Intermittent Continuance of Smart Health Devices:
A Zone-of-Tolerance Perspective

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Abstract

Smart health and wearable devices have recently received widespread attention from practitioners and scholars. However, intermittent continuance behavior of users is considered to be one of the most important reasons hindering the development of smart health. To address this issue, the current study employs the zone-of-tolerance theory to explore the mechanisms through which intermittent continuance is evoked. In particular, this study develops two new constructs (i.e., performance superiority and performance adequacy), and proposes that they affect intermittent continuance via satisfaction and neutral satisfaction, respectively. Results demonstrated that the effects of the two new variables on intermittent continuance of smart health devices had been fully mediated. This study concludes with theoretical and practical implications.

1. Introduction

Smart health and wearable devices have received widespread attention due to the rapid development and integration of the Internet of Things, big data, and artificial intelligence [1]. Compared with the traditional healthcare service, smart health is more data-driven and patient-centered. It can continuously collect real-time data and prevent worsening of health conditions [1]. Consequently, smart health devices have gradually become popular in Asia Pacific and worldwide [2]. A recent report from PricewaterhouseCoopers (PwC) [3] showed that 49% of respondents had at least one wearable device, up from 21% in 2014. Particularly, fitness wearable technology was the most popular wearable device. In China, the smart health devices market also exhibited considerable potential due to the continuous development of China's mobile Internet and the increase of an aging population.

Although the industry has made considerable efforts to promote the adoption of smart health devices, the initial adoption failed in translating to users' long-term commitment [3]. PwC's report demonstrated that users would gradually use these smart health devices less often, but "full abandonment was less severe" [3]. In other words, smart health devices users tend to behave in an intermittent continuance pattern, which has been rarely investigated in prior studies. More importantly, intermittent continuance will result in unexpected and occasionally tremendously destructive consequences. This result is due to the considerable dependence of smart health effectiveness on constant, comprehensive, and complete monitoring and recording of personal health data. In this regard, intermittent health data will lead to inaccurate or even wrong health diagnosis.

In addition to industry reports, a few previous studies (e.g., [4][5]) also confirmed the existence of intermittent continuance in the context of smart health. For example, Meyer et al. [4] have found that the usage pattern of most activity tracker users was intermittent. However, intermittent continuance still has not received sufficient and necessary attention from the academic community, and related research is rather limited [13]. In particular, previous empirical research on the post-adoptive usage behaviors of smart health devices mainly focused on continuance or discontinuance intention (e.g., [8][9][10]) and implicitly assumed that post-adoptive usage behavior was static or unchanging. As a result, these studies have failed to consider the dynamic usage process involved in the use of smart health devices. The dynamic usage process indicated that discontinuance usage of a new product or service does not necessarily mean the end of a decision making or product life cycle

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[6]. Instead, users may readopt/reuse the product after the discontinuance decisions. Based on this perspective, the concept of intermittent continuance can effectively describe and characterize the dynamic usage process.

This study employs zone of tolerance (ZOT) theory and develops two new variables (i.e., performance superiority and performance adequacy), to investigate the mechanisms that drive intermittent continuance. Considering that intermittent continuance is a type of post-adoptive usage behavior, this study further builds on satisfaction literature and includes satisfaction and neutral satisfaction in the research model. Based on the ZOT theory, the proposed research hypotheses attempt to explain the role of discrepancies between expectation (both desired and adequate) and actual performance in affecting smart health devices intermittent continuance, and how the effects are mediated by satisfaction and neutral satisfaction, respectively.

The rest of this study is organized as follows. We first review the related literature and develop the research model in Section 2. This is followed by a discussion of the research methodology and the data analysis results in Section 3 and 4, respectively. Section 5 highlights the key findings and further presents the implications and limitations. We summarize this study with a conclusion in Section 6.

2. Literature review and research model

2.1. Post-adoptive usage behavior of smart health devices

Smart health devices refer to any devices related to health or well-being, which often have physical sensors, storage and calculation of health data, and feedback function [2]. Compared with traditional health devices, smart health devices can provide long-term real-time monitoring of fitness, collect actual health data, and realize the "Quantified Self" [1][8]. The popularity of smart health has attracted extensive attention in the IS field. Currently, numerous studies on post-adoptive behaviors of smart health devices mainly focused on continuance and discontinuance behavior and viewed the usage process as unchanging or static [8][9][10][11].

Nonetheless, users may also intermittently continue using the devices because of some device defects, such as discomfort, short battery life, and poor seamless connection of devices [3]. Recent studies have showed the importance of intermittent continuance phenomenon in the smart health context. For example, researchers indicated that most of the users followed an intermittent continuance pattern in the long-term usage of activity tracker [4], and users were accustomed to taking short breaks when using health wearables [5]. Moreover, in terms of smart health devices with specific functions, such as mobile self-management system for people with diabetes, users were prone to gradually decrease their usage frequency, instead of completely continuance or discontinuance usage [7].

Generally speaking, current studies realized such an important phenomenon, but failed to achieve theoretical discussion and empirical analysis of smart health device intermittent continuance. In this sense, a thorough illustration of actual usage process and the underlying forming mechanisms of intermittent continuance in the smart health context is lacking. Therefore, this study aims to empirically explore the mechanisms and identify the factors predicting intermittent continuance.

2.2. Intermittent continuance

Intermittent continuance refers to a dynamic usage process in which information systems are used off and on. Intermittent continuance also can be considered as a usage state falling somewhere in between continuance and discontinuance [12], and it reflects a periodic cycle of "stop-readopt" process [13]. We can take the smart sphygmomanometer for example. The patients might wear smart sphygmomanometer during blood pressure fluctuations. However, when their blood pressure returned to normal, thy might stop or sometimes forget the smart sphygmomanometer until blood pressure disorders occur again. It is an interesting phenomenon, because compared to continuance and discontinuance, intermittent continuance is related to the irregular and dynamic usage process, which is very close to the actual post-adoptive usage behavior in some cases. Based on Ravindran et al. [12], we identify the following three dimensions of intermittent continuance in this study: 1) breaks in use, referring to rest breaks of users between two phases of usage; 2) controlled use, indicating downward moderation of usage behavior; 3) suspended use, reflecting the stop of IT use until the users feel ready to use it again.

In previous studies on post-adoptive usage behavior, satisfaction was regarded as an essential antecedent for continuance to occur. In line with previous research, we adopted satisfaction as a core variable predicting post-adoptive usage behavior, and further divided it into two variables, namely, satisfaction and neutral satisfaction. In particular, satisfaction is defined as an affect with a positive valence obtained from the evaluation of the device, while neutral satisfaction is defined as an affect with a neutral valence (that is, neither favorable nor unfavorable) from the assessment [13]. In this regard, users with satisfaction might express their feelings using positive words, such as "Good" or "I like it", while those with neutral satisfaction might say "Not bad" or "Sort of" to express some fairly neutral feelings.

The proposed research model is shown in Figure 1. Satisfaction reflects positive post-adoptive judgments concerning the usage of a focal system. Specifically, users might be inclined to continue the use of smart health devices due to the effect of satisfaction. Prior studies on smart health behavior also demonstrated that user satisfaction was a critical determinant of user continuance [9]. Satisfied users will be more likely to favor active or positive usage than those who were unsatisfied [15]. In the current investigation context, considering that intermittent continuance is placed at the middle ground between continuance and discontinuance, users thus will be more inclined to continue to use and stay away from this middle ground when they are very satisfied. Therefore, we have the following hypothesis.

H1: Satisfaction with smart health devices is negatively associated with intermittent continuance.

Neutral satisfaction represents post-adoptive system usage assessment with a neutral valence. Compared with satisfaction and dissatisfaction, neutral satisfaction is more related to the neutral feelings [16]. In particular, when individuals experience neutral satisfaction, it is not possible for them to behave with an extremely positive or negative inclination. In other words, they will not be likely to completely continue or discontinue the use of smart health device. The neutrally satisfied users tend to behave in a neutral state [17] between continuance and discontinuance, showing a state of intermittent usage. Therefore, we propose the following:

H2: Neutral satisfaction with smart health devices is positively associated with intermittent continuance.
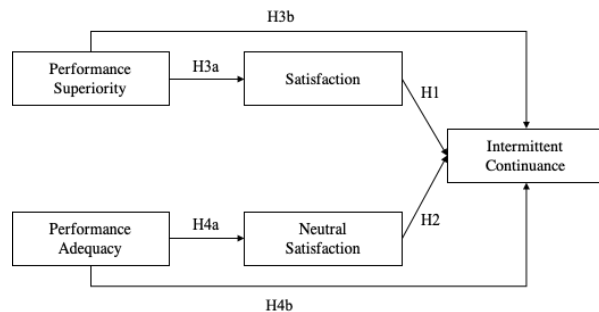

Figure 1. Research model

2.3. Zones of tolerance

As shown in Figure 2, a zone of tolerance (ZOT) can be considered as the zone between adequate expectation and desired expectation [18]. The concept of ZOT is originally derived from service quality research and it overcomes the ambiguity of the concept of expectation. ZOT also has been widely used in the IS field to evaluate information systems service quality [19] and website quality [20]. Specifically, the ZOT argues that users adopt "dual expectation standards" [18], including both desired expectation (the ideal performance level that users expect) and adequate expectation (the minimum performance level that users expect), to measure their expectations of the quality of a product or service. Due to the two levels of expectations standards, a two-gap measure (i.e., the discrepancies between perceived performance and the desired/adequate expectations) can be further developed [18]. In particular, the perceived performance will be in the superior zone if it exceeds the desired expectation, and the perceived performance will fall into the inadequate zone if it is lower than the adequate expectation. The former reflects the state of user satisfaction, while the latter reflects the state of user dissatisfaction. When perceived performance is better than the adequate level but worse than the desired level, the performance level will be within the ZOT (as shown in Figure 2). In this study, we would like to employ the ZOT theory to expand the satisfaction-dissatisfaction dichotomy, and propose that the ZOT implies a kind of neutral judgment of, and neutral satisfaction with, the performance of a focal system/service because user expectation is partially satisfied (adequate expectation) and partially unsatisfied (desired expectation).
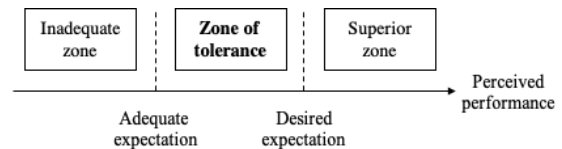
- Performance superiority=Perceived performance - Desired expectation
- Performance adequacy=Perceived performance - Adequate expectation

Figure 2. The zone of tolerance

Perceived performance is often regarded as the performance level that a user believes he/she actually receives. Following previous studies [18][19], desired expectation is defined as the performance level of a system or service that users expect to receive, while adequate expectation refers to the minimum level of performance of a system or service, and performance below this level will cause negative impacts (e.g., dissatisfaction and discontinuance). Based on the ZOT theory, this study conceptualizes two-gap measures of perceived quality as performance superiority and performance adequacy. In particular, performance superiority refers to the degree to which the perceived performance exceeds user desired expectation, while performance adequacy refers to the degree to which the perceived performance exceeds adequate expectation. Performance superiority and performance adequacy are further calculated based on the formula below Figure 2.

As this study focuses on smart health devices, we can take fitness tracker as an example. The minimum

level of expectation for a fitness tracker is that some basic functions should work properly (for example, as a step counter), but a desired level of expectation would be including more smart and automated functions, for example, monitoring user's real-time health status and throwing the popup prompts when necessary (e.g., sedentary reminder). In this regard, if the perceived performance of the fitness tracker can overtop the desired expectation, the performance of the tracker will be in the superior zone, and it will be perceived as performance superiority. However, if the perceived performance of the fitness tracker can just meet some of the minimum expectations, but fail to reach the high-level expectations, the performance of the tracker will be in the zone of tolerance, and it will be perceived as performance adequacy. It is also necessary to note that, the differences between performance superiority and adequacy do not simply lie in the differences in device functions, but in the differences in user expectations. Even for the same device, the perceived performance can be in inadequate zone, zone of tolerance, or superior zone for different users.

It is relatively easy to understand that performance superiority will lead to a high level of user satisfaction because the performance of devices fully satisfies and even goes far beyond user expectations. In the case of smart health device, if its performance reaches the level of users expectations about how an "ideal" smart health device should perform, users will be more likely to be satisfied with the smart health device. Prior studies also demonstrated that when perceived performance exceeds the desired level, users will have a sense of satisfaction [21]. Based on the discussion above, we thus propose the following hypothesis.

H3a: Performance superiority of smart health devices is positively associated with users satisfaction.

Different from performance superiority taking into account desired expectations, performance adequacy is comparing perceived performance and users adequate expectations. In this regard, a low level of performance adequacy indicates that perceived performance is close to adequate expectation, that is the performance of smart health devices just reaches the acceptable baseline. In other words, some of the minimum expectations are satisfied, but some of the extra user expectations are not met. As a result, users can tolerate the performance of smart health devices to a certain extent, but they will not develop any remarkable emotion tendency because they are in a state of neither being completely satisfied nor being completely dissatisfied [21], which would lead to neutral satisfaction [13]. On the other side, an extremely high level of performance adequacy implies that the perceived performance is quite good, even beyond users desired expectations. In this case, users tend to be more

satisfied [22], and thus less likely to feel neutrally-satisfied. We thus propose the following hypothesis.

H4a: Performance adequacy of smart health devices is negatively associated with users neutral satisfaction.

Prior studies have also demonstrated that system or service quality is an important determinant of customer behaviors [23]. In particular, system or service quality reflects user's cognitive evaluation of a focal system or service. Based on the framework of cognition-affect-behavior (intent) [25], this study further suggests that the influence of performance superiority and adequacy on smart health devices intermittent continuance may be mediated by users' affective states such as satisfaction and neutral satisfaction [26]. This argument is partially in line with previous studies which found an indirect effect of service performance quality on user behavioral intention through the mediation of user satisfaction [24] [27]. Therefore, we derive the following two hypotheses.

H3b: Satisfaction with smart health devices mediates the effect of performance superiority on intermittent continuance.

H4b: Neutral satisfaction with smart health devices mediates the effect of performance adequacy on intermittent continuance.

Table 1. Demographic profile of respondents

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

3. Data collection and measurement

3.1. Data collection

We conducted an online survey targeting the users of smart health devices in China. At the beginning of the survey, we asked the participants whether they had real experience with smart health devices. By using the screening question, we ensure that all the respondents had practical experience with smart health devices. At last, 428 valid responses were collected. In this study, approximately half (49.30%) of the respondents are male. Most of the respondents are between 26–40 years old (67.06%) and attained a bachelor degree (74.53%). Most respondents have used smart health devices for more than 6 months (71.73%). Table 1 shows the demographic profile of respondents.

We further divided the data into four quartiles according to the response order and then compared the demographic data of the first with the last quartile to assess the non-response bias. No significant differences in demographic characteristics including gender, age, education, usage experience, and monthly income were found, indicating the absence of non-response bias.

Common method bias might be another potential threat in this study because all the data were collected from a single source at the same time. To address this, we performed Harman's single-factor test using the exploratory factor analysis. We found that no single factor explained most of the variance, and the highest factor explained 37.59% of the variance, demonstrating that common method bias was unlikely to be a severe concern in this study.

Table 2. Reliability and validity of reflective constructs

Construct	AVE	CR	PS	PA	SAT	NSA	BU	CU	SUS
PS	0.790	0.883	**0.889**	*0.805*	*0.375*	*-0.179*	*-0.121*	*-0.283*	*-0.162*
PA	0.725	0.840	0.539	**0.851**	*0.326*	*-0.306*	*-0.111*	*-0.281*	*-0.196*
SAT	0.790	0.918	0.300	0.249	**0.889**	*-0.411*	*-0.393*	*-0.578*	*-0.537*
NSA	0.858	0.948	-0.148	-0.242	-0.368	**0.926**	*0.448*	*0.554*	*0.505*
BU	0.899	0.947	-0.098	-0.083	-0.346	0.405	**0.948**	*0.550*	*0.619*
CU	0.877	0.934	-0.225	-0.216	-0.500	0.492	0.481	**0.936**	*0.762*
SUS	0.848	0.918	-0.124	-0.137	-0.456	0.439	0.530	0.644	**0.921**

Note: 1. PS: Performance Superiority; PA: Performance Adequacy; SAT: Satisfaction; NSA: Neutral Satisfaction; BU: Breaks In Use; CU: Controlled Use; SUS: Suspended Use. 2. AVE (average variance extracted) and CR (composite reliability) values are presented in the first two columns. 3. The square root of AVE is presented along the diagonal in bold. 4. The HTMT criteria are given in italics at the upper right. 5. Other numbers represent the construct correlations.

Table 3. Reliability and validity of formative constructs

Formative construct	Subconstructs	Weights	t-values	VIF values
Intermittent continuance	Breaks in use	0.246	3.372	1.458
	Controlled use	0.614	7.640	1.880
	Suspended use	0.310	3.380	1.762

3.2. Measurement

Each variable was measured with multiple items derived from the existing literature and slightly adapted to fit the context of smart health devices. We invited actual users of smart health devices and two scholar in the field of IS to read the initial items and check the face validity. Overall, most of items were deemed to have clear and concise expression. The wordings and logical consistencies of some items were also suggested to be modified. Based on the suggestions, we developed the final questionnaire used for online survey.

Specifically, satisfaction was measured by using the three items developed from Bhattacherjee [14]. Neutral satisfaction were measured with three items adapted from Behling et al. [28]. The three sub-constructs and the associated items of intermittent continuance were adapted from Ravindran et al. [12] and Shen et al. [13]. Furthermore, performance superiority and performance adequacy were evaluated following the two formulas suggested by Gorla et al. [18] (as shown in Figure 2). Perceived performance, desired expectation and adequate expectation were measured with items adapted from Jackson et al. [29] by using a nine-point Likert scale, ranging from "very low" to "very high." Items for

other constructs were measured by a seven-point Likert scale, from strongly disagree–strongly agree. Due to the page limit, the detailed measurement items have not been attached in this conference paper, but they are available by request.

4. Results analysis

4.1. Measurement model

Due to a second-order construct (i.e., intermittent continuance) was incorporated in the research model, this study adopted the Partial Least Squares-based Structural Equation Modeling (PLS-SEM) approach for data analysis [37].

Construct reliability and convergent validity for reflective constructs were established by examining composite reliability (CR) and average variance extracted (AVE). Discriminant validity was examined by comparing the square roots of the AVE with the correlations among the constructs [32]. We also tested the heterotrait–monotrait (HTMT) ratio of correlations, which is considered as a new criterion to assess discriminant validity [33]. As shown in Table 2, composite reliability (CR) values are all above 0.7, indicating good construct reliability [31]. Convergent validity is confirmed with AVE of the latent constructs, ranging from 0.725 to 0.899. Finally, the correlation values for each construct are lower than the square root of AVE, and the HTMT ratio values are lower than 0.85, demonstrating satisfactory discriminant validity.

We also examined the significance of item weights and variance inflation factor (VIF) values to assess construct reliability and validity of formative constructs [30]. When item weights are statistically significant and VIF values are lower than the recommended value of 3.00, the construct reliability and validity are considered to be adequate. Table 3 shows the results, and all criteria are satisfied.
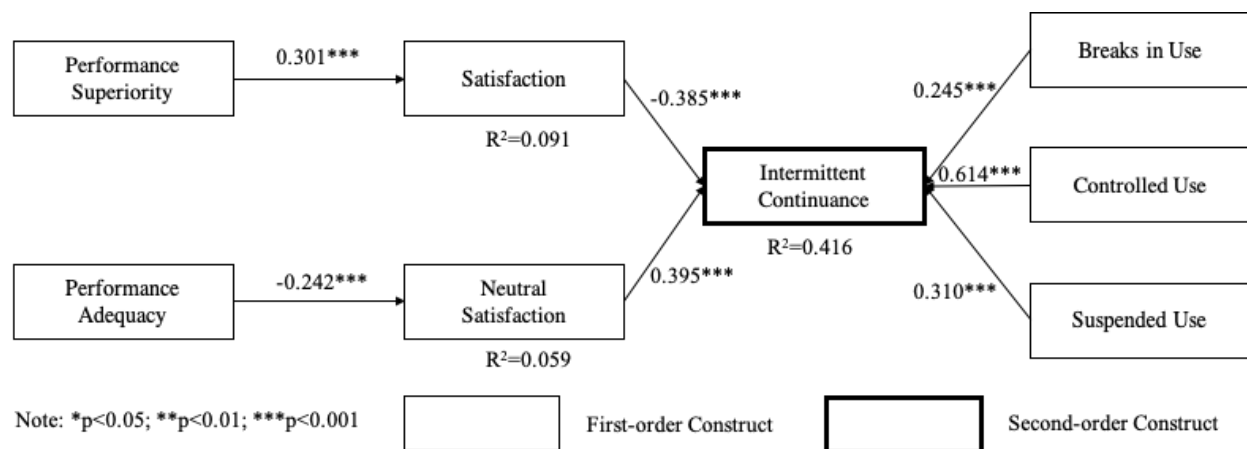

Figure 3. Structural model

Table 4. Mediating effect of satisfaction and neutral satisfaction

Independent variables	Mediating variables	Dependent variables	IV->DV	IV->MV	IV+MV->DV		Result
					IV->DV	MV->DV	
Performance superiority	Satisfaction	Intermittent continuance	-0.154*	0.303***	-0.037 [n.s.]	-0.377***	Full mediation
Performance adequacy	Neutral satisfaction	Intermittent continuance	-0.135*	-0.243***	0.013 [n.s.]	0.396***	Full mediation

Note: *p<0.05; **p<0.01; ***p<0.001; [n.s.] not significant.

4.2. Structural model

The results of the structural model are summarized in Figure 3. Overall, all the hypothesized relationships are supported. In particular, satisfaction is negatively related to intermittent continuance (β=-0.385, t=7.411), while neutral satisfaction is positively associated with intermittent continuance (β=0.395, t=8.521), supporting H1 and H2. The results also indicate that performance superiority has a positive impact on satisfaction

(β=0.301, t=5.365), and performance adequacy shows a negative effect on neutral satisfaction (β=-0.242, t=5.023), therefore supporting H3a and H4a. The research model explains a total of 41.6% of the variance in intermittent continuance, demonstrating a strong explanatory power of the model.

4.3. Mediation effect

A mediation test was conducted following the steps suggested by Baron & Kenny [34]. The direct impacts of performance superiority and performance adequacy on intermittent continuance were first examined to ensure there are effects that can be mediated. We then evaluated the effects of performance superiority and adequacy on satisfaction and neutral satisfaction, respectively. All the variables are included in the final model to examine if the direct effects of performance superiority/adequacy on intermittent continuance can be mediated by satisfaction and neutral satisfaction, respectively. Table 4 shows the results of each step for the mediating analysis. Based on the results, it thus can be concluded that satisfaction fully mediates the impact of performance superiority on intermittent continuance (supporting H3b), while neutral satisfaction fully mediates the impact of performance adequacy on intermittent continuance (supporting H4b).

5. Discussion

5.1. Discussion of key findings

This study presents an initial attempt to explore the underlying mechanisms of intermittent continuance in the context of smart health by employing the ZOT theory and developing the satisfaction literature. In particular, this study empirically examined the impacts of performance superiority and performance adequacy on satisfaction and neutral satisfaction, and further tested the effects of satisfaction and neutral satisfaction on the intermittent continuance of smart health devices. Two fully mediating effects were also found to clearly establish the involved mechanisms. A brief discussion of the key findings is presented below.

First, this study revealed the different roles of satisfaction and neutral satisfaction in predicting intermittent continuance of smart health devices. In particular, satisfaction negatively (β=-0.385, t=7.411) but neutral satisfaction positively (β=0.395, t=8.521) affected intermittent continuance. The two variables together explained 41.6% of the variance in intermittent continuance. In this regard, when smart health devices users are more neutrally-satisfied or less satisfied, they will be more likely to engage in intermittent continuance. The results also showed that intermittent continuance and continuance differ from each other in the key antecedents [14].

Second, the results demonstrated that performance superiority exerted a positive impact on satisfaction (β=0.301, t=5.365), whereas performance adequacy exerted a negative impact on neutral satisfaction (β=-0.242, t=5.023). The results confirmed the existing findings that performance superiority is an important predictor of customer satisfaction [18]. This study also further extended previous studies by demonstrating the relationship between performance adequacy and neutral satisfaction.

Third, the results offered empirical support for the mediating effects of satisfaction and neutral satisfaction. Specifically, two fully mediating paths have been identified in this study. As suggested by the reviewer, we further performed a mediation test following Zhao et al. [38] to check the robustness of mediating effects. As shown in Table 5, both paths are fully mediated, thus indicating the robustness of the results. In this regard, this study provides a comprehensive picture of the underlying mechanisms through which performance superiority and performance adequacy would influence users' intermittent continuance in the context of smart health.

Table 5. Robustness examination of mediating effect

Paths	Indirect effect			Direct effect			Results
	Size	LLCI	ULCI	Size	LLCI	ULCI	
PS→SAT→IC	-0.097	-0.152	-0.057	-0.009	-0.078	0.059	Full mediation
PA→NSA→IC	-0.085	-0.131	-0.046	0.010	-0.061	0.080	Full mediation

Note: PS: Performance Superiority; PA: Performance Adequacy; SAT: Satisfaction; NSA: Neutral Satisfaction; IC: Intermittent Continuance.

5.2. Theoretical implications

The theoretical implications of this study include the following three aspects. First, this study highlights the importance of intermittent continuance in smart health research. Prior studies on smart health devices/services usage behavior mainly focused on either continuance or discontinuance. However, the usage behavior may be

dynamic and changes with both internal and external environments. Actually, this phenomenon is particularly common for the use of smart health devices [3], and the concept of intermittent continuance could well reflect such kinds of behavioral pattern. This study is one of the first studies that empirically examined intermittent continuance of smart health devices and have addressed the critical issues related to intermittent continuance, including its definition, dimensions, and triggering mechanisms. In this regard, this study has the potential to provide a promising research direction for future smart health behavior research.

Second, this study also enriches current IS research on post-adoptive usage behavior by conceptually and empirically distinguishing the concept of intermittent continuance from continuance and discontinuance. In particular, satisfaction and dissatisfaction are commonly regarded as the key determinants of post-adoptive IS usage behavior [14][35][36]. However, it is interesting to find that satisfaction is negatively associated with intermittent continuance. This indicates that the forming mechanisms of users intermittent continuance and continuance are completely different. The result arises because intermittent continuance implies that users are neither completely satisfied nor completely dissatisfied. To address this issue, the present study employs the concept of "neutral satisfaction", which is between satisfaction and dissatisfaction, and the results shows a significant and positive relationship between neutral satisfaction and intermittent continuance. In this regard, this study introduces a new evaluation criteria of user satisfaction, and further confirms the importance of neutral satisfaction in evoking intermittent continuance. We believe future studies could rethink post-adoptive IS research and further identify the unique antecedents of intermittent continuance.

Third, this study employs the ZOT theory to explain the mechanisms through which intermittent continuance is established. Instead of simply applying the ZOT theory, this study builds two new variables, namely, performance superiority and adequacy. Notably, the two variables enrich the current understanding of IS performance by considering both desired and adequate performance levels. In this regard, we can distinguish the extent to which different levels of user expectations are met, thus providing an improved understanding of IS performance. The results show that the effects of performance superiority and adequacy on intermittent continuance are fully mediated by satisfaction and neutral satisfaction, respectively. This finding not only underscores the important roles of the two new variables, but also clearly identifies their influencing mechanisms. Therefore, future research can further explore smart health usage behavior based on the newly-developed variables and newly-discovered mechanisms.

5.3. Practical implications

Except for the theoretical implications, this study also has some implications for practice. First of all, this study emphasizes that users intermittent continuance behaviors may bring harm to smart health industry and companies. The sound development of the industry relies on large-scale active users and the continuous collection of personal health data [8]. In this regard, intermittent continuance behavior reflects relatively low user activity, and at the same time, it causes problems of data acquisition discontinuity. Therefore, smart health companies should pay special attention to intermittent continuance, which is often neglected in previous practice. Specifically, this study identified the three dimensions of intermittent continuance, namely, breaks in use, controlled use, and suspended use, with each representing a different level of intermittent continuance. They can be further used by the companies as the data monitoring indicators of smart health devices usage behavior. When suspended use is monitored, this may be the last chance for the companies to retain the users before their users completely abandon the products. Companies also can classify the users based on the three dimensions, and make countermeasures according to the category to which the users might belong.

In addition, this study also provides some useful guidelines for the companies to avoid users intermittent continuance. Generally speaking, it is very important for the practitioners to notice that it is not enough to just satisfy users' adequate expectations, because a low level of performance adequacy will be most likely to lead to a high level of user intermittent continuance. The most important thing for the companies is to try their best to surpass users' desired expectations, or at least they should greatly exceed the adequate expectations. There are different ways for the companies to understand user expectations and improve user experience. For example, companies could make regular return calls, build user community, quickly respond to feedback messages, etc.

5.4. Limitations and future research

Although this study has several important theoretical and practical implications, it also suffers from some limitations. First, this study focused on the context of smart health devices and was conducted in Mainland China. Given the specific context investigated in this study, the generalization of the findings should be made with caution. Considering that intermittent continuance behavior is a common phenomenon in some other contexts (e.g., Facebook) and cultures [12], exploring intermittent continuance under different contexts and in

different cultures is highly recommended in future research.

Second, survey method with a self-response scale was used in this study for data collection. However, it is important to note that purely qualitative or quantitative methods are believed to be insufficient to yield a comprehensive understanding of the complex phenomenon of IS usage behavior. In this regard, future research is recommended to utilize mixed methods designs to gain complementary views on the underlying reasons behind intermittent continuance.

Third, this study measures intermittent continuance by asking future intentions of respondents. Prior studies have reported a possible gap between usage intention and actual behavior. Hence, the extent to which the measured intention can determine actual intermittent continuance behavior of users remains a concern. Future research may consider employing longitudinal designs to effectively establish causality.

6. Conclusion

Smart health devices, such as smartwatches or fitness bands, have been widely used in Asia Pacific and worldwide. However, intermittent continuance of smart health devices represents a common problem that may damage the successful development of the smart health industry. Unfortunately, this important and challenging issue lacks sufficient academic attention. This study is an attempt to address this issue and call for further attention to this neglected but important research area.

Based on the ZOT theory, the present study proposes two new constructs, namely, performance superiority and adequacy, and empirically examines their effects on intermittent continuance via satisfaction and neutral satisfaction, respectively. The results reveals some interesting findings: (1) performance superiority exerts a positive impact on satisfaction, whereas performance adequacy exerts a negative effect on neutral satisfaction; (2) satisfaction is negatively associated with intermittent continuance, whereas neutral satisfaction is positively related to intermittent continuance; (3) satisfaction and neutral satisfaction fully mediate the impacts of performance superiority and performance adequacy on intermittent continuance, respectively.

This study contributes to the existing literature on smart health and IS continuance by proposing the concept of intermittent continuance and further offering a preliminary empirical explanation for this emerging phenomenon. As a fruitful but challenging question in smart health and IS continuance research, intermittent continuance clearly deserves more detailed scholarly attention in future studies.

7. References

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