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Unravelling the Relationship between Response time and User Experience in Mobile Applications

Abstract

Purpose – This study examines the impact of response time on user experience for mobile applications and considers the moderating influence of gender and network environment on this relationship.

Design/methodology/approach – An experiment was conducted with 50 young adults to evaluate their user experience of a mobile application that simulates variations in network environment and response time. User experience was evaluated based on the three constituent dimensions of tolerance, acceptance, and satisfaction.

Findings – Analytical results demonstrate that response time not only adversely affects user experience of mobile applications, but that this effect is not homogeneous across the three dimensions of tolerance, acceptance, and satisfaction. The findings also illustrate that gender moderates the effect of response time on user experience, however, the negative influence is more salient for males than females, which is opposite to our hypothesis. The joint moderating influence of gender and network environment turned out to be partly significant.

Practical implications – By illuminating users' tolerance, acceptance, and satisfaction with varied response times, findings from this study can inform the design of mobile applications such that desired levels of user experience can be assured with minimum resources.

Originality/value – Although response time has been hailed as a key determinant of user experience for desktop applications, there is a paucity of studies that have investigated the impact of response time on user experience for mobile applications. Furthermore, prior research on response time neglects the multi-dimensional nature of user experience. This study bridges the abovementioned knowledge gaps by delineating user experience into its constituent dimensions and clarifying the effects of response time on each of these dimensions.

Keywords: Mobile application, response time, user experience, zone-of-tolerance, gender, network, expectation disconfirmation theory

Article classification: Research paper

1. INTRODUCTION

The growing prevalence of mobile applications has had a profound influence on the daily lives of their users (Hoehle and Venkatesh, 2015; Xu *et al*., 2015). Embodying affordances of accessibility, interactivity, and portability, mobile applications have become pervasive across numerous contexts in the likes of commerce, education, entertainment, social networking, and transportation (Chang, 2015; Hoehle and Venkatesh, 2015; Hoehle *et al*., 2015; Huda *et al*., 2017; Siuhi and Mwakalonge, 2016). Yet, despite their merits, it is not uncommon for users to encounter protracted response times when interacting with these applications (Dabrowski and Munson, 2011; Laukkanen and Mantyla, 2015). From the late 1960s up to the present, ensuring adequate response time continues to be an elusive challenge during systems development (Kohrs *et al*., 2016). Extrapolated to the context of mobile applications, response time can be conceived as the delay between a user's input of a command into a mobile application and the subsequent display of the mobile application's response to this input on screen (Kohrs *et al*., 2016; Miller, 1968; Riedl and Fischer, 2018). Due to technological advances, mobile applications have become increasingly complex, which in turn adds to the difficulty of ensuring adequate response times. Indeed, the growing sophistication of mobile applications, as a consequence of backend multi-tiered infrastructure, functional incompatibility, and massive data storage requirements, has slowed down the response time of these applications considerably (Ferreira *et al*., 2014; Haller, 2013; Oulasvirta *et al*., 2012; Yan *et al*., 2012). To this end, this study attempts to uncover the effects of mobile applications' response time on user experience in order to aid mobile application developers in determining an adequate response time for attaining a targeted level of user experience.

Scholars have discovered that response time has an adverse impact on user experience because lengthy response times are likely to reduce users' satisfaction (Egger *et al.*, 2012a; Ryan and Valverde, 2003). When mobile applications kept users waiting for an unreasonably long period of time, users are more inclined to forsake the application and switch to faster alternatives (Hoxmeier and DiCesare, 2000; Nah, 2004). But at the same time, it is impractical for mobile application developers to concentrate solely on minimizing the response time of their applications without taking into account the amount of investment required for such efforts (Nah, 2004). Disentangling the effects of response time on user experience is hence imperative in guiding developers' pursuit of appropriate response times for their mobile applications such that they neither sacrifice user experience nor violate cost considerations. Although a handful of studies have examined the impact of response time on user experience within the broader domain of Human-Computer Interaction (HCI) (Egger *et al.*, 2012a; Kohrs *et al.*, 2016; Riedl and Fischer 2018; Ryan and Valverde, 2005; Thomaschke and Haering, 2014), we contend that this relationship still deserves scrutiny in the context of mobile applications due to the latter's unique characteristics.

Compared to their desktop counterparts, mobile applications deliver a variety of services without being constrained by spatial or temporal boundaries (Zhang and Adipat, 2005). Through granting convenient access to both entertainment and professional services, mobile applications can easily induce immersion among users by fulfilling their most pressing needs. In turn, such immersion can erode users' patience regarding response time, especially when alternative mobile applications, which offer comparable services, are abundant (de Assunção *et al.*, 2016; Sung and Mayer, 2012; Von Reischach *et al.*, 2009).

Besides, users' reactions to response times may differ between desktop and mobile devices, thereby necessitating identification of the effects of response time in the context of mobile applications.

Aligned with Expectation Disconfirmation Theory (EDT), user experience of mobile applications can be delineated into multiple zones of tolerance depending on the extent to which these applications confirm or disconfirm users' expectations of service performance (Johnston, 1995; Walker and Baker, 2000). Within extant literature, tolerance, acceptance, and satisfaction have been touted as three distinct zones of evaluation that correspond to varying levels of expectations harbored by users with respect to response time (Gwynne *et al*., 2000; Johnston, 1995; Stodnick and Marley, 2013). Accordingly, we advance *tolerance*, *acceptance*, and *satisfaction* as three separate dimensions that mirror users' distinct feelings upon experiencing the response time of a given mobile application. Even though tolerance, acceptance, and satisfaction have been employed extensively in past studies to investigate user experience, the majority of these studies have mostly conceptualized user experience as a unidimensional construct represented by one of the three dimension (Bielen and Demoulin, 2007; Lin and Lu, 2000; Nah, 2004; Otto *et al*., 2000). As asserted by Stodnick and Marley (2013), the multi-dimensionality of user experience has been ignored due to confounding and unclear conceptions of user experience. Consequently, conceptualizing user experience as a singular dimension is insufficient for capturing the richness it embodies (Walker and Baker, 2000). To better comprehend how response time affects the multi-faceted aspects of user experience, we distinguish tolerance, acceptance, and satisfaction as three dimensions that independently reflect users' differing levels of expectation regarding response time.

Intuitively, delay in response time within mobile applications is analogous to a form of service failure in that it corresponds to a mismatch between users' expectation and their actual experience of service performance (Fan and Suh, 2014; Johnston, 1995). As a form of service failure, lengthy response time in mobile applications can trigger attribution among users in that they will want to ascertain the underlying reasons for the service failure (Huang, 2008; Tan *et al*., 2016). In the context of mobile applications, gender and network are two important factors that impact users' evaluation of response time. Gender has been demonstrated to be a salient driver of users' perceptions because it dictates the attribution mechanism triggered by protracted response times (Hancock and Rausch, 2010; Beyer, 1998; Fatemi and Asghari, 2012). Selecting gender as a moderator therefore aligns with scholarly calls for inquiries into the impact of gender discrepancies on user perceptions for a given response time (Hancock and Rausch, 2010; Wittmann and Szelag, 2003). Similarly, network environment has been identified as the other primary consideration belonging to users of mobile applications when confronted with unexpected delays (Poncela *et al*., 2014; Kassar *et al*., 2008; Zhao *et al*., 2016). Because response time is vulnerable to network condition, studies have demonstrated that users are inclined to check the connectivity of the network environment whenever response times of mobile applications are longer than expected (Balasubramanian *et al*., 2009; Cabral, 2011; Chen *et al*., 2012). Arguably, network environment plays an instrumental role in shaping users' attribution processes by diverting blame for prolonged response times to the network. This study thus considers the dual moderating influence of gender and network environment (i.e., 3G, 4G, and Wi-Fi) in order to offer a comprehensive picture of the effects of response time on user experience.

This study contributes to extant literature by formulating and validating hypothesized relationships between response time and user experience in the context of mobile applications. Furthermore, in accordance with attribution theory, we consider gender and network environment as contingencies mitigating this relationship. That is, disparities in gender and network environment can significantly impact the attribution process. Findings from this study also bear implications for practitioners, especially mobile application developers, by offering a nuanced understanding of the impact of response time on focal aspects of user experience, as captured through notions of tolerance, acceptance, and satisfaction.

The remainder of this paper is organized as follows. In the next section, we review extant literature on response time in desktop systems and related user experience evaluations to formulate a series of hypotheses to be tested. Next, we elaborate on our methodology by describing the design of an exploratory experiment for isolating elements pertinent to our study, the mobile application program developed for testing, measurement items for the three constituent dimensions of user experience, sampling procedures, and the data collection process. Data analysis and analytical results are documented in Section 4. Finally, in Section 5, we discuss the implications of our findings for theory and practice, highlight potential limitations, and outline directions for future research.

2. THEORETICAL FOUNDATION AND HYPOTHESES FORMULATION

2.1 Response Time in Mobile Applications

Response time in mobile applications denotes the delay between a user's input of a command into a mobile application and the subsequent display of the mobile application's response to this input on screen (Kohrs *et al*., 2016; Riedl and Fischer, 2018). Although companies have strived to decrease response time by investing in advanced services systems, database optimization, and network technologies, such measures have been shown to be ineffective in solving the response time problem in mobile applications (Rose *et al*., 2005). However, it is important to note here that delayed response times can be unavoidable. One reason for this is that a mobile phone's operating system (e.g., iOS, Android) requires regular updates that grow in complexity. Such updates require corresponding updates of mobile applications to ensure compatibility with the new system, reduce matched bugs, and avoid an increase in response time (Ferreira *et al*., 2014; Oulasvirta *et al*., 2012). Another reason for delayed response times is slowed servers due to backend multi-tiered infrastructure (Haller, 2013). For example, e-commerce mobile applications tend to slow during particular shopping events (e.g., holidays, special promotions, natural disasters) due to large volumes of customer requests that can overload servers, thereby delaying response times. Similarly, mobile applications can be packed with excessive data accumulated by usage (Yan *et al*., 2012). Currently, most applications save cache (e.g., image, files, and videos) to optimize user experience. However, saving cache can expand in-app storage with superfluous data, which results in increased response times. While applications are designed to take seconds to fetch new content when launching, some gaming applications can take more than 20 seconds to launch when overcrowded with data (Yan *et al*., 2012). Taken together, these issues indicate that response time continues to be an enduring concern for mobile application developers (Rose *et al*., 2005). It is thus the goal of this study to investigate the effect of response time on user experience in an effort to provide pragmatic solutions for determining optimal waiting time.

2.2 EDT and Mobile Applications' User Experience

EDT is a widely used theoretical lens in information systems (Bhattacherjee and

Premkumar, 2004; Fan and Suh, 2014; Tan *et al*., 2016), marketing (Kopalle and Lehmann, 2001; Yi, 1990), organizational behaviors (Hom *et al*., 1999; Klein, 1999), and psychology (Phillips and Baumgartner, 2002) that explains the formation of user experience through the comparison of expectation and performance in services and products (Oliver, 1977, 1980 and 1981). Before experiencing a service or product, a user has an expectation that reflects their pre-experience belief about the service or product (Olson and Dover, 1979; Lankton and McKnight, 2012). After experiencing this service or product, a post-experience belief is generated based on the user's expectation, which is denoted as performance in EDT (Bhattacherjee and Premkumar, 2004; Lankton *et al*., 2014; Olson and Dover, 1979). When comparing expectation and performance, the consumer feels a sense of disconfirmation, which manifests in three ways: (1) performance is better than expectation (i.e., positive disconfirmation); (2) performance is the same as expectation (i.e., confirmation); and (3) performance is worse than expectation (i.e., negative disconfirmation) (Lankton and McKnight, 2012; Lankton *et al*., 2014). A user's sense of disconfirmation thereby determines user experience, which refers to the overall feeling that emerges from the process of interacting with and experiencing a service, system, or product (Hassenzahl and Tractinsky, 2006).

Mobile applications provide users with services to fulfill their requirements such as sharing pictures, searching information, and making payment. Based on EDT, user experience is determined by the disconfirmation between expectation and actual service performance. Response time, which is typically regarded as a service failure, results in a negative experience for users who expect speedy and convenient access to functions (Tan *et al*., 2016). Normally, mobile applications' users need to wait after inputting a command to arrive at response displays of the next service interface (Zhang and Adipat, 2005). They usually have expectations for the response time of mobile applications, which they compare with the actual response time to generate disconfirmation. User experience is therefore determined by this disconfirmation. Existing literature has indicated the suitability of EDT in investigating the relationship between response time and user experience. For example, long response times have been regarded as a severe problem that violates customer expectations and can negatively influence the desktop computer's user experience (Hong *et al*., 2013; Kohrs *et al*., 2016). Meanwhile, findings in past studies have shown that long response times can result in user complaints, frustration, and even anger due to the experience of negative disconfirmation in regards to their expectations (Kohrs *et al*., 2016; Tan *et al*., 2016). Although EDT has been widely applied to interpreting the determinants of user experience, few studies have focused on the mobile application context where users are more sensitive to response time (Harrison *et al*., 2013; Zhang and Adipat, 2005). This study thus attempts to employ EDT to scrutinize the role of response time in determining user experience in the context of mobile applications.

EDT further distinguishes different dimensions of user experience based on the zone of tolerance perspective (Johnston, 1995; Walker and Baker, 2000). According to this view, a user's pre-performance expectations can be divided into the following zones (See Figure 1): minimum tolerable zone, adequate zone, and ideal zone (Miller, 1977; Poiesz and Bloemer, 1991). Service processes fulfill these expectations in different zones, thereby generating user experience after service completion. Based on these zones, user experience is categorized as tolerance, acceptance, and satisfaction. Specifically, *tolerance* is defined as a user's after-service feeling regarding the fulfillment of his/her basic expectations.

Acceptance represents a user's after-service feeling regarding the fulfillment of his/her adequate expectations and *satisfaction* refers to a user's after-service feeling regarding the fulfillment of his/her ideal expectations (Mattsson, 1992; Wu and Wang, 2012; Zeithaml *et al*., 1993).

--- Insert Figure 1 here ---

2.3 Response Time and User Experience in Mobile Applications

Extant literature has construed response time to be a salient factor influencing user experience in terms of tolerance, acceptance, and satisfaction (See Table I for an overview) (Galletta *et al*., 2004; Kohlisch and Kuhmann, 1997; Ryan *et al*., 2015; Thum *et al*., 1995). Specifically, some studies have used tolerance to depict user experience by identifying its negative relationship with response time (El Louadi and Ali, 2010; Nah, 2004). Lin and Lu (2000) found that the response time of a website can have a negative impact on users' acceptance of the service. Satisfaction has similarly been found to be negatively influenced by response times of webpages and computer systems (Chen *et al*., 2018; Hoxmeier and DiCesare, 2000; Otto *et al*., 2000). Based on the above, previous studies have reached a consensus on the negative effect of delayed response times on user experience. However, a single dimension is inadequate for capturing the service process and user experience (Walker and Baker, 2000). There remains a lack of scrutinization on the differences among tolerance, acceptance, and satisfaction due to the unidimensional nature of user experience in prior research. As such, this study aims to scrutinize the dimensionality of user experience to determine the different influencing mechanisms of response time on tolerance, acceptance, and satisfaction.

--- Insert Table I here ---

2.4 *Hypotheses Formulation*

Because the negative effect of response time on user experience has been widely acknowledged (Galletta *et al*., 2004; Ryan *et al*., 2015; Weinberg, 2000), this study scrutinizes how response time differently impacts tolerance, acceptance, and satisfaction. Based on the tenets of EDT, a higher level of expectation will induce a larger discrepancy between expectation and service experience when a user encounters a long response time (Johnston, 1995; Marks and Kamins, 1988; Stodnick and Marley, 2013). Conceivably, the negative effect of response time is strongest when influencing satisfaction, which represents a user's after-service feeling with high expectations. On the contrary, tolerance reflects a user's feeling toward a basic expectation, such as completing a given task. Between satisfaction and tolerance, acceptance reflects the user's feeling regarding middle-level expectations. Prolonged response time can decrease this feeling, but with limited impact because basic expectations allow for flaws in service delivery. As such, the impact of response time on user experience is strongest for satisfaction, followed by acceptance, and is weakest for tolerance. In addition, scholars have attested that disconfirmation between expectation and service experience will be magnified when a user's expectations are high (Anderson, 1973; Isac and Rusu, 2014). The magnified disconfirmation further exaggerates the differences among satisfaction, acceptance, and tolerance in terms of the influence of response time on user experience. Given the above, we hypothesize that:

> ***Hypothesis 1****:* Response time negatively affects users' tolerance, acceptance, and satisfaction differently, such that this negative effect is strongest for satisfaction, followed by acceptance, and then tolerance.

Based on EDT, user experience is determined by disconfirmation between pre-performance expectations and actual service performance. A prolonged response time in mobile applications is a service failure because it results in disconfirmation between expected and actual response time. Service failures trigger users' attribution mechanism, which manifests how they explain and react to the causes of particular events (Burton *et al*. 2014; Kelley, 1967; Weiner, 2010). This attribution mechanism has been identified as a key to explaining how gender and network environment moderate the role of response time in influencing users' after-service experience (Akhtar *et al*., 2019). Attribution theory highlights the importance of attribution mindsets and locus of causality (Weiner, 1985; Fatemi and Asghari, 2012). It is widely attested that gender is an important determinant of attribution mindsets in that service failure is attributed to external entities or internal characteristics (Espinosa-Fernández *et al*., 2003; Hancock and Rausch, 2010; Wittmann and Szelag, 2003). In the context of mobile applications, the network environment—a locus of causality—attracts the most attention from users when they are confronted with prolonged response time (Poncela *et al*., 2014; Kim *et al*., 2017; Zhao *et al*., 2016). Given their importance, this study intends to tease out the moderating roles of gender and network environment in the relationship between response time and user experience.

There is an abundance of empirical evidence that confirms the significant differences between males and females in making attributions to service quality (Espinosa-Fernández *et al*., 2003; Hancock and Rausch, 2010; Wittmann and Szelag, 2003). Due to biological, historical, and cultural reasons, females have been shown to attribute success and failure to external entities rather than internal characteristics (Beyer, 1998; LaNoue and Curtis, 1985; Meehan and Overton, 1986). Comparatively, males have been shown to pay more attention to assertiveness, aggressiveness, and self-esteem rather than emotions, trust, and anxiety when making attributions (Beyer, 1998; Fatemi and Asghari, 2012; Feingold, 1994). As previously discussed, a prolonged response time initiates the attribution mechanism, which determines who should be blamed for this failure. Due to the inclination of attributing failure to external entities, females normally consider the mobile application to be responsible for this failure rather than entities related to themselves, such as cellphones and network, thereby resulting in a lower level of user experience. By contrast, males tend to check their own manipulation processes or devices to figure out if the delay is caused by themselves, which leads to a higher level of user experience. Therefore, we hypothesize that:

> ***Hypothesis 2:*** Gender moderates the negative relationship between response time and user experience such that this negative relationship is more salient for female users than for male users.

In terms of network, this study considers 3G, 4G, and Wi-Fi as three network environments that shape users' attribution processes. Compared to 3G, 4G has a higher speed with 2Mbps to 1Gbps capacity (Ezhilarasan and Dinakaran, 2017; Samaria, 2014). 4G's high speed is also equivalent to that of Wi-Fi and has better connection stability, which makes 4G an optimal network environment (Cecche *et al*., 2013; Chen *et al*., 2012). Wi-Fi, too, is better than 3G regarding speed and stability. Given that previous studies have found that females are inclined to make attributions to external entities while males are inclined to make attributions to internal characteristics, attribution of response time can be seen as an external entity while network environment can be seen as an internal attribution factor determined by users' discretion because they can freely switch among 3G, 4G, and Wi-Fi in most scenarios (Cabral, 2011). In other words, females' tendency to attribute prolonged response times to external entities like mobile applications rather than internal entities like network environment indicates an insignificant moderating role of network environment. In contrast, males' tendency to attribute prolonged response times to internal entities like network environment indicates a significant moderating role of network environment. For male users in the 3G network where the speed and stability are relatively low, user experience will be higher because they do not blame the mobile application. In the 4G network, which has a high level of speed and stability, male users tend to attribute long response times to the mobile application, which further decreases their user experience. Wi-Fi lies in the middle between 3G and 4G in terms of speed and stability, which induces user experience to be medium compared to other two network environments. Based on the above, the influence of response time on user experience is contingent on gender and network environment. We therefore hypothesize that:

> ***Hypothesis 3:*** Network environment and gender jointly moderate the relationship between response time and user experience. Particularly, for female users, the moderating effect of network environment is insignificant. For male users, network environment moderates the relationship between response time and user experience such that this negative relationship is most salient in 4G networks followed by Wi-Fi networks, and is least salient in 3G networks.

3. METHODOLOGY

To validate our proposed hypotheses, an experiment was conducted to capture user experience in response to response time manipulations. Figure 2 depicts our experimental design.

--- Insert Figure 2 here ---

3.1 Exploratory Experiment

To effectively develop the simulation application for the formal experiment, we first conducted an exploratory experiment. This process began with the extraction of elements relevant to our empirical efforts (i.e., experiment tasks, response time interval, minimum and maximum response times). Using these extracted elements, a mobile application based on Android APK was developed to explore the relationship between response time and user experience of mobile applications in a formal experimental setting. We then determined appropriate response time alternatives for exploring its effect on user experience in the formal experiment.

Psychological experiment software E-prime 2.0 was used in the simulation by way of a computer for the experimental procedure, material presentation, and data collection (Schneider *et al*., 2002). We chose screenshots of common mobile application interfaces on the market and used the Photoshop application to create screenshots with additional text to be used as experimental materials. Overall, we wanted to have enough settings to contain the normal response time and a final set of eight response time periods (0.5s-4s) as recommended in the literature (Kohrs *et al*., 2017; Galletta *et al*., 2004; Kohrs *et al*., 2012 and 2014) and mobile Internet industry data (China Mobile Research Institute support).

An expert panel was invited to provide recommendations on choosing mobile application tasks. Based on their recommendations and the length of response times of given tasks, we determined 11 general tasks: Opening Application, Page Switching, Map Information Searching, Information Searching, Mail Information Retrieval, Payment Feedback, Login Feedback, Text Details Viewing, Image Viewing, Local Photo Opening, and Photo Uploading. The participants recruited included 30 college students (21 males and 9 females) ranging in age from 19 to 25.

The main goal of the exploratory experiment was to determine the appropriate response time periods for exploring the relationship between response time and user experience in a formal experiment. As such, we established different response time periods in order to instruct users to assign scores according to their feelings in the exploratory experiment. Then, we compared users' experience with each response time period. Based on previous user experience data regarding response time (Galletta *et al*., 2004; Weinberg, 2000) and mobile applications data provided by China Mobile Research Institute (Appendix A), we determined the shortest and longest response times to be 0.5s and 4s, respectively. Meanwhile, we considered the effects of different response time intervals on user experience. Kohrs *et al.* (2012, 2014) investigated that the delays of 0.5s lead to a significant physiological response in participants. To balance the operability of the experiment and the accuracy of the data, we set the time interval as 0.5s, thus generating 8 response times. Therefore, given the results of the mobile application's exploratory experiment performance test, response times were set at 0.5s, 1s, 1.5s, 2s, 2.5s, 3s, 3.5s, and 4s. The identified tasks and response time periods were then used in the formal experiment.

3.2 Apparatus and Stimuli

Based on the tasks and response time periods determined in the exploratory experiment, an experimental application platform was programmed by Eclipse and installed on mobile phones with Android APK. The application program ran smoothly on smart phones and did not have significant differences from real mobile applications in marketplace. Each task simulated a real operating environment and had related prompt words for operation. Seven popular Android smart phones that are currently on the market were used in this experiment: Samsung Note II (two total), Samsung S5, China Mobile M812, Huawei P7, Nubia Z5s, Iuni U2, and Oppo Find 7. Each phone could be used by six or seven participants. As Android produces a variety of mobile phones, we selected the aforementioned models for their comparatively large market share. Moreover, we used a multitude of brands in the experiment to avoid brand preferences.

3.3 Sampling

An additional 50 participants (28 males and 22 females) were recruited who had not participated in the exploratory experiment to avoid possible learning effects. Participants did repeated operations within a similar task type. Compared to traditional between-subjects designs, the repeated-measure method of experiment design can control participants' heterogeneity and requires fewer participants (Bolls *et al*., 2001; Gumkwang and Dae-Young, 2014). Meanwhile, through post hoc power analysis, our sample size (n=50) achieved enough statistical power above 0.80 for repeated measures ANOVA (Cohen, 1988). Past studies implementing this type of analysis have used sample sizes of fewer than 30 participants (Gumkwang and Dae-Young, 2014; Pàmies *et al*., 2016; Trimmel *et al*., 2003). Participants from the formal experiment were college students who were first asked to read and sign the informed consent form and were rewarded after completing the experiment. Their ages ranged from 19 to 27 (M = 22.7, SD=2.2). The participants had to be users of Android mobile phones and have sufficient experience using mobile applications.

3.4 Formal Experimental Procedures

Before the experiment began, the participants provided their personal information and read the experimental guide material. Then, they clicked on the test application icon in the program environment. As shown in Step 1 of Figure 3, the main interface of the application platform had four buttons: text, 3G, 4G, and Wi-Fi. The button "text" represented the experimental practice. Participants first needed to click the "text" button to enter a practice environment. They were then asked to complete the same three task scenes operations as those in the exploratory experiment, which familiarized participants with the experimental process. The buttons "3G," "4G," and "Wi-Fi" represented three network environments.

In daily use, mobile phone users usually refer to the network logo displayed at the top of the application interface to ascertain the network environment. We thus used the psychology method of the "Barnum Effect" (Boyce and Geller, 2002) to deal with the experimental application platform. To do so, three network environment buttons were set up in the main interface. After participants clicked the network environment button, the next interface prompted them to enter the corresponding network environment operations. In certain network environments, the network logo at the top of the task interface notified participants of the current network environment. The order of selecting the network environment was made through the Complete Counterbalancing Method (Zhu, 2000). Accordingly, the three types of network environments in the experiment had six permutations: (3G, 4G, and Wi-Fi); (4G, Wi-Fi, and 3G); (Wi-Fi, 3G, and 4G); (3G, Wi-Fi, and 4G); (4G, 3G, and Wi-Fi); and (Wi-Fi, 4G, and 3G). Based on participants' numbering (i.e., in the order in which they participated), six order-adjacent participants were treated as a group, the sequences of which corresponded to the above six permutations. In terms of gender, the number of males and females in the permutations was mostly balanced. As such, we balanced the selection order of the three network environments and eliminated the effect of sequencing on the experiment. In fact, 11 tasks were similar in three network environments, but the order of the tasks and eight response times were represented randomly. The participants did not know this, but, in accordance with the Barnum Effect, the experimental application platform made users believe they were operating in three different network environments. Such a design enabled us to control experimental variables and explore the impact of different network environments on user experience under the same response time.

All 11 tasks were randomly presented under each network environment and, in accordance with the eight set response times, each task was randomly presented. For example, several participants chose the 4G network environment. Under the 4G network environment, one of the 11 tasks might appear first, such as Page Loading, and the task might be carried out in a randomly chosen response time, such as 3s. Then the user completed the questionnaire. Such a task would be carried out again in another response time, e.g., 1.5s, and the user would complete the questionnaire again. The process was repeated eight times until eight response times were traversed. The entire formal experiment therefore included 264 operations (3 network environments × 11 tasks × 8 response times). Users took approximately one hour to complete the experiment and the data were automatically saved to the smart phone afterward.

The formal experimental steps were as follows (shown in Figure 3).

Step 1. In the main interface, according to the experimenter's suggestion, participants chose to click a button of 3G, 4G, or Wi-Fi to reach the formal experiment.

Step 2. If the user clicked the 4G button in the main interface first, the text on the interface will prompt the user, "The following operations are in the 4G environment. Please click to continue." This interface prompt allowed users to enter the 4G environment. If the user clicked the 3G or Wi-Fi button, the interface presented a similar prompt.

Step 3. After entering the 4G network environment, 11 tasks randomly appeared. Every task operation was randomly repeated eight times according to eight different response times, after which the user continued to the next task. We used the Local Photo Opening task as an example to illustrate the process in the following steps. The task interface text on a yellow background prompted the user, "Please click the 'OK' button to open local photos.” The user would then click the “OK” button on a blue background.

Step 4. After a given response time period, the next interface text on a yellow background stated, “Opened the local photo successfully!” The user then clicked on the interface to enter the evaluative questionnaire interface.

Step 5. The evaluation’s interface prompted, “Please score the response time of this task operation according to your own experience.” The interface included three evaluative dimensions: tolerance, acceptance, and satisfaction. These dimensions were identical to the questionnaire in the exploratory experiment.

Step 6. The user produced an evaluation by clicking the white dots first and then blue dots representing scores. The users were familiar with the scoring process after their participation in the exploratory experiment. The user who completed the evaluation then clicked on the bottom button (Submission) and entered the Local Photo Opening task (the same task operation) again for another response time period. The user who completed the task operation with eight response time periods then entered the next task and repeated the above steps, generating 264 operations overall. After the experiment, the questionnaire scores and raw data were automatically stored in the mobile phone in a TXT file that could be transferred into the computer through a USB data cable.

--- Insert Figure 3 here ---

4. DATA ANALYSIS

Data were analyzed via SPSS version 22. We first calculated descriptive statistics and applied repeated measures ANOVA for tolerance, acceptance, and satisfaction (D’Amico *et al*. 2001; George and Mallery, 1999; Levine, 2013) to test the difference in all response time periods. Then, the logarithmic function was employed to analyze the relationship between response time and the three dimensions of user experience. Finally, we explored the impact of gender and network on the relationship between response time and user experience.

4.1 *Descriptive Statistics of Three Evaluative Dimensions*

Descriptive analysis was performed to manifest the trend of user experience concurrently with the increase of response time. As shown in Figure 4, the mean value of the user's experience—reflected by tolerance, acceptance, and satisfaction—decreased when response time increased. Moreover, we tested the difference across these three evaluative dimensions and found that the tolerance score was largest and the satisfaction score was lowest, regardless of response time.

--- Insert Figure 4 here ---

To avoid the influence of response time, we selected the data of each response time period and applied the repeated measures ANOVAs. We then explored the main effects of the evaluative dimension and compared them among three evaluative dimensions. For example, to analyze data for 3s response time, we chose tolerance, acceptance, and satisfaction as within-subjects variables of a repeated measures ANOVA. The result showed that the main effect of the evaluative dimension was significant with the $F(2, 3298) = 279.11$ and $p < 0.01$ for 3s response time. The same procedure was used to explore the main effect of three dimensions on each response time period, respectively. Results (see Appendix B) showed that the three evaluative dimensions had a significant difference on each response time period ($F \geqslant 134.51$, $p < 0.01$). Meanwhile, the multiple comparisons (see Appendix C) showed that the mean difference was significant between every two dimensions ($p < 0.01$). In other words, the mean differences of all three dyads (i.e., tolerance vs. acceptance, tolerance vs. satisfaction, and acceptance vs. satisfaction) were significant for each response time period. Based on this analysis, we found that the three evaluative dimensions had significant differences with each other and scores sorting were consistent with the following pattern: tolerance > acceptance > satisfaction, which corroborates Hypothesis 1.

4.2 Logarithmic Relationship between Response time and User Experience

In previous research, psychophysics functions have often been used to describe the relationship between objective reality and psychological reality, a move that is applicable to this study given its investigation of the relationship between response time and user experience (Antonides *et al*., 2002; Reichl *et al*., 2013). When the change of physical stimulation exceeds a constant ratio of its actual magnitude, people can notice a difference in perception (Reichl *et al*., 2013). Thus, the relationship between users' perceived and objective time is not a simple linear relationship (Antonides *et al*., 2002). For the relationship between user experience and mobile telecommunication services, a number of Quality of Experience studies have identified that user experience and response time follow logarithmic laws (Block *et al*., 2000; Egger *et al*., 2012b; Reichl *et al*., 2010; Strohmeier *et al*., 2012). For example, a 30s video on YouTube was selected to examine users' subjective scores for the number of delay events at 1s and 3s intervals and the results were fit into the logarithmic function (Egger *et al*., 2012a). Egger *et al*. (2012b) tested many scenarios—such as setting up a file download and establishing a wireless Internet connection via 3G—and fit the results into the logarithmic function.

Before using the logarithmic function to explore the relationship between user experience and response time, we first conducted repeated measures ANOVAs to analyze whether the eight response times had significant differences in each of the three evaluative dimensions. The within-subjects variables were the evaluation scores for the eight response time periods. Different response time periods affected users' subjective perception evaluations significantly, i.e., $F\ (7,\ 11543) = 1119.92$, $p < 0.01$ of tolerance, $F\ (7,\ 11543) = 1301.03$, $p < 0.01$ of acceptance, $F\ (7,\ 11543) = 1433.10$, $p < 0.01$ of satisfaction. The logarithmic function equation (1) adopted from previous research (Egger *et al*., 2012a) was used to explore the relationship between user experience and response time:

$$\mathrm{MS} = \mathrm{b} * \ln(\mathrm{RT}) + \mathrm{a} \tag{1}$$

where MS was the mean score for each response time for the different dimensions in this experiment, a and b were parameters, and RT was the response time.

The model summary and curve fitting in the user experience evaluations are shown in Table II. We found that the logarithmic function had a high degree of fit with the data. This reflected the relationship between user experience and response time, which was consistent with the previously mentioned Weber-Fechner Law (Antonides *et al*., 2002). Due to technical constraints and commercial operation considerations (i.e., inserting ads), response time cannot be 0 and could not be reduced to achieve higher customer satisfaction at this stage. However, we were able to set the user satisfaction score as the target value through the function curves and obtain the response time target value by optimizing the mobile application to achieve the satisfactory target value from acceptance or tolerance.

--- Insert Table II here ---

The differences in three dimensions' curves were compared by coefficients with T-statistics. Significant differences were found between tolerance and acceptance ($p < 0.01$), tolerance and satisfaction ($p < 0.01$), and acceptance and satisfaction ($p < 0.05$), respectively. The absolute value of the curves' coefficient represents the degree of the response time's negative effect on user experience. In other words, the higher the absolute value, the stronger the negative effect. Among three dimensions' curves, the coefficients' absolute values from high to low were satisfaction, acceptance, and tolerance. The above verifies that the response time's negative effect was strongest for satisfaction, followed by acceptance, and then tolerance, which also corroborates Hypothesis 1.

We divided zones of different user experience using three logarithmic curve functions, in which the abscissa axis is the response time and the ordinates axis is the user experience scores (curve graph is shown in Figure 5). For the actual application tasks, it is meaningless that the response time was infinite. According to the actual needs of users and the related results from research institutions, we determined the lower limit of 4.5 scores for the subjective evaluation's scores and obtained the approximate time thresholds of 5.5s based on the tolerance logarithmic function. Thus, the response time boundary on the right side of the curve graph (Figure 5) was set to 5.5s. Four zones of user experience were defined as: Zone 1 is the Satisfactory area, Zone 2 is the Acceptable area, Zone 3 is the Tolerable area, and Zone 4 is the None-Tolerable area. When response time increased, the satisfactory area became smaller and other zones became bigger. Meanwhile, when response time was short, the user's tolerance, acceptance, and satisfaction curves approached convergence and the gaps were small. However, the gaps between different user experience dimensions became larger as response time increased.

Implications derived from this analysis are two-fold. On one hand, mobile application developers can determine the appropriate response time for a mobile application if they know the acceptable difference among the three dimensions of user experience. For example, if users expect a consistent level of tolerance, acceptance, and satisfaction, the response time needs to be shortened. On the other hand, the maximum response time can be calculated based on curves if a mobile application has a certain score as the target for user experience. This application can be further optimized to reduce response time in reaching the target.

--- Insert Figure 5 here ---

4.3 Effects of Gender and Network Environment on Evaluation of User Experience

The mean scores for the evaluation of tolerance, acceptance, and satisfaction considering gender and network environment are depicted with their corresponding standard errors in Figures 6 and 7, respectively. We found that the mean scores of the female group were higher than those of the male group in each dimension of user experience. This finding suggests that females' tolerance, acceptance, and satisfaction were higher than that of males under the same response time. Females, as compared to males, tended to underestimate the time interval. In the network environments, the 3G mean scores were close to those of Wi-Fi, and the 3G and Wi-Fi mean scores were higher than those of 4G.

--- Insert Figure 6 here ---

--- Insert Figure 7 here ---

The logarithmic function model was then used to consider the roles of gender and network environment in the relationship between user experience and response time. The model summary and curve fitting are shown in Table III. The results indicate that the logarithmic function had a high degree of fit with the data.

--- Insert Tables III here ---

We compared the differences in curves using coefficients to explore the role of gender and network environment in moderating the relationship between response time and user experience. In the above analysis, significant differences were found between the three dimensions, so each evaluative dimension was analyzed separately. For gender, the results show that, under any specific network environment, males and females have a significant difference in each evaluative dimension ($p < 0.01$). That is, gender can moderate the negative relationship between response time and user experience. However, under any of the networks in any evaluative dimension, the coefficient's absolute value of males' curve was shown to be higher than females'. Conceivably, then, males exhibit more salient effects on the negative relationship between response time and user experience than females. Thus, the results do not support Hypothesis 2. For the networks, participants were separated by gender. Under three dimensions, the results show that 3G and 4G as well as Wi-Fi and 4G had a significant difference for females ($p < 0.01$), while 3G and Wi-Fi had no significant difference ($p > 0.1$). For males, any two networks of 3G, 4G, and Wi-Fi had significant difference ($p < 0.1$) under any evaluation dimension, while 4G and Wi-Fi had no significant difference ($p > 0.1$) under the acceptance dimension. Therefore, Hypothesis 3 is partly supported.

5. DISCUSSION

This study unravels the relationship between response time and user experience in the context of mobile applications. To glean deeper insights into the effects of response time on user experience, we distinguished among tolerance, acceptance, and satisfaction as constituent dimensions of user experience and scrutinized the impact of response time on each of these dimensions. Furthermore, we incorporated gender and network environment as contingencies that moderate the relationship between response time and user experience.

The analytical results from our experimental study have manifested substantial differences across users' tolerance, acceptance, and satisfaction in users' reactions to response time. Additionally, even though we observed that gender moderates the effect of response time on user experience, the direction of the moderating effect is opposite that of our hypothesis. As such, t moderating influence of the network environment turned out to be partly significant. Empirical findings from this study thus bear important implications for theory and practice.

5.1 Implications for Theory

This study contributes to theory development on three fronts. First, by focusing on response time in the context of mobile phone applications, it extends existing literature on the impact of response time that has mostly focused on desktop and webpage applications (Bai *et al.*, 2017; Dabrowski and Munson, 2011; El Louadi and Ali, 2010; Nah, 2004; Szameitat *et al.*, 2009). The results reveal a negative impact of response time on the user experience of mobile applications with a significant difference compared to other contexts. Particularly, we found that user experience reaches the highest level when response time hovers around 0.5s, but drops below average once response time extends to 5.5s. This finding differs from studies on response time in the context of desktop and webpage applications. For desktop applications, the turning point where user satisfaction decreased has been found to be insignificant after 12s of response time (Hoxmeier and DiCesare, 2000). A study on webpage application response time similarly showed that user satisfaction flattened when response time exceeds 8s (Galletta *et al.*, 2004). By comparing the response time among different contexts, we concluded that the expectation for response time of mobile applications is much shorter than it is for other applications. This is consistent with the claim that mobile devices with less processing capability and a lower power capacity (compared to desktop devices) make users less patient and causes them to lower their expectations of response time.

Second, this study enriches extant literature on user experience by distinguishing its three dimensions and each of their different influencing mechanisms. Based on the zone of tolerance proposition in EDT, user experience is categorized as tolerance, acceptance, and satisfaction to reflect users' feelings regarding different levels of expectation (Johnston, 1995; Lankton *et al*., 2014). Consistent with the hypothesis, our results show the negative impact of response time is most salient for satisfaction and least salient for tolerance, which corroborates the argument on the discrepancy between expectation and service performance (Anderson, 1973; Isac and Rusu, 2014). In this sense, our study yields novel insights into the effects of response time on user experience that go beyond the traditional single dimension approach of conceptualizing user experience in literature on Human-Computer Interaction (Bielen and Demoulin, 2007; Lin and Lu, 2000; Otto *et al*., 2000).

Third, this study incorporates gender and network environment as contingencies and generates compelling findings with theoretical implications. The results show that females' tolerance, acceptance, and satisfaction are higher than those of males given the same response time. As response time increased, the negative relationship between response time and user experience was more conspicuous for males than for females. This result differs from the finding of Block *et al*. (2000) that suggested females' estimation of time to be longer than that of males. A possible explanation is that this study evaluates the role of response time in user experience rather than a simple time estimation. Females' evaluation of experience involved more cognitive and emotional responses, which made them more tolerant of response time (Chebat *et al*., 2010). From neurobiological evidence, the proportion of white matter and gray matter in gender influences the cognitive functions of time (Wittmann and Szelag, 2003). Specifically, males tend to have a greater white matter proportion with faster information transmission and lower simultaneity thresholds than females. Males can thus be more prone to negative user experience than females, resulting in lower scores for tolerance, acceptance, and satisfaction. This finding draws our attention to how males and females differ in how they are influenced by the prolonged response time of the moderating effect of gender on user experience in relation to response time in the context of mobile applications.

In terms of network environment, the results show that the relationship between response time and user experience differs significantly in 3G and 4G networks regardless of gender. It therefore validates the claim that different perceptions on the speed and stability of 3G and 4G networks lead to different attribution mechanisms (Lehr and McKnight, 2003; Poncela *et al*., 2014). However, the impact of response time on females' experience remains consistent when compared with 4G and Wi-Fi, while exhibiting inconsistency in comparing 3G and Wi-Fi. Males' experience was shown to have a significant difference between 3G and Wi-Fi and a significant difference between 4G and Wi-Fi, except in the acceptance dimension. As such, the gender difference in attribution preference was validated to influence the moderating role of network environment. Compared to females, it was verified that males prefer to make attribution to the network environment, which is an internal attribution factor.

5.2 Implications for Practice

Overall, this study shows that improvements to user experience in mobile applications can be explored from the perspectives of different dimensions. The zones of different user experience with the three logarithmic function curves can serve as a reference for mobile applications' technological development and operations. Given this, we suggest mobile application developers take steps to improve user experience based on the experience depicted by different zones (shown in Figure 5). In accordance with users' needs, developers can determine the subjective perception target value of y_1 and then obtain a corresponding time threshold of the three dimensions' logarithmic function curves: x_1, x_2, and x_3. Developers can use this information to build a response time performance standard for mobile applications so the model can be extensively applied. In addition, a comparative analysis can be conducted by choosing a focal application and other similar applications for testing response time. This allows for the corresponding user experience evaluation scores of three dimensions by curve graph to be obtained. The response time would require improvement if a disparity exists in the gap between the scores or if the gap is small but in different scoring zones.

Findings on the contingent role of gender can benefit developers who target to a certain gender for their mobile application design. For example, some online shopping mobile applications whose major users are females—such as JUMEI, a mobile application of mainly selling cosmetics in China—can support them in setting a response time that keeps a balance between cost and customer experience. For female-dominant mobile applications, response time can be slightly longer than for male-dominant ones.

5.3 Limitations and Future Research

Despite the merits mentioned above, this study has limitations for future research to explore. First, the effect of sample heterogeneity is not taken into account. For the sample selected in this study, the major, qualification, and age are different across participants. The heterogeneity of the sample can affect response time evaluations as there may be a relationship between the sample heterogeneity and variables in this study. Additionally, the samples consist of only students, so future samples should expand to include other groups of people. Second, factors affecting the human perception of time are multifaceted. However, due to the limitation of experimental conditions, this paper only investigated specific factors and their effects. Third, the “3G,” “4G,” and “Wi-Fi” buttons on the main interface represented three kinds of network environments and were selected through the Complete Counterbalancing Method. However, the number of participants was not exactly a multiple of six, and the proportion of males to females in order selection was not strictly controlled. We therefore suggest future studies implement randomization with the application program. Fourth, for users’ tolerance, acceptance, and satisfaction, we adopted single-item measurement (Ryan *et al*., 2015; Weinberg, 2000). Although it is acceptable within the literature on user experience, this operationalization could be improved by introducing multi-item measurements for tolerance, acceptance, and satisfaction. Last but not least, future research should consider other factors that affect user experience response times and build a more comprehensive index of factors to establish a relational model between objective response time and subjective user experience. For example, factors related to mobile devices can be considered as moderators influencing the impact of response time on user experience by shaping the user’s attribution mechanism. An outdated cellphone makes users attribute the long response time to hardware rather than mobile application design, which alleviates the negative impact of response time.

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A: RTs of Mobile Applications Provided by China Mobile Research Institute (2014)

Task	Application (Version)	RTs Under the Network	
		3G	Wi-Fi
Opening Application	APP 1 (V2.6.6)	2.44s	2.32s
	APP 2 (V6.0)	2.78s	2.65s
	APP 3 (V5.60)	2.69s	2.63s
Map Information Searching	APP 4 (V3.0)	2.23s	2.15s
	APP 5 (V5.1.3)	3.46s	2.82s
	APP 6 (V5.2.0)	2.59s	1.78s
Text Details Viewing	APP 7 (V1.5.3)	3.24s	1.61s
	APP 8 (V3.0.6)	2.43s	1.64s
	APP 9 (V3.0)	2.67s	1.38s
Local Photo Opening	APP 10 (V3.6)	3.67s	3.17s
	APP 11 (V3.0.03)	1.99s	1.97s
	APP 12 (V1.6.0)	1.16s	1.12s
Login Feedback	APP 13 (V2.0.1)	3.47s	3.35s
	APP 14 (V2.6.0)	2.78s	2.63s
	APP 15 (V4.0.2）	2.56s	2.48s
Information Searching	APP 16 (V2.0.1)	2.55s	1.52s
	APP 17 (V2.6.0)	2.27s	1.31s
	APP 18 (V4.0.2)	1.65s	1.08s

Appendix B: Repeated Measures ANOVA for Evaluative Dimension in Each Response Time

Response Time	Sum of Squares	*df*	Mean Square	*F*	*p*
0.5 s	29.31	2	14.66	134.51***	0.000
Error	359.36	3298	0.11		
1.0 s	50.71	2	25.35	181.80***	0.000
Error	459.96	3298	0.14		
1.5 s	67.71	2	33.85	203.87***	0.000
Error	547.63	3298	0.17		
2.0 s	83.00	2	41.50	225.47***	0.000
Error	607.00	3298	0.18		
2.5 s	104.51	2	52.26	270.06***	0.000
Error	638.16	3298	0.19		
3.0 s	119.18	2	59.59	279.11***	0.000
Error	704.15	3298	0.21		
3.5 s	145.91	2	72.95	329.85***	0.000
Error	729.43	3298	0.22		
4.0 s	162.85	2	81.43	359.74***	0.000
Error	746.48	3298	0.23		

Note: $*p < 0.05$; $** p < 0.01$; $*** p < 0.001$

Appendix C: Multiple Comparison of Three Evaluative Dimensions

Response Time	(I) Dimension	(J) Dimension	Mean Difference (I-J)	Std. Error	*p*	95% Confidence Interval	
						Lower Bound	Upper Bound
0.5s	Tolerance	Acceptance	0.09***	0.01	0.00	0.07	0.11
		Satisfaction	0.19***	0.01	0.00	0.16	0.21
	Acceptance	Tolerance	-0.09***	0.01	0.00	-0.11	-0.07
		Satisfaction	0.10***	0.01	0.00	0.08	0.12
	Satisfaction	Tolerance	-0.19***	0.01	0.00	-0.21	-0.16
		Acceptance	-0.10***	0.01	0.00	-0.12	-0.08
1.0s	Tolerance	Acceptance	0.13***	0.01	0.00	0.11	0.15
		Satisfaction	0.25***	0.02	0.00	0.22	0.28
	Acceptance	Tolerance	-0.13***	0.01	0.00	-0.15	-0.11
		Satisfaction	0.12***	0.01	0.00	0.10	0.14
	Satisfaction	Tolerance	-0.25***	0.02	0.00	-0.28	-0.22
		Acceptance	-0.12***	0.01	0.00	-0.14	-0.10
1.5s	Tolerance	Acceptance	0.16***	0.01	0.00	0.13	0.18
		Satisfaction	0.29***	0.02	0.00	0.25	0.32
	Acceptance	Tolerance	-0.16***	0.01	0.00	-0.18	-0.13
		Satisfaction	0.13***	0.01	0.00	0.11	0.16
	Satisfaction	Tolerance	-0.29***	0.02	0.00	-0.32	-0.25
		Acceptance	-0.13***	0.01	0.00	-0.16	-0.11
2.0s	Tolerance	Acceptance	0.17***	0.01	0.00	0.14	0.20
		Satisfaction	0.32***	0.02	0.00	0.28	0.35
	Acceptance	Tolerance	-0.17***	0.01	0.00	-0.20	-0.14
		Satisfaction	0.15***	0.01	0.00	0.12	0.17
	Satisfaction	Tolerance	-0.32***	0.02	0.00	-0.35	-0.28
		Acceptance	-0.15***	0.01	0.00	-0.17	-0.12
2.5s	Tolerance	Acceptance	0.19***	0.01	0.00	0.16	0.21
		Satisfaction	0.36***	0.02	0.00	0.32	0.39
	Acceptance	Tolerance	-0.19***	0.01	0.00	-0.21	-0.16
		Satisfaction	0.17***	0.01	0.00	0.14	0.19
	Satisfaction	Tolerance	-0.36***	0.02	0.00	-0.39	-0.32
		Acceptance	-0.17***	0.01	0.00	-0.19	-0.14

3.0s	Tolerance	Acceptance	0.20***	0.01	0.00	0.17	0.23
		Satisfaction	0.38***	0.02	0.00	0.34	0.42
	Acceptance	Tolerance	-0.20***	0.01	0.00	-0.23	-0.17
		Satisfaction	0.18***	0.01	0.00	0.16	0.21
	Satisfaction	Tolerance	-0.38***	0.02	0.00	-0.42	-0.34
		Acceptance	-0.18***	0.01	0.00	-0.21	-0.16
3.5s	Tolerance	Acceptance	0.23***	0.02	0.00	0.20	0.26
		Satisfaction	0.42***	0.02	0.00	0.38	0.46
	Acceptance	Tolerance	-0.23***	0.02	0.00	-0.26	-0.20
		Satisfaction	0.19***	0.01	0.00	0.17	0.22
	Satisfaction	Tolerance	-0.42***	0.02	0.00	-0.46	-0.38
		Acceptance	-0.19***	0.01	0.00	-0.22	-0.17
4.0s	Tolerance	Acceptance	0.23***	0.02	0.00	0.20	0.26
		Satisfaction	0.44***	0.02	0.00	0.41	0.48
	Acceptance	Tolerance	-0.23***	0.02	0.00	-0.26	-0.20
		Satisfaction	0.22***	0.01	0.00	0.19	0.24
	Satisfaction	Tolerance	-0.44***	0.02	0.00	-0.48	-0.41
		Acceptance	-0.22***	0.01	0.00	-0.24	-0.19

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$