their rank in the friends group, and provide both extrinsic and intrinsic incentives, such as information, points, rebates, and discounts, to enhance users' stickiness with the business ecosystems. Moreover, wearable health device vendors could rely on accumulating users' health data to provide free and professional health services, and this will help users understand the importance of continued use.

Second, wearable health device vendors should recognize the fact that users are likely to intermittently discontinue using the devices. In this regard, practitioners should not consider the disadopters as someone who will never reuse the devices and thus stop customer relationship management. Instead, they should try their best to win the users back via different manners, such as more targeted and interesting services or a further call-back. Third, this study shows neutral disconfirmation of expectations has positive effects on neutral satisfaction and attitudinal ambivalence, which further affect intermittent discontinuance. In this regard, wearable health device vendors should conduct thorough and serious research on users' perceptions toward the devices, and further identify users' desired and adequate levels of expectations on the use of wearable health devices. This will help the practitioners improve the product performance to meet user's desired expectations. Furthermore, practitioners also can provide the users some other related services, such as social, gaming, and entertainment services, to enhance users' habit of using the wearable health devices, thereby reducing their intention to intermittently discontinue the devices.

Limitations and future research

There are some limitations which should be acknowledged before generalizing the findings of this study. First of all, although the proposed model in this study has accounted for nearly half of the variance in intermittent discontinuance, some other factors and influencing mechanisms may also contribute to the development of intermittent discontinuance. In this regard, future research could incorporate other potential factors such as perceived health conditions (e.g. perceived healthiness and perceived vulnerability or chronic disease), privacy concerns, mixed emotions, and mechanics of vacillation to develop a more comprehensive view of intermittent discontinuance for wearable health IS. Second, this study was conducted in mainland China with an online survey targeting wearable health IS users. As a result, cultural and product bias should be considered before generalizing our findings to other contexts. We thus recommend future research to extend this study in different cultures and with different products, such as social networking services.

Acknowledgement

The work described in this paper was partially supported by the grants from the National Natural Science Foundation of China (Project No. 71671132), Humanities and Social Sciences Foundation of the Ministry of Education, China (Project Nos 16YJC870011, 17YJC630157), the Humanities and Social Science Foundation (Project No. 17G002) and Higher Educational Research Project (Project No. 2014025) of Hubei Provincial Department of Education, and the Research Fund for Academic Team of Young Scholars at Wuhan University (Project No. Whu2016013).

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Appendix. Constructs and items

Neutral disconfirmation (Bhattacherjee, 2001; Kettinger and Lee, 2005)

ND1: My experience with using the wearable health device was worse than what I desired, but better than my minimum expectations.

ND2: The service level provided by the wearable health device did not meet a lot of my desired expectations, but it fulfilled my minimum expectations.

ND3: Overall, most of my desired expectations from using the wearable health device were disconfirmed, but my minimum expectations were confirmed.

Neutral satisfaction (Behling *et al.*, 1968)

NS1: I feel neither satisfied nor dissatisfied with the wearable health device.

NS2: I am in a neutral state of satisfaction with the wearable health device.

NS3: I have a neutral satisfaction level regarding the wearable health device.

Intermittent discontinuance

Controlled use (Ravindran *et al.*, 2014; Shen and Li, 2017)

CU1: I will use the wearable health device not as regularly as I used to.

CU2: I will use the wearable health device less frequently than today.

Breaks in use (Ravindran *et al.*, 2014; Shen and Li, 2017)

BU1: I will take a short break from using the wearable health device, and then re-use it.

BU2: I want to stay away from the wearable health device for a while, and then re-use it.

Suspended use (Ravindran *et al.*, 2014; Shen and Li, 2017)

SU1: I will stop using the wearable health device, but it does not mean that I will completely abandon the use of it.

SU2: I will suspend my use of the wearable health device.

Attitudinal ambivalence (Cornil *et al.*, 2014)

AA1a: Think about your evaluation of the wearable health device. Considering only the favorable aspects of it and ignoring its unfavorable aspects, how favorable is your evaluation of the wearable health device? (1 = not at all favorable, 4 = neutral state, 7 = extremely favorable)

AA1b: Think about your evaluation of the wearable health device. Considering only the unfavorable aspects of it and ignoring its favorable aspects, how unfavorable is your evaluation of the wearable health device? (1 = not at all unfavorable, 4 = neutral state, 7 = extremely unfavorable)

AA2a: Think about your evaluation of the wearable health device. Considering only the positive aspects of it and ignoring its negative aspects, how positive is your evaluation of the wearable health device? (1 = not at all positive, 4 = neutral state, 7 = extremely positive)

AA2b: Think about your evaluation of the wearable health device. Considering only the negative aspects of it and ignoring its positive aspects, how negative is your evaluation of the wearable health device? (1 = not at all negative, 4 = neutral state, 7 = extremely negative)

AA3a: Think about your evaluation of the wearable health device. Considering only the beneficial aspects of it and ignoring its harmful aspects, how beneficial is your evaluation of the wearable health device? (1 = not at all beneficial, 4 = neutral state, 7 = extremely beneficial)

AA3b: Think about your evaluation of the wearable health device. Considering only the harmful aspects of it and ignoring its beneficial aspects, how harmful is your evaluation of the wearable health device? (1 = not at all harmful, 4 = neutral state, 7 = extremely harmful)

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