

Breaking through Fuzzy Positioning: Diverse Design Communication Strategies for Older Adults' Healthcare Wearables

Chen Li, Graduate School of Design, National Yunlin University of Science and Technology, China, fionalee1125@qq.com

Chang – Franw Lee, Graduate School of Design, National Yunlin University of Science and Technology, Taiwan, leecf@yuntech.edu.tw

Abstract

In this study, based on the perception of older adults, fuzzy positioning of healthcare wearables and impacts of differentiated product positioning on human considerations and design communication strategies are studied. Empirical researches are performed by adopting both quantitative research (248 questionnaires for clustering and regression analysis) and qualitative research (15 cases for in- depth interview). The perceptions of older adults on product positioning are divided into three types: Tech-Aid, Fash-Acc, and Fash-Tech. Results indicate that the influential human considerations for each positioning were different from each other. Through coding and storyline analysis, diverse communication strategies are found for each positioning. The outcomes for each type are as follows. For Tech-Aid, wherein older adults lay emphasis on usefulness, ease of use, and privacy, the designers can adopt a calm communication strategy by giving priority to older adults' control power, fitting symptoms, user-friendly, and cautious interconnection. For Fash-Acc, wherein older adults focus on personal image, aesthetic appearance, and ease of use, an active communication strategy for modeling a style for elderly fashion that agrees with aesthetic appreciation and simplified operation can be adopted. For Fash-Tech, wherein older adults require to integrate usefulness, ease of use, aesthetic appearance, comfort, privacy, and self-image, a persuasive communication strategy can be used, through which designers can offer older adults more data insights and entertainment, along with data association, and in the meantime, reduce data interferences and pay attention to style modality and appropriate display with context fusion and contact comfort.

Keywords: Healthcare Wearables, Older Adults, Product Positioning, Design Communication, Human Consideration, Design Elements.

In recent years, accelerated social aging causes older adults to improve their demands of healthcare, life assistance and independence. The wearables attach great importance to health self-management and medical association of local older adults. However, practical cases that older adults make use of the wearables for healthcare are still very limited despite that designers deem that such a design is able to bring independent and safety to older adults in their daily life (Dickinson & Hill, 2007). In other words, it is difficult for them to accept them. Thus, the researchers start from perceptual product positioning of healthcare wearables, then explore the influential human considerations and communication strategies for design, the

following problems are presented here:

- Do older adults have different recognition tendency and agreement towards the positioning of healthcare wearables?
- What influences does the perceptual positioning have on human considerations which are related to acceptability?
- Which communication strategy should be taken specific to each positioning of healthcare wearables?

Literature Review

Fuzzy Product Positioning for Older Adults

Research hot spots related to the present healthcare wearables are involved with how users treat such new product positioning (Choi & Kim, 2016; Rauschnabel et al., 2016). Among them, an interesting issue is that wearables fall into the type of medical technology or fashion accessories and how to treat fuzzy boundary between such two types of positioning. Product positioning is a critical part of product decision and closely related to ultimate physical characteristics and the perception nature of design (Kaul & Rao, 1995). The essence of product positioning cognition difference is rooted in the differences in perception of categorization. In accordance with the categorization research about consumer psychology, categorization is a mental process during which individuals make their quantities of life experiences structured by classification construction and description (Loken, Barsalou, & Joiner, 2008). On this basis, it can be inferred that categorization different from the previous can be generated among older adults so as to further affect clear and definite product positioning of healthcare wearables, as far as conflicts between new medical technology inherent in the devices and the corresponding acquainted appearances. For older adults, diverse categorization and product positioning absence have an impact on their perceptions on benefits incurred by the related design, especially when the boundary between medical technology aids and fashion accessories is involved.

Human Considerations to Acceptability in Wearable Interaction

Considering the research of Buenaflor and Kim (2013) about human considerations to acceptability and some other research about older adults, this paper first puts emphasis on influences of human considerations related to cognitive, social and physical aspects on the wearable interaction design.

Human considerations in cognitive aspect: (1) Perceived Usefulness (PU): Utility is a problem of design and also an essential value of devices (Ledger & McCaffrey, 2014). PU means that older adults consider utilizing particular devices to improve degree of healthcare performances. Although the wearables with complex sensors may not be fully interpreted by older adults, the emphasis of design communication can be exerted on how to prove the design is able to truly improve health benefits of older adults. (2) Perceived Ease of Use (PEU): In terms of older adult technologies, ease of use, as a non-ignorable basic principle (Czaja & Sharit, 2013; Fisk, Rogers, Charness, Czaja, & Sharit, 2009), is put on an important position by studies on mobile technologies (Renaud & Van Biljon, 2008). PEU refers to

mental and physical efforts taken by particular devices in the opinion of the elder users. As the wearables is a type of intelligent technology, considerations about older adults' difficulties in learning and perceiving them affect the ease of use of related products and services.

Human considerations in social aspect: (1) Personal Image (PI): Personal image means that a particular healthcare wearables is able to offer older adults with a self-identity feeling suitable for overall identities and status of them on one hand; on the other hand, it determines that whether such a particular healthcare wearables is able to improve the status of relevant older adults in social system (Moore & Benbasat, 1991). Most of healthcare wearables are exhibited in forms of clothes and accessories that are exposed in social environment surrounding these older adults. Therefore, it has a more significant influence on appearances of older adults than other technology products. (2) Personal Privacy (PP): Evaluations between practical values and privacy risks emerge with the development of information technology. In line with privacy calculus model (Dinev & Hart, 2006), users are willing to give up some privacies (e.g., personal information) to acquire certain benefits (individualized services). However, the role that privacy plays in health wearable interaction for older adults, that is still not clearly discussed, has been incorporated into considerations of this paper.

Human considerations in physical aspect: (1)Aesthetic Appearance (AA): Aesthetic experience is a critical part of healthcare wearables (Lin, Chien, & Kerh, 2016). Perception of older adults on particular design features in the process of healthcare wearable design can coordinate the design so that aesthetic preferences of the elder users are comprehended more thoroughly. (2) Physical Comfort (PC): Tehrani and Michael (2014) points out that wearables are electronic technique or computers that can be put on comfortably and this is the uppermost feature of wearables; in addition, comfort of the healthcare wearables including clothes, etc. has an important influence on consumers' decisions (Kaplan & Okur, 2008). As wearables for health monitoring requires wearing for a long time, the corresponding comfort cannot be overlooked.

Research Methods and Procedure

Based on explorations in relevant theoretical background, we proposed three hypotheses: First, differences lie in older adults' perceptions on product positioning of healthcare wearables. Second, product positioning may have influence on influential human considerations to acceptability. Third, dependent on different kinds of perceptual positioning, design elements related to influential human considerations in interactive contexts would be different from each other.

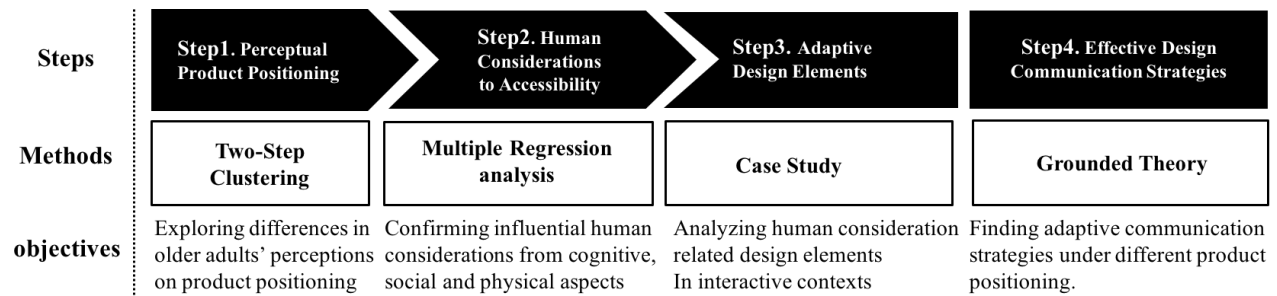


Figure 1: Research Methods and Procedure

Then, empirical researches were performed by adopting both quantitative and qualitative research studies (please refer to Figure 1). Tested objects of this study are urban older adults who are interested in the healthcare wearables. In quantitative phase, relevant data are collected here by questionnaires that should use scales with good reliability and validity in references as bases to the greatest extent. Questionnaire surveys are also carried out to gather data and SPSS 24.0 is adopted to perform data analysis. The Cronbach's α value of 248 effective questionnaires as a whole is 0.90 (>0.70), and relevant results indicate that the KMO value is 0.87, sphericity test of Bartlett exhibits significant results ($p < 0.001$), which proves that the questionnaires surveys have preferable reliability and validity. In qualitative phase, case study was adopted to explore critical design elements and adaptive communication strategies of the wearable interaction design under the circumstance of the perceptual positioning of them. During interview, the older adults put on device of the same type as stimulus material to obtain the firsthand experience, see Figure 2. Grounded theory was utilized as a methodology and QSR NVivo 11.0 as an analysis tool to assist with data processing of interview recording for 15 older adults.



Figure 2: Stimulus material

Discussion

Cluster Analysis of Perceptual Product Positioning

From the beginning of analysis, Two-Step Clustering from SPSS is also employed to perform cluster analysis on stimulus materials. Research results of cluster analysis indicate that 248 testing results are divided into three clusters (87 cases for Cluster 1; 53 cases for Cluster 2; and, 108 cases for Cluster 3) to obtain an excellent cluster quality. Mean values of product positioning perception and lifestyle items in three clusters (see Figure 3) are both comprehensively analyzed in detail here:

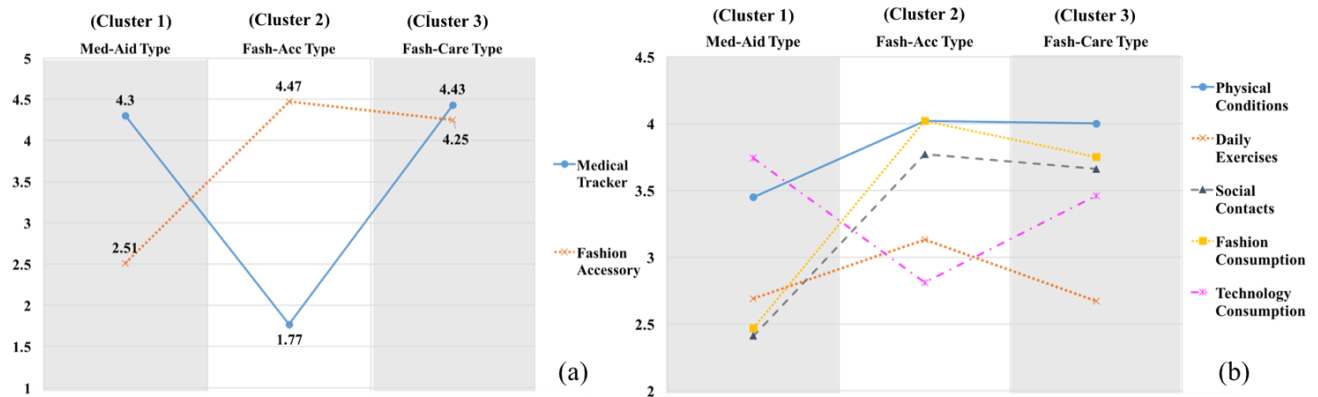


Figure 3. Mean results of cluster analysis: (a) mean value results of product positioning perception; (b) mean value results of lifestyle

In Cluster 1, which is named as Tech-Aid (TA) type, older adults have a high degree of recognition in medical technology, while low in fashion accessory. It signifies that technology assistive capability of wearables is considered to be very important by older adults from this cluster. Then, lifestyles of older adults are further analyzed and it turns out that they share some features such as poor physical conditions, daily exercise occasionally, fewer social contacts than other clusters, and more technology consumptions than those of fashion.

In Cluster 2, which is named as Fash-Acc (FA) type, older adults have a high degree of recognition in fashion accessory, while low in medical technology. It signifies that fashion values of wearables are deemed to be very important by older adults from this cluster. Then, most significant lifestyle features of older adults in this cluster include good physical conditions, most daily exercises, most social contacts among three clusters, and higher identification degree of fashion consumptions than technology consumptions.

In Cluster 3, is named as Fash-Tech (FT) Type, older adults have high degrees of recognition in both medical technology and accessory, which proves that they pay close attention to combined actions of technology abilities and fashion values. Among older adults from FT type, evident lifestyle differences lie in the fact that not only do they have optimal physical conditions, but similar identification degrees of fashion and technology consumptions.

The Influential Human Considerations in Different Product Positioning

This research focuses on estimations on healthcare wearable design with diverse types of product positioning. The mean values of influence human considerations show that three types of product positioning are similar to each other in terms of physical characteristics. However, as far as cognitive attitudes and social interactions are concerned, they are dramatically different (see Figure 4).

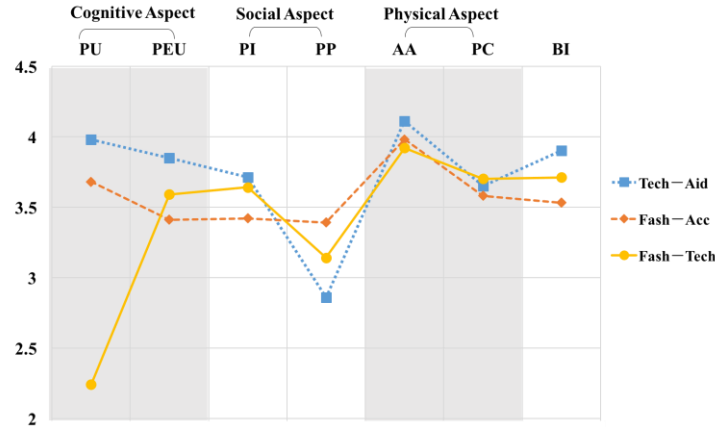


Figure 4: The mean results of human consideration on each product positioning

The mean values of design factors also clearly show different perception degrees on every stimulus sample. Nevertheless, it is difficult to carry out deductions in a wide range due to influences of stimulus sample selections. Therefore, this study pays much more attention to the potential influence relations between variables. In this process, PU, PEU, PI, PP, AA and PC are all used as independent variables, BI as a dependent variable, to perform multiple regression analysis. As for related data obtained, please see Table 1. According to coefficient of determination of the regression equation, such coefficients of three regression equations are all greater than 0.50. Thus, these multivariate regression results can be utilized to conduct detections correspondingly in this paper, see Table 1. Significances of standardized regression weights in three groups serve as basis for discussions below:

For TA type positioning, PU, PEU and PP are significantly related to acceptance behaviors. To be specific, PU ($\beta = 0.668^{***}$) has the most important influence on such behaviors, followed by PP ($\beta = 0.265^{**}$) and PEU ($\beta = 0.260^{**}$) successively. **For FA type positioning**, factors significantly related to acceptance behaviors are PEU, PI and AA. In detail, AA ($\beta = 0.418^{**}$) has the most important influence on such behaviors, followed by PI ($\beta = 0.334^{**}$) and PEU ($\beta = 0.297^{*}$) successively. **For FT type positioning**, all factors explored during study are significantly associated with acceptance behaviors of older adults. Clearly, Fash-Tech type positioning is a fusion of medical technology and fashion accessories, which differs from Tech-Aid type and Fash-Acc type positioning. Corresponding data results indicate that PEU ($\beta = 0.379^{***}$) has the most important influences, followed by AA ($\beta = 0.228^{**}$), PC ($\beta = 0.215^{*}$) and PU ($\beta = 0.207^{**}$) take the third place while PI ($\beta = 0.199^{*}$) and PP ($\beta = 0.161^{*}$) come last. On account of this data with diverse influential human considerations of product positioning, it is unnecessary to define which type of product

positioning is the best as each type is specialized and has its own strong points.

Table 1: The different influence of human considerations to acceptability in different product positioning

<i>Type</i>	<i>Tech-Aid (TA)</i>	<i>Fash-Acc (FA)</i>	<i>Fash-Tech (FT)</i>
Sample Size	35.1% (n=87)	21.4% (n=53)	43.5% (n=108)
Adjusted R ²	0.522	0.630	0.652
β	Perceived Usefulness (PU)	0.668***	-0.129
	Perceived Ease of Use (PEU)	0.260**	0.297*
	Personal Image (PI)	0.010	0.334**
	Personal Privacy (PP)	0.265**	-0.092
	Physical Comfort (PC)	-0.156	0.115
	Aesthetic Appearance (AA)	-0.160	0.418**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Diverse Communication Strategies based on Grounded Theory

Dependent on the aforementioned difference in human considerations affecting the adoption of healthcare wearables of diverse types of product positioning, it is deemed in design study that grasping product positioning defined for the healthcare wearables as well as essential human consideration for each kinds of positioning is the first critical step. Meanwhile, understanding the interactive context of communications between influential human considerations and design elements adopted by the designer is another critical step to probe into adaptive design communications continuously in a qualitative phase. In this part, grounded theory was utilized as a methodology and QSR NVivo 11.0 as an analysis tool to assist with data processing of interview recording for 15 older adults. Free Nodes of NVivo was employed for open coding encoding according to Vivo encoding principle, and Tree Nodes for axial coding related to each kind of positioning. Thus, the common encoding book could be obtained with reliability of three researchers arrived at 72%. Furthermore, Model was also utilized to connect axial codes to describe the interactive development story line between human consideration and all design elements.

A Calm Communication Strategy for Tech-Aid (TA) Positioning

Encoding of TA positioning came from five interviewees. In total, 95 free nodes were sorted out and then used as the open codes converged into 21 axial codes. Settlement of the storyline, axial codes of PU, PEU and PP were used as the center to construct the interactive contexts between them and other axial codes. After Storylines analysis in in TA positioning, a calm

communication strategy is proposed, explorations were made centering on PU, PP and PEU which have the greatest influence on the adoption of the older adults, see Figure 5.

(1) Priority to control power; Fit symptoms. Starting from PU, it was found that design element that has the largest impact on usefulness was Control Power. The design should endow the older adults with a sense of accomplishment that they had the ability to control by themselves and the age of physical condition recording in a passive way has ended. Furthermore, older adults who gave the devices TA positioning usually have more experience in and are more concerned chronic diseases, especially high cholesterol, high blood pressure, high blood sugar (Three-highs) problems regionally commonly seen.

(2) Friendly learning; Straightforward. As far as PEU is concerned, the factor that has the largest influence on the ease of use is Learnability. During interviews, it was found that the older adults indeed became nervous at the time of wearing devices and they were also not accustomed to too much learning. It is much likely for the older adults to accept wearable parts of easy operation.

However, some old people do not want to learn to use smart phones and thus hope that devices are able to fulfill measurements and get command of enough health information independently. Then for older adults who use wearable parts or smart phones, their expectations to Readability and Interoperability can be traced back to Visualizing Data. In other words, they hope that the devices can be provided with clear large characters that are easy to understand and can be seen by just raising hands at the time of using smart watch.

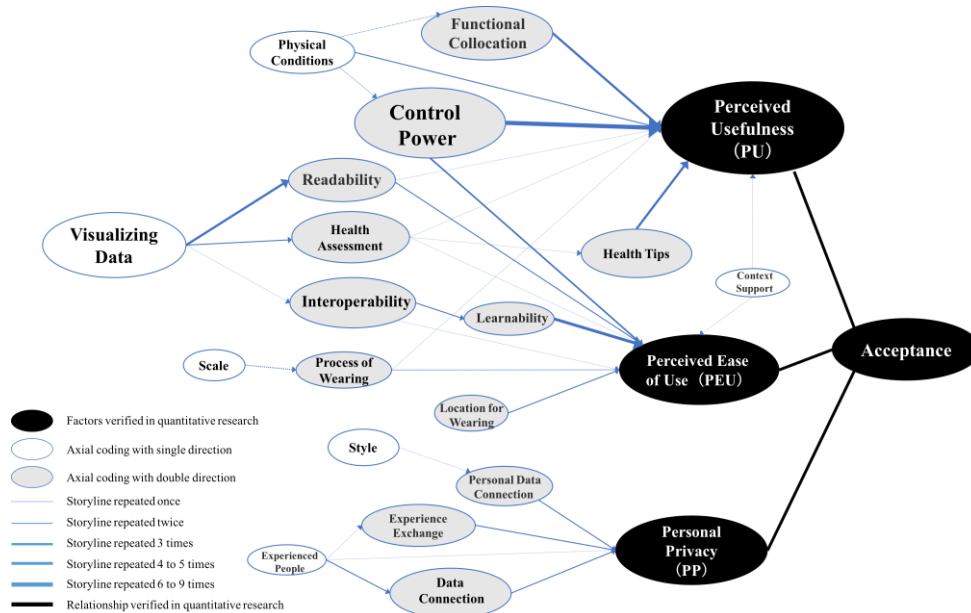


Figure 5: Storylines in TA positioning

(3) Information hierarchy; Cautious interconnection. PP is identified by the older adults

from three levels: personal data, measurement data, and personal experience. Older adults hope to reveal such information to the least extent, while be only willing to talk about them with experienced friends or interconnect with doctors, and share their healthcare experience with any one and hope that more people can benefit from it. As a result, at the time of considering privacy problems of wearables, the designer should start with data type identification and rationally arrange disclosure degree of data in diverse types, so that reasonable privacy arrangement can be made on the basis of meeting interactive intentions of the older adults.

An Active Communication Strategy for Fash-Acc (FA) Positioning

Encoding of FA positioning came from four interviewees. In total, 170 free nodes were sorted out and then used as the open codes converged into 25 axial codes. Settlement of the story line, axial codes of PI, AA and PEU were used as the center to construct the interactive contexts between them and other axial codes, see Figure 6. After storylines analysis in FA positioning, an active communication strategy is proposed, explorations were made centering on PI, AA and PEU which have the greatest influence on the adoption of the older adults:

(1) Thinking about modeling; Concealing stigma. The most influential code of PI is Modeling Implication. In interview, health monitoring function deliberately displayed on devices by designer becomes a burden to the older adults. With aging and the arrival of diseases, the older adults begin to play a minor role in the entire social so that they become especially sensitive to senses of identity. If the design is accompanied with a stigma of “Old Patient”, older adults can be ashamed of displaying such wearables. In comparison, they are more willing to show those beautiful ones. Besides, the older adults of this positioning have many social contacts and they expect to maintain personal images of being healthy and active in Social, Data Connection and Experience Exchange.

(2) Modeling style, Agreeing with aesthetic appreciation. An important relation exists between Modeling Implication and Visibility, and AA. The older adults hope that these wearables could be accessories that look normal and can be exposed as usual. Additionally, Style is also a factor that should be taken into account as far as beauty is concerned. Older women may expect wearables to be strongly decorative on behalf of their pursuits for beauty. By contrast, older men prefer smart watch and expect the corresponding products to be high-end, but not over high-profile.

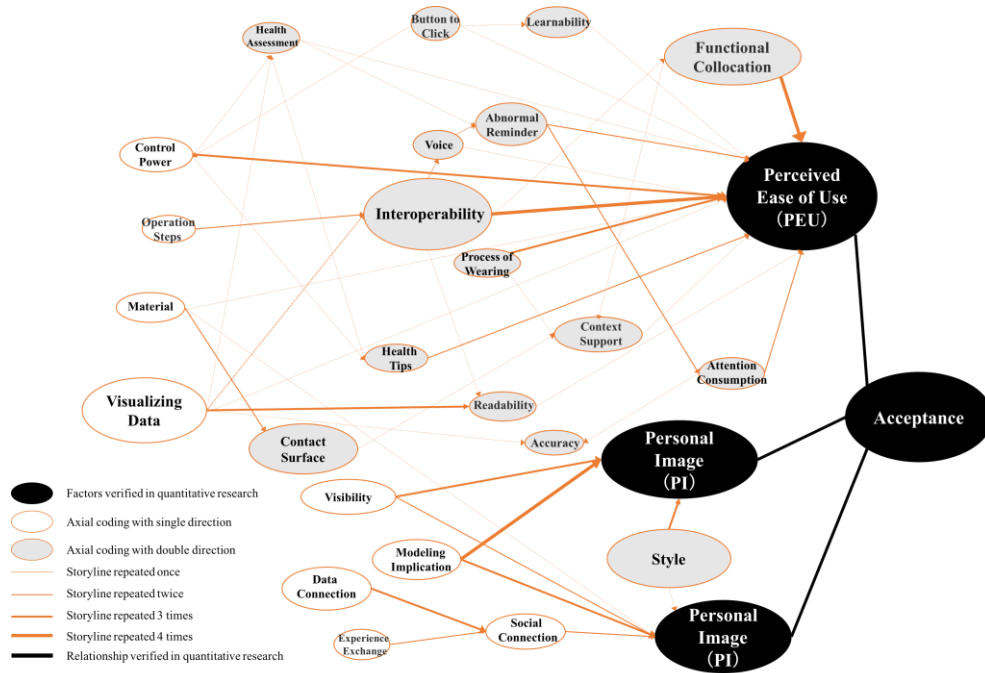


Figure 6: Storylines in FT Positioning

(3) Simplified operation; Popping on and off at will. Starting from PEU, the most evident code is Interoperability. It is apparent that the older adults pay less attention to health monitoring functions of such wearables than appearance and self-image. Simplification of Operation Steps on interoperability to reduce operation levels is indispensable. If the design is able to provide an Abnormal Reminder by voice interaction, the corresponding devices can become very convenient for the older adults; furthermore, the older adults also need to pay less attention to them. Moreover, they also keep a watchful eye on the process of popping on and off, for it is less likely for them to put on these devices frequently. In order to develop a habit of wearing for a long time, it is necessary to take multiple scenarios in their life into consideration.

A Persuasive Communication Strategy for Fash-Tech (FT) Positioning

Encoding of FA positioning came from six interviewees. In total, 219 free nodes were sorted out and then used as the open codes converged into 26 axial codes. Settlement of the story line, axial codes of PU, PEU, PI, PP, AA and PC were used as the center to construct the interactive contexts between them and other axial codes, see Figure 7. After storylines analysis in in FT positioning, a persuasive communication strategy is proposed, explorations were made centering on PU, PEU, PI, PP, AA and PC which have the greatest influence on the adoption of the older adults:

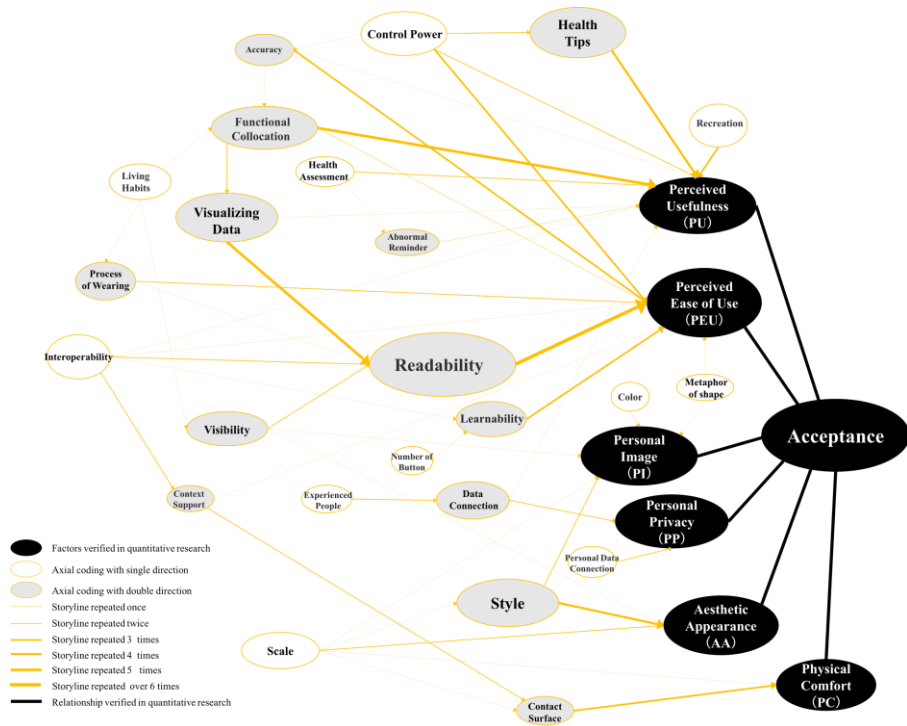


Figure 7: Storylines in FT positioning

(1) Data insights; Entertainment complementary. PU is a human consideration that has the largest influence on adoption. Implications of data can be explored in a more thorough manner on the basis on Health Assessment so as to offer more specific Health Tips. Although data are readable for the older adults, the older adults also hope that Health Tips can assist them with healthcare. Expansions to the Entertainment function are also offered to the older adults. In this case, the power of health behavior can be improved by virtue of competitions among people and radio function is also incorporated into the device to increase their willingness to put on it.

(2) Visual data to reduce interferences. From the perspective of usability, Readability of data plays a critical part. The core technique of wearables should be closely associated with data monitoring. Therefore, Visualizing data is a necessary design element, including static data, dynamic data, characters and charts. Use procedures of various data interleaving in the device may make the older adults confused. During interview, there are still many old adults who do not know the meanings expressed in the curve chart and they hence hope that auxiliary characters can be provided clearly on the screen.

(3) Style modality; Appropriate display. The context of PI gets involved with Color, Modeling Implication, Scale and Style. according to the context of original texts, those the older adults keep saying over and over again are liberality and reserved as far as color, size, modeling and visibility are concerned. The older adults need the design to conform to their identities without over highlighting their own images. As for the color, they prefer low-profile dark colors. Nevertheless, they expect the wearables to meet their aesthetic tastes; and, the integral shapes of them look delicate and nice.

(4) Professional people, Data association. At the level of PP similar to TA positioning, the older adults interviewed are concerned about protection of Personal Information Connection, despite that they prefer Data Connection. As for the concrete crowds of association, they consist of professional doctors, wellness counselors and friends, etc.. With an aim to obtain more effective design suggestions by data association, the designer pay more attention to the specialty of crowds associated in the process of design.

(5) Appropriate size; Proper style. It was found that design elements involved with AA always turns up in accompany with PI. Although no direct causal association has been found between them, they are still closely related to each other. Design elements contained in appearance are Style, Scale and Visibility. Taking smart watch as an example, the older adults pay attention to lighter modeling of smart watch, a right ratio between the watchband and the dial plate, as well as its novel and concise style. All these aesthetic tastes properly display their ages.

(6) Context fusion; Contact comfort. In terms of PC, the older adults deem that they should feel comfortable with wearables as soon as they are touched. In addition, the older adults also pointed out that the Contact Surface should be ventilated, light and possess a simultaneous loose-tight property so that no special senses can be generated after they put on them. Especially in winter and summer, breathable and skin-friendly materials should be selected for the contact surface, including dermal and cotton fabrics, to ensure Context Support and also guarantee that the older adults can put on them comfortably.

Comprehensive Discussions

Based on influences of human considerations related to devices of different kinds of positioning on the design element at qualitative and quantitative research stages, it is deemed in this study that at the very beginning of design, product positioning should be defined and followed so as to distinctly go back to life styles of the target older adults and considerations about human considerations. On this basis, both designers and developers could figure out diverse design communication strategies by making positioning of healthcare wearables clear to improve the adoption of the older adults in the development plan. Calm strategy suggests using passive healthcare interactive mode to give priority to older adults' control power; While, active strategy suggests using more peripheral interaction during healthcare, such as voice interface, appearance and social cue; At last, persuasive strategy suggests being a healthcare companion, amplifying the best of technology and the best of humanity.

Conclusion

Through empirical studies on samples in a large size, two important findings are further put forward based on data results. First, older adults' perceptions on product positioning of devices are classified into three types, including Tech-Aid type, Fash-Acc type and Fash-Tech type. Second, product positioning developed for older adults in a particular lifestyle should be definitely judged to designate an effective design communication strategy. In concrete, Tech-Aid type puts emphasis on perceived usefulness, ease of use and older adults' personal privacy. Designers can take a calm communication strategy by giving priority to older adults being active, fitting symptoms, User- friendly and cautious interconnection.; while, Fash-Acc type stresses older adults' personal image, aesthetics appearance and ease of use of devices. An active communication strategy is adaptive by modeling style for elderly fashion, agreeing with aesthetic appreciation and simplified operation It emphasizes privacy preferences and personal image preferences. As for Fash-Tech type, perceived usefulness, ease of use, and aesthetics appearance of devices should be integrated in combination with living habits of older adults. A persuasive communication strategy can be used, through which designers can offer older adults more data insights and entertainment complementary by data association, but reduce data interferences and pay attention to style modality, and in the meantime, appropriate display with context fusion and contact comfort.

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Author Biography

Chen Li

Chen Li is currently a doctoral student at National Yunlin University of Science and Technology (YunTech). She has a bachelor's degree and a master's degree in industrial design from Beijing Institute of Technology (BIT). Her areas of interest are technology acceptance in older adults, wearable design, and designing for special populations.

Chang-Franw Lee

Chang-Franw Lee (PhD) is a Professor in Graduate School of Design, National Yunlin University of Science and Technology (YunTech), Taiwan. Professor Lee was previously Chairman of the Department of Industrial Design (1999-2002), Director of the Graduate School of Design (2003- 2010) and the Dean of the College of Design, YunTech (2011-2016). Currently, he is the Dean of the Office of Academic Affairs, YunTech. His research interests include Ergonomic Design, User Interface Design, and Universal Design.