Diverging Influences of Usability in Online Authentication System: The Role of Culture (U.S. vs. Korea)

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Abstract

Purpose — Although the use of online authentication systems in banking services is expanding globally, little is known about cultural differences in forming consumers' responses to these services. This paper examines how the usability of an online security service and culture impact consumers' behaviour.

Design/methodology/approach — We conduct a 2 (usability: high vs. low) X 2 (culture: U.S. vs. Korea) between-subjects, full factorial design.

Findings — The results indicate a differential influence of the usability of a security system by culture. In particular, U.S. consumers exhibit greater behavioural intention in a high (vs. low) usability condition, whereas Korean consumers showed more favourable responses in a low usability condition. Moreover, perceived effort is confirmed as a crucial mediator that explains the psychological mechanism of the proposed effect.

Originality/value — The current study is one of a very few attempts to examine the role of usability of an online security system in forming consumers' behavioural intention. More importantly, this study integrates the concept of culture to explain how usability influences positive or negative behavioural intention in an international market.

Practical implications — Our research contributes to the literature on online banking, a context in which security is an important determinant of success. Especially for managers involved in international banking services, our findings of cultural differences offer insights about the importance of local understanding and differentiation of bank services for specific target markets which can enhance consumers' response toward an online security service.

Keywords: online authentication service; usability; cultural difference; perceived effort

Diverging Influences of Usability in Online Authentication System: The Role of Culture (U.S. vs. Korea)

1. Introduction

Online banking is one of the most popular ways to make financial transactions. More than three-quarters of Americans access their bank account to check the balance through a mobile device (Statista, 2019), and 76% of the UK population use online banking regularly (Statista, 2020). People use online banking mainly for convenience, but, not surprisingly, the level of security concern is highest for online banking among different types of online services. According to a recent survey conducted in the UK, 44% of respondents reported "security" as their main concern about using online banking (Statista, 2021). Anderson *et al.* (2019) reported that security concerns prevent 16% of the population from using online banking. It is crucial for marketers of banks and other financial institutions to understand factors influencing users' perceptions about online security systems.

In the current research, we have a particular interest in understanding the interrelationship of usability and security and their influences on users' perception and behavioural intention toward online authentication systems, specifically an online security card system. Usability and security, two focal attributes that determine people's attitude toward online security systems, are closely involved with each other (Elahi and Yu, 2007; Friedman *et al.*, 2002; Mihajlov *et al.*, 2016; Park *et al.*, 2016; Weir *et al.*, 2009; Zviran and Haga, 1993). Traditionally, the security community has believed usability and security to be competing goals (Elahi and Yu, 2007), such that enhancing usability would reduce the level of security. However, emerging views approach them as complementary factors, defining users as the critical component in building secure systems (Tognazzini and Yu, 2007). For instance, the security of a particular system depends on

the components of users' passwords or how frequently they change passwords, which are connected to the magnitude of users' effort.

In the present research, we propose that usability may evoke different reactions among people from different cultural backgrounds due to their different cognitive processing styles. A vast amount of research has shown that individualistic and collectivistic societies are characterized by analytical thinking and holistic thinking, respectively (Nisbett *et al.*, 2001). Drawing on this line of literature, we predict that Westerners, who tend to have an analytical thinking style, would process usability independently from other attributes, like security of the system. Thus, users from Western cultures are likely to consider high usability a positive attribute. In contrast, Easterners, who tend to have a holistic thinking style, would consider the usage experience in connection with performance-related attributes. Based on the lay belief that "the more difficult, the safer", these users are likely to interpret a low level of usability as a signal of security.

This research contributes to the literature on the relationship between usability and security perception in online security systems, where usability can have either a positive or a negative influence on users' behavioural intention. Specifically, the present study provides explanations for previous contradictory findings by empirically identifying and confirming cultural differences as an overlooked boundary condition, thus filling an important gap. We also show that the influence of usability and culture is transmitted to consumers' behavioural intention via perceived effort as a critical mediator

The next sections are organized as follows. First, we review the relevant literature and present our hypotheses. We then describe a study conducted to test our hypotheses. This study examines the aforementioned prediction and explores the hypothesized roles of usability and

culture on these effects. In addition, we provide evidence that perceived effort is the psychological mechanism underlying the relationships among usability, culture, and behavioural intention. We then discuss the theoretical and practical implications of our findings and develop directions for future research.

2. Conceptual Framework and Hypothesis Development

2.1. The Dual Role of Usability in the Acceptance of an Online Security Service

Nielsen (1994; 2012) defines usability as an attribute representing the ease of use of a human-computer interface. We adopt this approach for the purpose of the current research because we consider that ease of use is the most representative characteristic when people try to use a security service. It is also the most applicable dimension to describe the usability of the security service described in the experimental scenario in the current study.

Almost all extant research suggests that high usability is a desirable characteristic of a product. For instance, a higher level of usability is generally associated with a lower level of difficulty (Nielsen, 1994), complexity (Thompson *et al.*, 2005), or effort required to manage a system (Casaló *et al.*,2007). These positive associations have been found to enhance the attractiveness of products and increase the likelihood of adoption of new technologies (Baker-Eveleth and Stone, 2015; Bruun and Stage, 2014; Kim *et al.*, 2012; Teoh *et al.*, 2013). Positive roles of usability are well documented in security-related product categories as well. For example, users of e-banking services have been found to prefer the authentication system with the least number of steps among commonly used security methods (Weir *et al.*, 2009). Similarly, highly complex password requirements prevent users from accessing security systems (Zviran

and Haga, 1993). When security systems are perceived to be effortful and time-consuming, users are inclined to avoid using them and look for ways around them (Friedman *et al*., 2002).

However, predictions based on the conventional belief challenge the general conclusion of such assessments; some users may consider an easy-to-use security system to be more vulnerable (Park *et al*., 2016). Accordingly, low usability can enhance the overall evaluation of the security system. This may be established and reinforced by several factors. The security community has long been educating users to create complex passwords (e.g., combinations of different lengths or alpha-numeric passwords; Federal Information Processing Standards, 1985) or difficult-to-guess (and hence difficult-to-remember) authentication keys (Garfinkel *et al.*, 2003), which are often rationalized by the idea that easy-to-use passwords are easy to hack. Furthermore, this information from external education converges with the popular belief that the effort invested in a task correlates with the quality and performance of the outcome (Aronson and Mills, 1959; Axsom and Cooper, 1985; Kruger *et al.,* 2004). In a similar vein, when the usability of a security system is low, users are likely to perceive that the effort expended is high, which increases their subjective judgment about the level of performance of the system.

There is a great deal of evidence to assume the potential trade-off relationship between perceived usability and perceived security. For instance, a recent study asked people to choose the more secure password from randomly picked pairs out of 16 million passwords extracted from the RockYou dataset (Wash and Rader 2021). Larger differences in the degree of complexity led more people to choose complex options, and the authors argued that password complexity is a reasonable proxy for user's security perception of the password. A similar pattern of results was observed in various products and services offered online. Users considered a web browser to be more secure when asked to answer a long list of seven meaningless

questions than when asked a short list of two questions (Park *et al.*, 2016). Furthermore, the complete removal of the security barrier on security systems lessened the attractiveness of a mobile device. In evaluating the transparent authentication system on a mobile device, users preferred the option with a few barriers to data access than the option with no barriers as they believed the former to be more secure (Crawford and Renaud 2014).

Of particular relevance to the current study, in the context of online banking, Wash and Rader (2021) conducted a survey among college students and found that they use less usable (more complex) passwords for financial websites, which are believed to have higher security needs than for information- and entertainment-related websites (e.g., games, travel and sports). Gunson *et al.* (2011) compared perceived security and usability of single-factor and two-factor authentications in automated telephone banking. A single-factor approach required the user to recall a secret number previously registered, whereas a two-factor approach added a second step to input a one-time access code generated from a security token. There was a negative relationship between usability and security perceptions toward the two systems: the two-factor authentication method was perceived as less usable but more secure than the one-factor security system. Gunson *et al.*'s analysis of user comments also revealed that although the participants liked the single-factor approach because it was quick and easy, they valued the extra security from the two-factor approach.

In sum, prior research suggests that usability may have two distinct functions. It may have a positive and direct influence on intentions to use a security system, but it may also negatively affect product evaluation by lowering the perception of security. Acknowledging the dual role of usability, the natural question that arises is how these two sets of findings – one arguing that usability enhances product attractiveness and the other that usability hampers it and

therefore reduces usage intention – can be reconciled. As a potential answer to this question, we

introduce cultural differences as moderating factors influencing the relative importance of the

two opposite roles of usability. Using prior findings on information processing differences by

culture, we suggest that consumers who have a collectivistic (vs. individualistic) cultural

background are more likely to rely on usability information as a signal to infer security. In the

next section, we provide more detailed evidence of such cross-cultural variation in judging

usability/security.

2.2. Evidence for Cross-Cultural Variation in Usability-Security Judgment

We posit that cultural differences in the style of thinking may influence how the degree

of usability influences users' judgment and adoption intention regarding security systems.

Considerable research suggests that cross-cultural differences in the social environment and the

subsequent self-views promote different cognitive processing styles. Specifically, in

individualistic cultures where the society endorses the value of independence, people tend to

view themselves as separate and independent entities, defined by their distinguishing attributes

and characteristics (Liu *et al.*, 2015; Monga and John, 2006). Individuals with independent self-

views believe that the world is composed of discrete and unrelated objects and tend to focus on

the independence of individual objects (Liu *et al.*, 2015; Monga and John, 2006). As such,

individualistic cultures encourage *analytical thinking*, which "involves a detachment of the

object from its context, a tendency to focus on attributes of the object to assign it to categories,

and a preference for using rules about the categories to explain and predict the object's

behaviour" (Nisbett *et al.*, 2001: p.293).

In contrast, in societies where the roles of individuals as part of a larger social context are emphasized, people define themselves in terms of others and as interdependent entities within the social relationship (Ji *et al*., 2000; Nisbett *et al*., 2001; Okazaki and Rivas, 2002; Yu *et al*., 2008). Individuals with an interdependent self-view believe that the world is composed of interconnected objects and pay attention to the relationships among them (Monga and John, 2008; Yu *et al.*, 2008). Accordingly, collectivistic cultures nurture a *holistic thinking style*, which "involves an orientation to the context or field as a whole, including attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships" (Nisbett *et al*., 2001: p.293).

The influence of thinking styles on people's judgment and evaluation of products and services is well-documented in diverse marketing contexts. Holistic thinkers perceive a greater fit between a parent brand and its extension than analytical thinkers and display more favourable responses toward seemingly unrelated brand extensions (Monga and John, 2008). Findings from prior research suggest that individuals with a holistic thinking style tend to consider a product as an integrated combination of many relevant factors when evaluating it. Consequently, holistic thinkers have a greater tendency to pay attention to the connections even among seemingly unrelated cues and use those as the information for judgment. For instance, Zhu and Myers-Levy (2009) showed that holistic thinkers are more likely than analytical thinkers to perceive neutral products displayed on a table made of glass (vs. wood) to be more modern and less natural. Lee (2018) found that holistic thinkers are more likely than analytical thinkers to be influenced by a service failure in one dimension when evaluating another dimension that is irrelevant to the failure incidence. As such, participants in Lee's study who were primed with holistic thinking

style responded less favourably than those in an analytical priming group to food quality at a restaurant after reading a story about an inattentive waiter.

Cross-cultural studies have also reported that cultural differences in thinking styles have significant influence on consumers' evaluations of products with different attributes or dimensions. For example, Song and colleagues (2015) demonstrated that when receiving mixed-quality online service (attributes with high and low quality), East Asians tend to show greater satisfaction than Westerners. The authors argue that Easterners consider various attributes as an integrated whole when forming their perceptions of a product, whereas Westerners tend to focus on low-quality service attributes.

Similarly, Lalwani and Shavitt (2013) suggested that Asian consumers are more likely to perceive interrelations between the elements within a product and to use one attribute to evaluate another attribute. Their study showed that consumers from a collectivistic culture have a stronger tendency to use the price of a product in judging its quality than consumers with individualistic cultural backgrounds. They asked different groups of consumers to evaluate the perceived quality of the same clock with different prices. The participants who were from a collectivistic cultural background judged the clock to be significantly better when it was priced high than low, while those with an individualistic background judged the high- and low-priced clocks to be similar in terms of quality. These results suggest that consumers with collectivistic cultural backgrounds assumed relational connections between price and quality, whereas consumers with individualistic cultural backgrounds processed price and quality as separate attributes of the product.

In a similar vein, we anticipate that the role of usability of online information security systems is likely to differ based on an individual's cultural background. Specifically, Easterners

with a holistic thinking style would assume a relational connection between the level of usability

in terms of the level of security and overall quality. Therefore, they would have a greater

tendency to use the level of usability as information to infer the level of security. Due to the

belief that usability and security are in a trade-off relationship (Park *et al.*, 2016), people may

judge that the level of security is compromised when the system is very easy to use, where low

usability may lead to a favourable evaluation of a security system. In contrast, Westerners with

an analytical thinking style would tend to evaluate usability and security as independent

attributes, making it less likely that their belief about the usability of a security service would

influence their belief about the level of security. Thus, low usability may not enhance security

perception, and high usability may not undermine security perception. Consequently, when the

other aspects of the products are the same, high (vs. low) usability may lead to higher (lower)

evaluation of a security system.

Hence, we predict that cultural orientation (i.e., collectivistic vs. individualistic) will

moderate the relation between usability and behavioural intention toward an online security

system. Specifically, we hypothesize that:

H1a: Consumers in collectivistic cultures (Korea in this study) will show greater

behavioural intention in the low usability condition than consumers in individualistic

cultures (the U.S. in this study).

H1b: Consumers in individualistic cultures (the U.S. in this study) will show greater

behavioural intention in the high usability condition than consumers in collectivistic

cultures (Korea in this study).

2.3. Perceived Effort as a Mediator

We propose that the level of usability of the security system can have both positive and negative effects on behavioural intentions in opposite directions. The premise for this prediction is that users' usage experience of a system plays an important role in forming their behavioural intention related to future use. Particularly in services that involve human-computer interaction, usage experience has been emphasized to distinguish users' experience in a particular situation and characteristics of products (Hassenzahl and Tractinsky, 2006).

In the context of the current research, we focus on perceived effort exerted during usage as an important experience variable of an online security system. Effort is distinct from difficulty or easiness: effort refers to the actors' subjective intensification of work, whereas difficulty or easiness corresponds to a property of the stimulus (e.g., task or product; Inzlicht et al., 2018). For instance, compared with using an online security system with high usability, a system that has low usability and is difficult to use is likely to require greater effort in using and managing it (Casaló et al., 2007). Interestingly, prior research argues that effort can be considered as benefits as well as costs (Kruger et al., 2004). People not only are motivated to avoid an effortful task (Kim and Labroo, 2011) but also use the effort exerted in carrying out the task as a basis for the appraisal of the value of the outcome (Inzlicht et al., 2018; Kruger et al. 2004).

We propose that different levels of usability of a security product result in differences in subjective perception depending on the effort exerted in using an online security system. As such, people may attach opposite meanings to the effort depending on their cultural background and allocate different weights to the product's usability in forming their adoption intention. That is, the perceived effort expended in using a security system represents the feelings from the

usage experience and therefore mediates the controversial influences of usability on usage

intention. Thus, we predict that:

H2: Perceived effort mediates the relationship among usability and culture and

behavioural intention toward the online security product.

To summarize the hypotheses, we propose a research model for the current research in

Figure 1.

Insert Figure 1 here

3. Experiment

3.1. Pre-test of Usability

Prior to the main experiment, a pre-test was conducted to identify stimuli among diverse

authentication methods that would allow for the appropriate manipulation of usability. Of

particular importance, we considered stimuli that would enable us to vary the level of usability

while maintaining a similar actual level of security between conditions. We chose the security

card because its usability can be easily manipulated even though other variables are controlled.

For instance, we can provide the same information across conditions. Consequently, the context

for the experiment was a situation in which the user was trying a new security card system in an

online context.

We manipulated the usability of the security card using different matrix set-ups. The

security card consisted of 30 random 4-digit numbers. In the high usability condition, the 30

numbers were presented in a 6×5 matrix based on a horizontal display, whereas the low

usability condition presented a 5×6 matrix. We provided identical numbers but different

presentations to manipulate only the level of usability. A pre-test with 140 participants (U.S. = 64; 42.2% female, Korea = 76; 47.4% female) was conducted to determine whether the presentation modes of the security card might result in differences in participants' perceived usability during the usage trials.

Participants were first given a security card and told it represented a new security system that would launch in a few months and used to secure banking safely. They were asked to find and encode the specific numbers from the provided security card and were given three practice sessions before the "real" test. After the trial session, to ensure the validity of our manipulation of the usability of the security card, we asked participants to evaluate the usability with four items ranked on a 7-point scale (1 = "Not at all", 7 = "Very much"): "I thought the system was easy to use," "I thought the system was difficult to use," "I felt very confident using the system," and "I found the system very cumbersome to use" (Cronbach's α = 0.89; Brooke, 1996; Lewis and Sauro, 2009). The overall usability was indexed as the average of the items.

A one-way ANOVA was run with usability as the dependent variable and country and presentation modes of the security card as the independent variables. The main effect of presentation mode was significant ($M_{high\ usability}$ = 4.49 vs. $M_{low\ usability}$ = 3.89, $F(1, 136)$ = 7.505, p = 0.007). More importantly, there was no significant interaction effect of the two variables ($F(1, 136)$ = 0.116, p = 0.734). Participants, regardless of country, perceived that it was easier to complete the task in the high usability condition than in the low usability condition.

In addition, we conducted a one-way ANOVA with the average response time for each trial as the dependent variable. Consistent with the previous results, the main effect of the presentation modes was also significant ($M_{high\ usability}$ = 10.92 vs. $M_{low\ usability}$ = 13.82, $F(1, 136)$ = 10.591, p = 0.001). Moreover, the interaction effect of the two independent variables was not

significant ($F(1, 136) = 0.801$, $p = 0.372$). Consequently, we can conclude that participants in both countries completed the task faster in the high usability condition than in the low usability condition. The results of the pre-test confirm that usability was successfully manipulated (see Appendix A for stimuli).

3.2. Design and Participants

The main study used a 2 (usability: *high* vs. *low*) × 2 (culture: *individualistic* vs. *collectivistic*) between-subjects, full factorial design. The independent variables were usability of the security card and culture. As we described in the pre-test, usability was manipulated. We selected participants from Korea to represent a collectivistic cultural background and from the U.S. to represent an individualistic cultural background. According to Hofstede's (1980) indicators, Korea has one of the lowest individualism scores on a 100-point individualism scale, indicating that Koreans possess high collectivistic characteristics, whereas the U.S. has the highest individualism score. This categorization has also been used in previous studies (i.e., Ko *et al.*, 2015; Monga and John, 2006; Yu *et al.*, 2008).

To examine whether the thinking styles of Koreans and Americans differ as we theorized, we conducted a separate test ($N = 106$; U.S. = 52, Korea = 54). Participants responded to questions developed by Choi *et al.* (2007; see Appendix B). A one-way ANOVA was conducted, and the comparison of the two groups revealed a main effect of the cultural differences between the two countries in which the U.S. data exhibited a stronger tendency toward the analytic thinking style compared to the results for Korea ($M_{U.S.} = 4.33$ vs. $M_{Korea} = 4.66$, $F(1, 104) = 5.025$, $p = 0.027$). A one-way MANOVA was also conducted using sub-dimensions of thinking style as the dependent variable, and the results were consistent: causality ($M_{U.S.} = 4.67$ vs. M_{Korea}

= 5.74, $F(1, 104) = 34.851$, $p < 0.001$), contradiction ($M_{U.S.} = 4.65$ vs. $M_{Korea} = 5.15$, $F(1, 104) = 5.919$, $p = 0.017$), prediction of change ($M_{U.S.} = 3.25$ vs. $M_{Korea} = 4.35$, $F(1, 104) = 21.781$, $p < 0.001$), and attention ($M_{U.S.} = 4.26$ vs. $M_{Korea} = 5.11$, $F(1, 104) = 20.322$, $p < 0.001$). These results support our assumption that there is a cultural difference between Americans and Koreans as individualistic and collectivistic groups, respectively.

A total of 89 U.S. participants (49.4% female) and 137 Korean participants (40.9% female) were recruited to complete an online survey using Qualtrics survey software. Respondents participated voluntarily and filled out the survey for minimal course extra credit or a small monetary reward. The participants were randomly assigned to different conditions.

3.3. Procedure

All participants in the U.S. and Korea were told that we were introducing a new authentication form, that is, a security card system that would allow them to secure and manage online activities safely. They were then asked to test the security card using the same instructions described in the pre-test section. In the high (vs. low) usability condition, participants were provided with 30 random 4-digit numbers in a 6×5 (vs. 5×6) matrix representing the security card on a computer screen and were asked to find and encode a specific number from the presented security card. After three trials, participants were asked two questions about their behavioural intention to adopt the new security card system: "I am willing to use the security card for a trial period,", and "I am willing to use the new security card after the trial period as a regular security system". They gave answers ranked on a 7-point Likert scale (1 = "strongly disagree", 7 = "strongly agree"; Cronbach's $\alpha = 0.80$). They also assessed perceived effort with two items ranked on a 7-point Likert scale (1 = "Not at all", 7 = "Very much"): "effortful" and

"effortless" (Cronbach's α = 0.90). Participants then answered several questions about their demographic characteristics before being debriefed and dismissed.

An exploratory factor analysis with a varimax rotation was conducted to test whether behavioural intention and perceived effort are independent constructs. The analysis showed two factors. The three measures for behavioural intention were loaded to the first factor (loadings > .50; eigenvalue = 1.98) and the two measures for perceived effort were loaded to the second factor (loadings > .38, eigenvalue = 1.50). The results indicated the independence of the two variables. In sum, the results of the reliability and exploratory factor analyses reveal that the construct validity was successfully tested and identified.

3.4. Analyses and Results

3.4.1. Analysis of Moderation Effect of Culture: Usability of Online Security Card System, Culture, and Behavioural Intention

Behavioural intention (standardized) toward the online security card system was submitted to a two-way analysis of variance (ANOVA), including usability (high vs. low) and culture (individualistic vs. collectivistic) as between-groups variables. The result of the analysis showed a significant two-way interaction between usability and culture ($F(1,222)$ = 7.938, p = 0.005), suggesting that usability differently influenced behavioural intention depending on culture. Next, to understand the conditional effect of culture, we conducted the PROCESS macro for SPSS (Hayes 2013; Model 1, 5000 bootstrap samples) with 95% confidence intervals (CIs) to specifically explain the effect of usability on behavioural intention depending on culture (see Figure 2).

Consistent with our expectation, U.S. consumers showed significantly higher behavioural intention in the *high usability* condition than in the *low usability* condition ($M_{high\ usability}$ = 0.24 vs. $M_{low\ usability}$ = -0.18, conditional effect = -.21, p = 0.047, 95% CI [-.412,-.003]), whereas Korean consumers showed the opposite result of significantly higher behavioural intention in the *low usability* condition than in the *high usability* condition ($M_{high\ usability}$ = -0.15 vs. $M_{low\ usability}$ = 0.19, conditional effect = .17, p = 0.046, 95% CI [.003, .332]). Thus, H1a and H1b were supported.

3.4.2. Moderated Mediation Analysis: Perceived Effort as a Mediator

To test our moderated mediation hypothesis (Muller *et al.*, 2005) that the indirect effect of usability on behavioural intention in adopting the new security card system through perceived effort would be moderated by the culture, we conducted the PROCESS macro for SPSS (Hayes, 2013; Model 15, *n* boots = 5,000 with 95% CI). This analysis confirmed that the mediation effect of perceived effort (indirect effect = .039, 95% CI [.001, .110]) was significant because the confidence interval did not include 0. More interestingly, this analysis with the results of the conditional effect confirmed our expectation that perceived effort was negatively associated with behavioural intention among U.S. consumers but was positively associated with behavioural intention among Korean consumers. In other words, consumers perceive how much effort they exerted during the usage experience depending on different levels of usability, which leads to enhanced or attenuated behavioural intention toward the security card system depending on the culture. Based on these test results, H2 was supported: the influence of the interaction between usability and culture on behavioural intention was fully mediated by perceived effort (Zhao *et al.*, 2010). (see Figure 3).

Insert Figure 3 here

3.4.3. Robustness Check: Eliminating an Alternative Explanation

It could be argued that the results are driven by familiarity, whereby Americans are less familiar with the experimental stimuli (the security card in our experimental condition) compared to Koreans. If this is so, participants in each country might show an opposite pattern of the results irrespective of whether usability is high or low. To rule out this possibility, we conducted a post-hoc study with additional questions measuring familiarity with the stimuli. A total of 59 participants ($N = 59$, 33.9% female, $M_{age} = 35.51$) were recruited in the U.S. using Amazon's Mechanical Turk (MTurk) panel. The participants were provided a monetary reward of \$0.40 for participating in the survey, which required less than 3 minutes to complete. The survey followed the same procedure using the same stimuli as in the main study. Familiarity with the stimuli was measured using two items based on the question "What do you think of the newly introduced security system for online banking?" ranked on a 7-point scale (1 = "Not at all", 7 = "Very much"): "familiar" and "well-informed" (Cronbach $\alpha = .91$).

We conducted two rounds of ANOVA, one with no covariate and the other with familiarity as a covariate, to see if the pattern of results differed. First, a basic ANOVA confirmed a consistent result with the proposed hypothesis ($M_{high\ usability} = 5.75$ vs. $M_{low\ usability} = 4.86$, $F(1,57) = 4.367$, $p = .041$). Next, an ANOVA with familiarity as a covariate revealed a significant effect of familiarity. More importantly, the same pattern as in the first analysis emerged ($M_{high\ usability} = 5.75$ vs. $M_{low\ usability} = 4.86$, $F(1,56) = 5.023$, $p = .029$). Even though there is a significant main effect of familiarity, these results suggest that even after controlling for

familiarity, usability is a significant determinant of the usage intention toward online banking

authentication systems. Thus, the possibility of an alternative explanation that the effects of our

findings can be attributed to familiarity can be ruled out.

3.5. Discussion

The results supported our hypotheses. Participants with an individualistic cultural

background (U.S. consumers in this study) preferred the high-usability system, whereas those

with a collectivistic cultural background (Korean consumers in this study) showed a greater

behavioural intention toward the low-usability system. More importantly, these results were

consistent after controlling for familiarity, which is a potential alternative determinant of the

usage intention toward online banking authentication systems, especially for U.S. consumers

who are not familiar with the security card. Moreover, the mediation test confirmed that the

observed effect was driven by the experience of perceived effort.

4. General Discussion

Usability is a key determinant of the success of online financial services like internet and

mobile banking, along with security (Herzberg, 2003; Singh *et al.*, 2010). Accordingly, financial

institutions offering online services have invested great efforts to enhance the usability of their

online security systems. However, users' perceptions of a "good" security system may be

different from what is actually "good" from a technical standpoint. Some people may assume

that easy-to-use security systems are less secure. Thus, in the present study, our goal was to

examine the effect of usability on consumers' security perception and behavioural intention. In

particular, we expected that the influence of usability on the attractiveness of a security system

could differ by culture due to different information processing styles. Through empirical tests conducted in two countries (i.e., the U.S. and Korea), a reversed pattern of the behavioural consequences of usability across cultures was observed. Specifically, consumers with an individualistic cultural background reported lower attractiveness toward a difficult-to-use security system. By contrast, those from a collectivistic cultural background, who tend to assume a relationship between different attributes of a product, had higher behavioural intention toward the security card with lower usability. Furthermore, we found perceived effort invested in using the system as the specific mechanism that underlies these effects. Specifically, when they need to exert greater effort in using the security system, the usage intention of U.S. consumers decreased, whereas that of Korean consumers increased.

4.1 Theoretical Implications

The present study offers several theoretical contributions. First, we contribute to the literature on security systems by focusing on users' perceptions of usability and security. Previous research has established two seemingly opposite directions of the effects of usability in the acceptance of online security systems. Ample research has shown that a low level of usability generally decreases intention to use a product, but recent findings from Park *et al*. (2016) suggest that in the context of security systems, difficulty in using products may increase the perception of security, which increases usage intention. The current research combines two different research streams into a comprehensive framework, deriving a novel finding suggesting cultural differences as a meaningful boundary condition regarding the effect of ease of experience on adoption behaviour. Consequently, our findings fill a gap in previous studies and extend the understanding of consumer behaviour related to online security systems.

Moreover, we propose cognitive thinking styles as forces driving differences in users'

judgment in two different cultures. There is a large amount of cross-cultural comparison research

on the differences across East and West based on Hofstede's distinction between collectivism

and individualism (Albers-Miller and Gelb, 1996; Choi and Miracle, 2004). We extend the

studies considering holistic versus analytic processing style and provide further evidence that

culture can be defined as a pattern of cognitive processing styles (Monga and John 2008, 2010;

Nisbett *et al.*, 2001).

Finally, the results of the current study also extend recent findings from meta-cognitive

research demonstrating that difficult processing may have both positive and negative effects on

consumers' attitudes and behaviours. A wide variety of factors have been examined as

moderating variables, including task characteristics (Tamir *et al.*, 2004), advertisement format

(Nielsen and Escalas, 2010), the instrumentality of a product (Labroo and Kim, 2009), and

luxury product category (Pocheptsova *et al.*, 2010). In the current research, we demonstrate that

in the context of security products, fluent experience (easiness-to-use) can have both positive and

negative influences on the attractiveness of the products.

4.2 Practical Implications

Our findings offer valuable practical implications for banks and financial institutions that

operate across global markets. Through a demonstration of the diverging influences of the

usability of online security systems, in this case, e-banking authentication systems by culture, our

findings provide insights about the importance of local understanding and differentiation of

products. For users in an individualistic culture, it may be important to develop a security system

that is both easy to use and highly secure to increase adoption and usage; intuitive and simple

designs of security products and services to minimise the perceived effort required to use them would also be desirable. However, in a collectivistic culture, contrary to the general understanding and practice that less effort may increase usage intention, too easy-to-use may lower the intention to adopt a security system. Thus, it is important to find the appropriate level of usability that ensure security perception and is easy enough not to hinder adoption. Our findings suggest that slightly changing the way the access code was displayed, making it inconvenient to find, increased the perceived effort without severely hampering the usability and, thus, enhanced Korean participants' adoption intention. Similarly, taxing the trivial efforts of users, such as by adding frivolous steps, requiring special characters in a password, or embedding complex visual cues, may work to increase the attractiveness of security services for customers from a collectivistic background.

4.3 Limitations and Directions for Further Research

Our study examined the influence of usability on consumers' usage intention. However, online security services often involve repeated usage; hence, it is crucial to understand consumers' post-adoption behaviours. In particular, how people who adopt a product with low usability would address usability issues and whether they would continue using the service are important questions to answer. Prior studies on product design suggest that general users put greater weight on usability in the post-use situation than in the pre-use situation (Thompson *et al.*, 2005). However, we believe that a moderate level of disadvantage in usability may be overcome by repeated usage, especially among those who focus on security over usability in evaluating security services. While there is only limited evidence to support our prediction, one study on user perceptions of e-banking authentication systems (Weir *et al*., 2009) separately

measured users' evaluations after their initial use of three types of tokens and their reuse of the

preferred option. The majority of participants in that study preferred the easiest-to-use option,

which is consistent with our findings. More interestingly, participants who chose the difficult-to-

use options reported much higher usability after using the product for a while. This indicates that

perceived usability may improve after repeated usages. Furthermore, reuse intention increased as

the participants continued to use the product. Further research will extend this finding and

provide meaningful insights on post-adoption behaviour with a low-usability product.

Limitations to the external validity of our findings can be minimized by offering

respondents more realistic situations that involve actual financial transactions. In addition,

concerns about potential common method bias between our mediating variable and the

dependent variable can be lowered by inserting additional marker variables that are theoretically

unrelated to other measurements in the survey.

In addition, our rationale to develop the hypotheses proposed that the interaction effect

between usability and culture is mediated by perceived effort to predict perceived security. In

turn, the perceived security mediated the effect of perceived effort on consumers' usage intention

toward e-banking authentication systems. However, our empirical study did not include

perceived security in the research model because we consider perceived effort to be a more

critical moderator in our research model. Thus, it would be interesting to further test the serial

mediation model of the observed findings by including perceived effort and security as

sequential mediators. This analysis will provide a clearer picture of the underlying psychological

mechanism.

Finally, novel technologies have been introduced to increase the security and usability of

text-based systems, including graphical authentication and biometric techniques such as face- or

fingerprint-based systems. While these new systems may significantly enhance usability, their

implications for users' perceptions are not yet clear. For instance, easy-to-use fingerprint identity

authentication may not always be preferred to text-based passwords. If our findings that people

from collectivistic cultures interpret usability as a signal of low security apply to these systems

as well, firms may need to offer additional education to customers to address their security

concerns if they wish to facilitate the adoption of these new technologies.

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Disclosure statement

The authors report no potential conflict of interest.

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Figure 1: Research Model

Figure 2: Behavioural Intention and Usability Comparison between U.S. and Korean Consumers

(*Note:* Unstandardized regression coefficients are reported. * $p < .05$; ** $p < .01$

Figure 3: Statistical Results of Moderated Mediation (PROCESS macro for SPSS; Model 15)

Appendix A: Information Security Code Table (Stimuli in Experiments)

1	80 21	2	42 73	3	73 61	4	49 17	5	71 59
6	63 57	7	28 19	8	37 05	9	13 60	10	26 86
11	62 93	12	02 85	13	53 38	14	79 04	15	19 50
16	32 49	17	57 35	18	04 57	19	92 72	20	30 24
21	97 49	22	14 20	23	95 34	24	42 36	25	38 59
26	08 73	27	81 46	28	26 15	29	50 82	30	87 52

High Usability Condition

1	80 21	2	08 73	3	14 20	4	04 57	5	79 04	6	26 86
7	63 57	8	42 73	9	81 46	10	95 34	11	92 72	12	19 50
13	62 93	14	28 19	15	73 61	16	26 15	17	42 36	18	30 24
19	32 49	20	02 85	21	37 05	22	49 17	23	50 82	24	38 59
25	97 49	26	57 35	27	53 38	28	13 60	29	71 59	30	87 52

Low Usability Condition

Appendix B: Measures

Usability *(α = .89)*

- I thought the system was easy to use.
- I thought the system was difficult to use. ®
- I felt very confident using the system.
- I found the system very cumbersome to use. ®

Thinking Style

Causality (α = .80)

- Nothing is unrelated.
- Even a small change in any element of the universe can lead to significant alterations in other elements.
- Any phenomenon has numerous causes, although some of the causes are not known.
- Any phenomenon entails numerous consequences, although some of them may not be known.

Attitude Toward Contradictions (α = .64)

- It is more desirable to take the middle ground than to go to extremes.
- When disagreement exists among people, they should search for ways to compromise and embrace everyone's opinions.
- We should avoid going to extremes.

Perception of Change (α = .88)

- Every phenomenon in the world moves in predictable directions. ®
- A person who is currently living a successful life will continue to stay successful. ®
- An individual who is currently honest will stay honest in the future. ®
- If an event is moving toward a certain direction, it will continue to move toward that direction. ®

Locus of Attention (α = .74)

- The whole, rather than its parts, should be considered in order to understand a phenomenon.
- It is more important to pay attention to the whole than its parts.
- The whole is greater than the sum of its parts.
- It is more important to pay attention to the whole context rather than the details.

Behavioural Intention *(α = .80)*

- I am willing to use the security card for a trial period
- I am willing to use the new security card after the trial period as a regular security system

Perceived Effort *(α = .90)*

How did you feel while you were using the newly introduced security system?
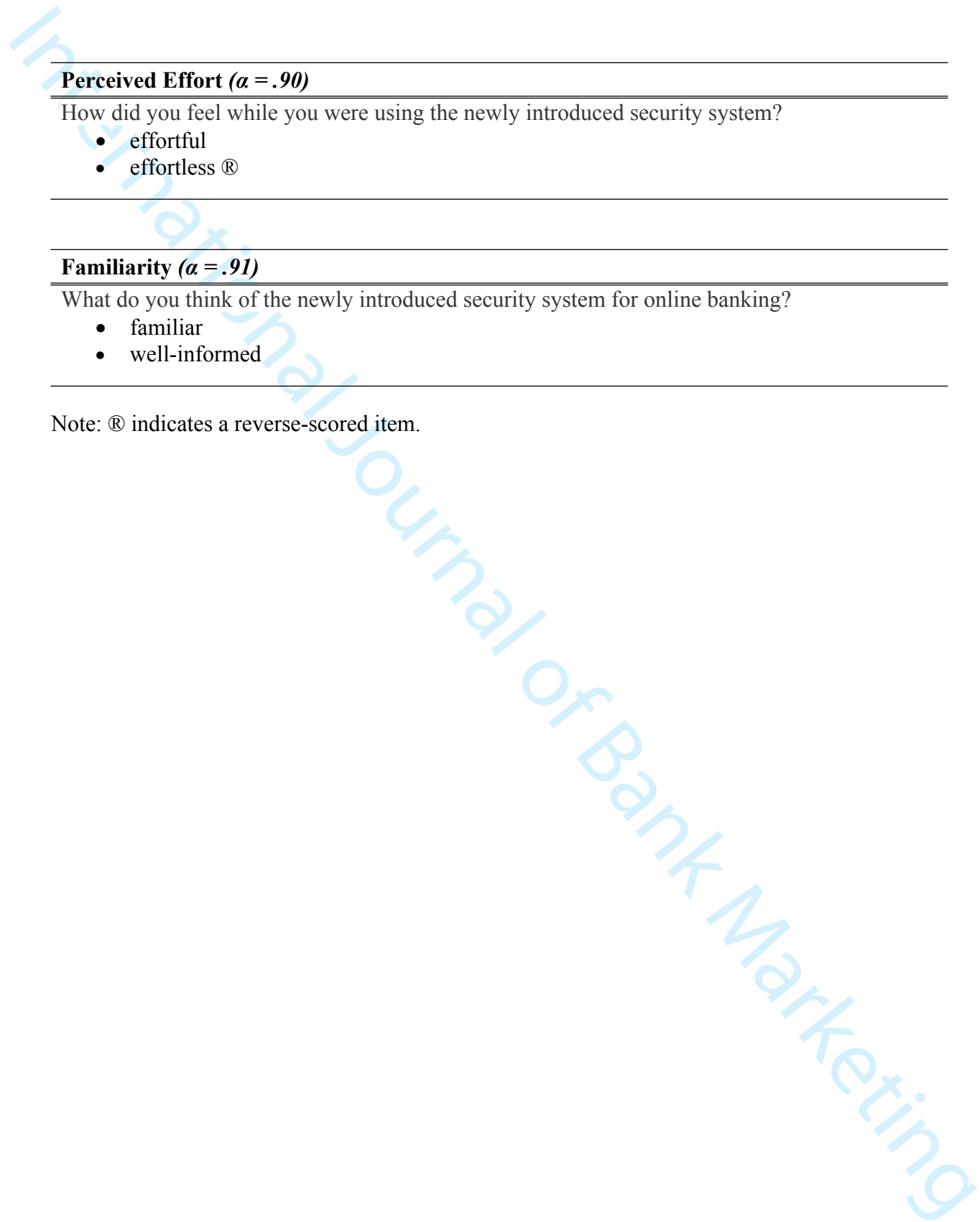- effortful
- effortless ®

Familiarity *(α = .91)*

What do you think of the newly introduced security system for online banking?
- familiar
- well-informed

Note: ® indicates a reverse-scored item.

Appendix C: Participants' Demographic Characteristics

Variables		Pretest (N = 140)		Main Study (N = 226)	
		US (N = 64)	Korea (N = 76)	US (N = 89)	Korea (N = 137)
Gender	Female	27 (42.2%)	36 (47.4%)	44 (49.4%)	56 (40.9%)
	Male	35 (54.7%)	40 (52.6%)	45 (50.6%)	81 (59.1%)
Age	Mean (*SD*)	32.47 (9.05)	34.95 (5.26)	37.21 (12.05)	33.21 (6.51)