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Wearable Computing Healthcare by Smart Band: Based on Fear-Appeal Persuasion

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Abstract

Objectives: As Internet of Things (IoT) leads the growth of wearable computing market. In this study, the healthcare market represented by smart watch and the smart band is one part of the fields that the IoT are the most actively utilized. **Methods/Statistical Analysis**: This study applies the Extended Parallel Process Model (EPPM) to the wearable healthcare utility using smart band display as the substantial theoretical and empirical evidence. With 32 subjects, the analysis utilized a 2×2 between-subjects fully crossed design. Based on the design, four experimental groups, which are high-threat/high-efficacy, high-threat/low-efficacy, low-threat/high-efficacy, and low-threat/low-efficacy, were composed. **Findings**: As the result of the 1 and 2 research questions, the threat and efficacy were not in a multiplicative relationship but an additive relationship under the both fear and danger control condition on a smart band display. These results lead to the conclusion that the most persuasive message facilitating wearable healthcare users' danger control responses while impeding their fear control responses could be high efficacy message regardless of the level of threat. **Improvements/Applications**: This study proved empirically that the threat and efficacy have an additive relationship rather than a multiplicative relationship with wearable healthcare devices.

Keywords: Extended Parallel Process Model (EPPM), Healthcare, Internet of Things (IoT), Smart Band, Wearable Computing

1. Introduction

As all things are connected by the Internet (Internet of Things: IoT), the wearable device market has been dramatically growing. Recently, Allied Business Intelligence (ABI) Research predicted release of 48,500 million wearable devices around the world by 2018. This is a figure that corresponds to 28% of the total Smartphone market forecasts scale. In addition, many research institutions such as Business Insider Intelligence (BI Intelligence) and Intelligent Maintenance Systems (IMS) research are forecasting the production of wearable device shipped more than 100 million every year[1]. The current Internet of Things (IoT) stream, trying to connect all things with a variety of devices based on the mobile platform by applying standardized software, leads the growth of wearable computing market. Especially, the healthcare market represented by smart watch and smart band is one part of the fields that the IoT are the most actively utilized. MarketResearch.com estimated in 2015 the healthcare IoT market segment would hit $117 billion by 2020[2].

As growth of the younger ages threatened in a variety of diseases such as hypertension, diabetes, and obesity, the development of the wearable healthcare has raised

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to give individuals the ability to manage and protect the threats. In the case of smart band, recently emerging wearable healthcare product, it visually expresses a variety of information as collecting and digitizing biometric data by the activity tracker sensor. However, there is insufficient to lead sustained motivation and behavioral changes because the functions are limited as just reviews and checks of the user's daily life. It may mean that the smart hand users need to additional information to know their current health condition and motivating cures to be healthier over just review or check through the User Interface (UI) of smart phone screen showing the healthcare information by connecting with a smart band. In addition, many of released wearable services so far simply have focused on technical part such as connecting speed, duration, and distance between the devices more than User Experience (UX) such as users' feeling, desire, and value by wearing the IoT devices. Because the current wearable computing healthcare ultimately fail to get users' empathy (mind share) and create their value (user value), it is difficult to expect user centered qualitative growth of wearable computing market.

From the issue, this study aims to find the motivation factors leading to healthcare like diet, sleep, fluids by consistently using smart band through fear appeals which is addressed in the field of health communication. Fear, as an aversive affective state, is a state that individuals are highly motivated to avoid[3]. In academic and industrial fields, therefore, a persuasive strategy using the fear appeals has received much attention. The Extended Parallel Process Model (EPPM) may be an efficacious framework for explaining the persuasive process and outcomes of emotion-based messages more broadly when such messages are addressing serious health topics[4].This study applies the EPPM to the wearable healthcare utility using smart band as the substantial theoretical and empirical evidence.

2. Wearable Computer-Smart Band

In general, a wearable computer may be defined as a computer that is subsumed into the personal space of the user, controlled by the wearer and has both operational and interactional constancy, i.e. is always on and always accessible 5. Wearable computer can be made to be worn by small modules that can interact with the user and other devices. In addition, the user can change the configuration anytime when they need with always operating condition. The surveymonkey.com 6 released that users' main reasons of using the wearable computer are to record the daily activities, improve the general health, and experience the latest technology. Most users want to use wearable devices as health related applications. That users take the wearable devices for their healthcare can be referred as the wearable computing healthcare. According the survey, medical field got users' highest interesting as 38%, and chose the wrist-type device with 32%, a head-mounted device with 21%, and the form of clothing as 8%. More specifically, the respondents most importantly presented the function, which can measure vital signs and notify them to the users or guardians. At 39% of them, they mainly used the function which can count walking, monitoring sleeping behaviors.

Wristband-type or smart band unit is mainly used in applications that primarily monitor by measuring users' movement amount, and it can encourage their movement then enable individual healthcare[5]. Even though many of wearable computing users are interested with the smart band devices due to their unique features like lightweight, fashionable and competitive price, most users reported that they stop using them between 1 to 6 months because of performance and effectiveness of the devices[6]. In fact, wearable computing healthcare market is expected to reach 41.3 hundred million US dollars in 2020 and to show a significant increase of 21.3% from 2015 to 2020[7]. Wearable technology through smart band is going to create a future where users can manage their own health and fitness. In addition, users are becoming increasingly aware of the importance of wearable healthcare device that can obtain a seamlessly acquire and recognize their information in their ordinary life. On this trend, user-centered research about smart band that can motivate and upgrade users' intention to use is required.

3. Extended Parallel Process Model (EPPM)

The Extended Parallel Process Model, or the EPPM, represents the most contemporary model of fear-based persuasion[8]. The EPPM posits that an individual's response to a threat-based message involves two distinct cognitive appraisals[8]. The first appraisal, threat appraisal, relates to the degree to which the message is perceived as threatening (i.e., how susceptible an individual believes they are to the threat and how severe the consequences would be should the threat occur). If the individual perceives that they are personally vulnerable and the threat is severe, a second appraisal, coping appraisal, occurs whereby the individual considers whether the message provides effective and useful strategies (i.e., termed 'response efficacy'), and whether they believe that they possess the ability to enact such strategies (i.e., termed 'message self-efficacy') to help avoid/reduce the threat[9]. In the EPPM, the emotion of fear is posited to, if threat is considered relevant and severe, ensure ongoing processing of the message and, efficacy will determine whether an individual seeks to control the threat (danger control) or control the fear (fear control)[10]. Thus, the emotion of fear may be considered important for individuals' attention and functioning to ensure ongoing processing[11] shown in Figure 1.

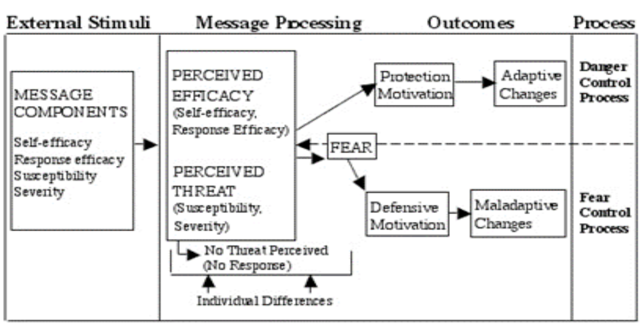

Figure 1. Extended Parallel Process Model (EPPM).

The result of fear appeal messages can be broadly divided into two types except the cases when people do not response (no response) for the fear appeal message. In the first type, people accept the recommendations given in the response messages. This process is defined as an adaptive response[11] or a danger control response and it can be considered as a success of persuasive message. In the second type, people do not accept the recommendations presented in the response message. It means that they do not follow the recommendation reaction. It refers to avoid the messages themselves, reject them, or the case of backlash. This process is a maladaptive response[4], or fear control response. It can be seen as the failure of the fear appeal message.

It is very important how the threat and efficacy affect to the result in the EPPM. It is about the relationship of threat and efficacy variables to the effect of fear appeal messages. Many researchers have provided two relationships which are a multiplicative and an additive relationship. In a multiplicative relationship, two variables have an interaction effect. It means if a variable is under the same or fixed condition, the result will be different according to the condition of another variable. Most of the fear appeal theories assume that the levels of threat are higher than them of the efficacy to succeed of fear appeal messages[11]. It is assumed that a different result in the EPPM may occur in accordance with the level of efficacy[8]. In other words, the high-threat/high-efficacy messages induce the danger control responses while the high-threat/low-efficacy messages cause the fear control responses. When the threat levels are the same, in the assumption, the message may succeed or fail according to the efficacy levels. Different from the perspective[10], confirmed that the threat and efficacy are not in a multiplicative relationship but in an additive relationship through their meta-analysis. In the additive relationship, two variables represent each primary effect. Therefore, the threat and efficacy have each independently main effect in the danger control process and fear control process. According to their analysis, the threat has a positive relationship with both the danger control process and fear control process. In addition, the efficacy has a positive relationship with the danger control process but it has a negative relationship with the fear control process. The relationship between the multiplicative and additive is very important issue with an establishment of the persuasive message or Public Relation (PR) campaign using the fear appeal messages. If the multiplicative relationship has the validity, the high-threat/high-efficacy messages may be seen as the most beneficial effect in terms of persuasion in that the combination has a high potential to facilitate danger control responses and inhibit the fear control responses. However, only high-threat/high-efficacy message combination will not be necessary if the additive relationship is more appropriate. If the threat is in negative relationship with the fear control responses, the low-threat/high-efficacy message will be more beneficial in the persuasive effectiveness. Therefore, it cannot rule out the possibility that the persuading effect by the low efficacy may be higher than in the case of high-efficacy messages according to the message context because the cases of the additive relationship can be variously occurred. Further study will be consistently pursued to figure out more reasonable combination by using a variety of populations, research topics and research methods[8].

The purpose of this study is to examine the relationship between the threat and efficacy in the calculating process for the result. Furthermore, it is to seek a fear appeal message type that may have the most convincing effects in wearable healthcare market by the smart band. Based on the preceding discussion, we proposed three research questions.

RQ1: Do the threat and efficacy have an additive (main) or a multiplicative (interaction) relationship under the danger control condition on a smart band display?

RQ2: Do the threat and efficacy have an additive (main) or a multiplicative (interaction) relationship under the fear control condition on a smart band display?

RQ3: What is the most persuasive message type under the both danger and fear control conditions on a smart band display?

4. Method

4.1 Participants

With convenience sampling, data from 32 subjects (16 males & 16 females) in Seoul (Korea) who had volunteered for the experiment were analyzed. Participants ranged from 31 to 53 years of age, with a mean of 37.2 years (SD = 6.35). As smart band users, their average time spent monitoring their information through mobile display was 1.4 hours per day. To ensure comparability, the self-administered survey was first developed in English, later translated into Korean, and then back translated into English. Some items were adopted from related literature and modified to suit the study while others were developed based on the literature.

4.2 Research Design

This analysis utilized a 2×2 between-subjects fully crossed design. Based on the design, four experimental groups, which were high-threat/high-efficacy, high-threat/low-efficacy, low-threat/high-efficacy, and low-threat /low-efficacy, were composed. All four groups were evenly divided with 8 participants. After exposing the manipulated visual materials, all participants in each four group responded to the survey shown in Figure 2.

Figure 2. Examples of the manipulated experimental materials.

T-test was performed to ascertain statistical significance between-group differences to ensure the adequacy of manipulating the level of threat and efficacy according to each message type. The result of t-test showed the high threat groups (M=4.31, SD=.95) were higher than the low threat groups (M=3.53, SD=.84). It was statistically significant (t=5.04, p<.001, df =130). In addition, the high efficacy groups (M=5.62, SD=.94) were higher than the low efficacy groups (M=5.11, SD=1.11). It was also statistically significant (t=2.65, p<.01, df =128). It means the experimental materials were properly manipulated. The manipulated independent variables were the threat and efficacy. The threat was divided as the perceived vulnerability and severity, Efficacy was composed of the perceived response efficacy and self-efficacy. The dependent variables are divided into the danger control responses and fear control responses. The threat and efficacy variables were measured by a Risk Behavior Diagnosis (RBD) scale developed by[10]. All of the items were measured using a seven-point modified Likert scale, anchored by (1) Strongly Disagree, and (7) Strongly Agree. SPSS Statistics v. 18 was used for the statistical analysis.

5. Result

The validity and reliability (cronbach's alpha) of the proposed scales for the empirical study were evaluated by performing Exploratory Factor Analysis (EFA). The factors were extracted based on eigen values greater than 1, and these were required to have a significant factor loading greater than 0.6. A multiple regression analysis was conducted to examine whether the threat and efficacy have an additive (main) or a multiplicative (interaction) relationship under the danger control condition. For the first research question, a hierarchical regression analysis was carried out twice as the dependent variables with the attitude and intention. The independent variables were the threat, efficacy, and threat × efficacy. The threat and efficacy were conducted in the first step, and then the threat × efficacy was input in the next step. Table 1 shows the result of the regression. The results imply that there was no interaction effect between the threat and efficacy in the attitude and intention. Even though the threat was not significant, the efficacy was statistically significant in attitude (β = .42, p <.001) and intention (β = .37, p <.001). Therefore, the threat and efficacy had an additive relationship under the danger control responses.

Table 1. Regression of threats, efficacy, threatening × efficacy

Danger Control Responses			Fear Control Responses		
	Attitude (β)	Intention (β)	Escape (β)	Reject (β)	Resist (β)
Treat	.07	.09	-.17	-.16	-.14
efficacy	.42***	.37***	-.18*	-.17*	-.17*
Treat ×efficacy	.08	.09	.-.17	-.14	-.15
R2	.14	.17	.03	.04	.03

*** p<.001, * p<.05

In the same way with the first research question, the hierarchical regression analyzes were performed three times with the dependent variables as avoidance, reject, and resist. The independent variables were the threat, efficacy, and threat × efficacy. Likewise the first question, the threat and efficacy were conducted in the first step, and then the threat × efficacy was input in the next stage. In Table 1, the result of the fear control responses showed very similar as a result of the danger control responses. Also, there was no interaction between the threat and efficacy in all items. In addition, the threat did not have a significant impact across the entire items. But, the efficacy had negatively main effects in the avoidance (β = -.18), denial (β = -.17), and opposition (β = -.17). As the result of the second question, the threat and efficacy had an additive relationship under the fear control condition on a smart band display. Through RQ1 and 2, the threat and efficacy commonly showed the main effect under the both fear and danger control condition. In other words, the threat and efficacy were not in a multiplicative relationship but an additive relationship under the both fear and danger control condition on a smart band display.

Research question three was tested using one-way Analysis Of Variance (ANOVA). The messages of four types were independent variables and the attitude and intention were dependent variables. Table 2 shows the result of ANOVA under the danger control condition. They were significant (attitude: F = 13.01, p <.001, intention: F = 22.47, p <.001). Specifically, the values of high efficacy groups, which were high-threat/high-efficacy (attitude: M = 6.06, SD = .69, intention: M = 6.05, SD = .80) and low-threat/high-efficacy (attitude: M = 6.47, SD = .62, intention: M = 5.11, SD = .61), were much higher than them of the low efficacy groups, which were high-threat/low-efficacy (attitude: M = 6.33, SD = .87, intention: M = 5.97, SD = .79) and low-threat/low-efficacy (attitude: M = 5.07, SD = 1.23, intention: M = 4.97, SD = 1.69). However, there was no statistically significant between the high efficacy groups which were high-threat/high-efficacy and low-threat/high–efficacy. As the result, the most efficient message type that may promote the danger control responses on a smart band display was the high efficacy group consisting high-threat/high efficacy or low threat/high efficacy.

Table 2. Danger control condition according to the message types

	HT/HEM (SD)	HT/LEM(SD)	LT/HEM(SD)	LT/LEM(SD)	F
Attitude	6.06(.69)	6.33(.87)	6.47(.62)	5.07(1.23)	13.01***
Intention	6.05(.81)	5.97(.79)	5.11(.61)	4.97(1.69)	22.47***

*** p<.001

Table 3 shows the result of one-way ANOVA with avoidance, reject, resist as dependent variables under the fear control condition. They were all significantly analyzed (avoidance: F = 4.36, p<.01, reject: F = 4.47, p<.01, resist: F = 4.87, p<.01). Specifically, the high efficacy groups which were high-threat/high-efficacy (avoidance: M = 2.93, SD = 1.23, reject: M = 3.27, SD = 1.08, resist: M = 3.06, SD = 1.01) and low-threat/high-efficacy (avoidance: M = 2.82, SD = 1.02, reject: M = 3.19, SD = 1.13, resist: M = 3.11, SD = 1.07) were lower than the low efficacy groups which were high-threat/low-efficacy (avoidance: M = 3.62, SD = 1.18, reject: M = 3.97, SD = .98, resist: M = 3.69, SD = 1.12) and low-threat/low-efficacy (avoidance: M = 3.78, SD = 1.23, reject: M = 4.97, SD = 1.69, resist: M = 4.06, SD = 1.43). As the result, the most efficient message type that may suppress the fear control condition on a smart band display was the high efficacy group consisting high-threat/high- efficacy or low-threat/high-efficacy.

Table 3. Fear control condition according to the message types

	HT/HE M (SD)	H T/L EM(SD)	LT/ HEM(SD)	LT/ LEM(SD)	F
Avoidance	2.93(1.23)	3.62(1.18)	2.82(1.02)	3.78(1.23)	4.36**
Reject	3.27(1.08)	3.97(.98)	3.19(1.13)	4.97(1.69)	4.47**
Resist	3.06(1.01)	3.69(1.12)	3.11(1.07)	4.06(1.43)	4.87**

** p<.01

Through the RQ3, the most effective message type on a smart band display that may facilitate the danger control responses and restrain the fear control responses was the high-threat/high-efficacy or low-threat/high- efficacy type.

6. Discussion

This study is to explore empirically which relationship between the additive and multiplicative relationships in the situation when the fear appeal messages were used as the persuasive format with the EPPM is more appropriate for showing the healthcare information to smart band display. In addition, the most effective fear appeal message type on a smart band display was researched in terms of persuasion. Accordingly, this study raised three research questions. The first and second research questions were to research the relationship between the threat and efficacy in each danger and fear control response. The third question was to derive the most effective fear appeal message type based on the first and second results. As the result for the first and second research questions, the threat and efficacy had each main effect rather than the interaction effect under the both fear and danger control responses. Therefore, the threat and efficacy were in an additive relationship under the both fear and danger control condition. From the result, the highly persuasive message type may be seen as a high level of efficacy messages regardless of the level of threat. The high-threat/high-efficacy or low-threat/high-efficacy message was in the message type. Therefore, this high level of efficacy message was the most effective message type that can facilitate the danger control responses and suppress the fear control responses regardless of the level of a threat on a smart mobile display reflecting healthcare information of a smart band. The result of this study may provide academic and practical implications. This study applied the fear appeal to the wearable computing healthcare area by a smart band as a persuasive tool. As the result through experiment and survey, this study proved empirically that the threat and efficacy have an additive relationship rather than a multiplicative relationship with wearable healthcare devices. More specifically, threat is not significantly related with either danger or fear control responses to wearable computing healthcare among smart band users. To the contrary, efficacy found related positively to danger control responses, and negatively to fear control responses respectively.

In conclusion, the fear appeal message focusing on just threat may be not an effective persuasive format on a smart band display because there was no difference in effect between the high-threat/high efficacy and low-threat/high-efficacy messages. In other words, high efficacy factors can be more effective than the threat factors to get the change of smart band users' attitude and intention for their healthcare. Future study about the fear appeal message as persuasive tools with various wearable healthcare devices will be required.

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