Exploring the Role of Culture-Centric Design Guidelines in the Design of mHealth Application for Senior Informal Caregivers: Lessons Learned in a Field Study

Wen-Lin Chiao[1], Ying-Jia Hong[1], Hsin-Pei Tsai[1], Yu-Hsin Wang[1], Yu-Jou Chou[1], Wen-Lin Chen[2], Yi-Chun Tseng[2], and Pei-Yi Kuo[1(✉)]

[1] National Tsing Hua University, Hsinchu, Taiwan
pykuo@iss.nthu.edu.tw
[2] Smart Ageing Tech Co., Ltd., Taipei, Taiwan

Abstract. Mobile health (mHealth) applications help reduce the burden of informal caregivers. However, limited mHealth applications are fully adopted by informal caregivers. Research has suggested that cultural tendency may affect the motivations and willingness of informal caregivers to adopt technological tools. Our study aims to explore how we can incorporate Hofstede's five cultural dimensions and Aaron Marcus's matrix of culture-centric interface design guidelines into mHealth application design for senior informal caregivers in Taiwan. Through participatory design sessions, we examined senior informal caregivers' perceptions of our mHealth app user interface (UI) design. Our findings include lessons learned from participatory process with senior informal caregivers, translating Aaron Marcus's guidelines to mHealth app UI elements and design considerations of mHealth app. We conclude by offering suggestions for future research aiming to incorporate culture-centric design guidelines into mHealth app design for senior informal caregivers from specific cultural background.

Keywords: mHealth · Informal caregivers · Participatory design · Culture-centric interface design · Cultural dimensions

1 Introduction

With the continuous decline in birth and death rates, one in six people in the world will be over 65 years old by 2050 [1]. Technology-assisted health promotion for elderly is seen as a feasible way to solve related issues. However, the adoption rate of mHealth apps among informal caregivers remains relatively low [2]. The critical reasons include the lack of ease of use and accessibility of mobile apps, especially the lack of consideration of cultural influence on interfaces and process design for the elderly [3]. Therefore, this research aims to explore and establish a culture-adaptive design guideline for mHealth apps used by Taiwanese mid-aged informal caregivers. To address this, we engaged senior informal caregivers in participatory design sessions using a mHealth app, Jubook (Jubo 照顧筆記), to gain insights into their perspectives on the design for mHealth app.

C. Stephanidis et al. (Eds.): HCII 2022, CCIS 1583, pp. 399–406, 2022.
https://doi.org/10.1007/978-3-031-06394-7_50

2 Literature Review

2.1 mHealth Apps for Elders: Design Emphases and Challenges

Health-related mobile apps can provide task-related help as well as care for caregivers' mental well-being. Common features such as tracking caring information, providing practical solutions, facilitating communications can reduce the burden of caregiving tasks [2, 4, 5]. The majority of the current mHealth related research is conducted in the laboratory and more field studies should be carried out to understand the needs of informal caregivers. As Skolik (2018) pointed out that mHealth apps need to be made together with the informal caregiver in the early design stage to develop a more user-centered design and increase the effectiveness of the intervention [5]. Thus, participatory design is a suitable approach to engage seniors and gain insights into their lives in order to improve the quality of design for older people [6].

2.2 Benefits and Importance of Culturally Adapted User Interface

The UIs design of mHealth apps should also consider different users' cultural backgrounds as they may be affected by cultural traits [7]. Research suggests that caregiver's cultural identity can affect their willingness to use related assistance tools [3, 8]. Given the importance of culturally-adapted UIs, it's crucial to establish culture-based design guidelines tailored to users of different cultures. Hofstede proposed five cultural dimensions - power distance (the relationship between authority and subordinates), collectivism versus individualism (the value of prioritizing group cohesion or personal pursuits), femininity versus masculinity (the role distribution between two genders), uncertainty avoidance (the level of tolerance of unpredictability), and long- versus short- term orientation (the focus on the future or the present and past) [9]. A country's score on each cultural dimension is interpreted relatively to other countries. Enlightened by Hofstede's culture model, Marcus combined his definition of UI with culture-related design guidelines into a matrix that maps culture dimensions to user-interface components [10]. He proposed that UI can be generalized by five components, including metaphors (fundamental concepts communicated through various content forms), mental models (structure of data, functions, tasks, etc.), navigation, appearance, and interaction [11].

3 Methods

This study adopted exploratory qualitative methods to investigate how culture-centric design guidelines can be incorporated into mHealth application designed for senior informal caregivers in Taiwan. The main purpose of the mHealth app used in this study is to continuously monitoring elders' vital signs (e.g., blood pressure). The app has a total of three primary functions, including health reminders, health data monitoring, and medical device integration. We conducted participatory design sessions in the field with five senior informal caregivers to examine their thoughts on our mHealth app UI design. Our inclusion criteria include those who: (1) age between 50 and 65, (2) had informal caregiving experience with aging parents, and (3) had no prior exposure with our app. Figure 1 shows the demographics, care experience, and the level of technology familiarity of our five participants (three female). They age between 52 and 60 years old.

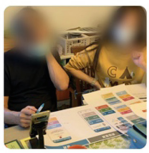
Five Senior Informal Caregivers					
Participants	**P1** Female/ 53	**P2** Male/ 58	**P3** Male/ 56	**P4** Male/ 60	**P5** Female/ 52
Care Recipients' Gender/ Age/ Relationship	Female/ 85 Mother-in-law	Female/ 85 Mother	Female/ 81 Mother	Female/ Aged 80 Mother	Female/ Aged 69 Mother-in-law
Care Period	On-going	On-going	On-going	2011~2018	2011~2013
Tech Familiarity	Strongly confident	Little confident	Confident	Confident	Little confident

Fig. 1. Participants overview

3.1 Participatory Design Sessions

Informed by Marcus [11], we first generated a design guideline matrix based on Taiwanese culture design principles by mapping Taiwan's score on each of Hofstede's five cultural dimensions with Marcus's matrix of culture-centric interface design. We then built a menu of mHealth app UI elements based on the matrix for participants to use during participatory design sessions (Fig. 2). Taiwan corresponds to Power Distance: High (PDH), Collectivism (CO), Femininity (FE), Uncertainty Avoidance: High (UAH), and Long-term Time Orientation (LTO) in comparison to the United States [12].

Each participatory design session involves three steps. First, participants were introduced the main functions of the app to get familiar with it. This provides an opportunity to have convergent discussions on design decisions. Second, the participants designed interfaces using our pre-defined UI elements through collage on paper. The researchers helped draw the interfaces on papers according to participants' design feedback. Participants provided feedback on the appearance, flow, content, and functionalities of our app. When they had difficulty giving feedback, we provided them with the pre-designed UI elements to choose from. This allows participants to disclose their perceived priorities in terms of functionalities, and helps elaborate their concerns in a more concrete and easy-to-understand manner. Third, participants examined their collage in its entirety for consistency to see if more adjustment is needed. They were expected to make UI elements design on four pages (homepage, measurement, record, and device pairing). Both paper and digital versions of the collages were available.

3.2 Data Analysis

We systematically collected feedback on our culture-centric app UI designs and delved into participants' experience throughout the participatory design process. Our sessions resulted in a 4 h 50 min of video data. We transcribed each design session's video verbatim, and conducted affinity diagram following the structure of Hoftstede's five cultural dimensions.

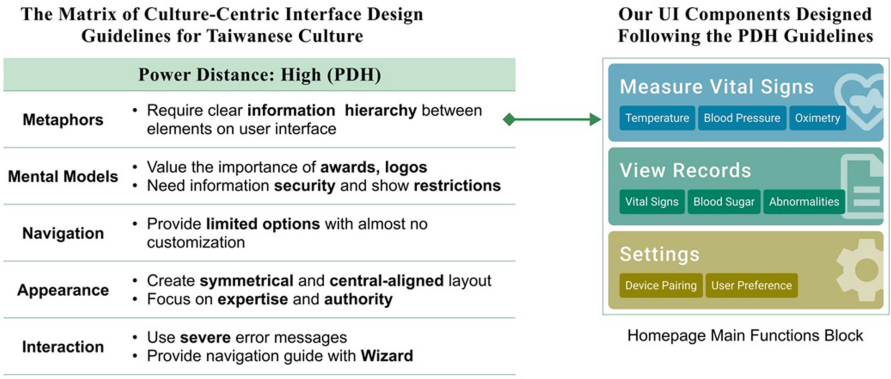


Fig. 2. Example of translating the power distance cultural dimension into UI design elements for Taiwanese culture

4 Results

4.1 Feedback from Participatory Design Sessions

We present participant feedback on general design as well as the app's four main pages in the following. In terms of general design, we found that most participants favored rounded corner buttons, which relates to the Femininity (FE) dimension. Participants' color preferences, on the other hand, could not be allocated to a single cultural dimension as they ranged from pinkish colors (P1), dignified colors (P2), natural colors (P3), to vivid colors (P4 and P5). They also held different opinions toward the text tones of the health reminders in the app, ranging from close and warm (P1 and P5) to serious and professional (P3).

Homepage. Most participants (P1, P2, P4, and P5) expressed a preference for a flat information hierarchy when it came to the design of Homepage core functions. They intended to find what they were seeking for with a single glance rather than digging through multiple layers (Fig. 3a). This was in line with the cultural dimension of UAH. Participants had mixed reactions toward the design of the app's health reminder, the corporate logo, and the graphics. The decision on whether or not to include the corporate logo was related to the PDH cultural dimension. Some preferred to see the company logo displayed ("*I can keep in mind who I'm working with.*"-*P2*), while some felt it unnecessary ("*you don't see Apple's logo in Apple's apps.*"-*P3*). They also tend to have difficult recalling what they said sometimes during the process. Furthermore, participants mentioned adding various types image they would like to display on the homepage (e.g., cartoon-like graphics, photographs) – they are unable to be classified into a single cultural dimension. P4 opted to use a camera image of a doctor to illustrate the software's trustworthiness, which matched the PDH cultural dimension but went against the FE cultural dimension. P1, on the other hand, preferred a pleasant avatar of a cartoon figure to reduce the stress of caregiving.

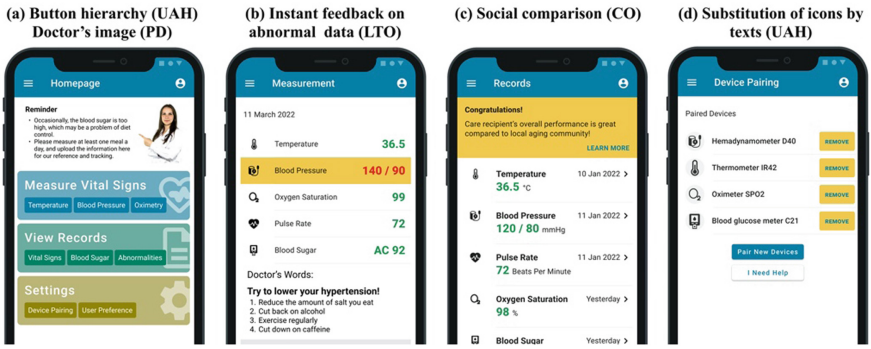


Fig. 3. Illustrations of participant suggestions on the app's four main pages

Measurement Page. The measurement page consists of current vital sign data input blocks and a memo textfield. Participants (P1, P3 and P5) frequently mentioned the importance of showing instant feedback (Fig. 3b) on the abnormal data inputted (*"I want to know how (her blood pressure is) higher than yesterday and what I can do about it."-P3*). It corresponded to the LTO cultural dimension as the caregivers expected the data to present its value in a more futuristic manner.

The memo textfield is designed for informal caregivers to note down the symptoms or events causing fluctuations in data. However, four participants (P2, P3, P4, and P5) indicated the importance of specificity - they expected to know what to note (P3 and P5), who would view the notes (P4), and what would happen if leaving it blank (P2). This was in accordance with the cultural dimension of UAH.

Record Page. The record page consists of a data picker and historical vital sign records shown on a daily basis. All five participants pointed out the need to include additional information about whether the numerical data falls within the normal medical reference range. In addition, participants (P1, P2, P3 and P5) further selected a pre-designed UI element containing a short description of how the data was compared to the local aging community (Fig. 3c). This was in accordance with the CO cultural dimension.

When it comes to the design collage activity on this page, some participants (P1, P3, and P4) struggled. P1 and P3 used other mHealth apps before, and the design of the record page was quite different, making it difficult to adapt to our app. The features requested by participants included showing the most recent inputs rather than displaying the data by dates (P1), displaying data with the trend graph, and enabling customizable dashboard of the records (P3). P4 proposed designing an obvious button that navigates to all abnormal data in the past from a doctor's perspective.

Device Pairing Page. The device pairing page consists of Bluetooth device pairing instructions, device connection status, and pairing buttons. During the first step of the participatory design activity, all participants had trouble navigating on this page. Some (P1 and P2) claimed that the technology of remote data entry is quite complex for them, and that they required additional assistance. Besides, P2 had problem understanding the

term "Bluetooth". However, the current remote connection instruction was neglected by all participants due to the length of text. This shows a discrepancy between UAH cultural dimension and senior users' memory abilities.

In terms of device connection status and pairing buttons, most participants (P1, P2, P3 and P4) opted to replace the icons with texts (Fig. 3d) as they had trouble understanding their meanings. Furthermore, some participants appeared to be hesitant when trying to tap on an icon because they were afraid of activating irreversible process by accident. These all corresponded to UAH cultural dimension.

4.2 Reflection on Participatory Design Sessions

We conducted interviews with senior informal caregivers at the end of participatory design session to further understand their feelings and experience toward the design procedure and collage activity. Most participants said that the pre-designed UI elements menu aided them in making quick and easy decisions. We have tested whether participants can envision their preferred redesign of the app without any references or support at the beginning of the session, yet they felt frustrated when thinking about the colors and font/button design. They mentioned avoiding designing UI elements that are too micro ("*As long as the app is easy-to-use, I am fine with everything about it. But for the minor things, like colors, I think seniors including me, won't pay attention to it."-P1*). Furthermore, P1 and P3 found the digital prototype more realistic (higher fidelity) than paper prototype. The participants thought the paper prototypes drew by the researcher during the session were only served as a way to concrete their ideas.

5 Discussion

5.1 Applicability of the Culture-Centric Interface Design Guidelines

Aaron Marcus's matrix of culture-centric interface design helps researchers analyze whether the interfaces are culturally appropriate. However, challenges remain when translating Aaron Marcus's design guidelines to UI design for mHealth app. We found the design guidelines contradicted one another sometimes, making interface design challenging to implement. According to Hofstede's culture index, Taiwan has tendency toward PDH and FE. It suggests that while people prefer adorable visual style under FE, they simultaneously prefer formal image presentation under PDH. We observed the conflict when participants mentioned their preferences for health reminders, the corporate logo, and the graphics. Moreover, some UI design element preferences and features suggested by participants are unable to be classified into the Taiwanese cultural design guideline, such as the trend graph for vital sign data. One possible reason is that the research on Taiwanese cultural design preferences remains limited. Another potential reason is that technological modernization may increase cultural diversity. Therefore, further research is needed to provide more design examples for explaining the guidelines, and examine whether cultural tendencies change or not in this fast-changing information environment.

5.2 Implications for Vital Sign Data Visualization

Our participants offered several recommendations regarding the presentation of vital signs data for mHealth App design. First, provide a trend graph of prediction demonstrating on a weekly or monthly basis is desirable. Second, incorporate social comparison information to illustrate how users rank in contrast to one another. This provides users a comparison point, and eases unnecessary on data fluctuations. Last, create a social support system, particularly reminders or instructions from doctors directly. Participants indicated the mHealth app needs to serve as a link between health institutions and informal caregivers, instead of just a digital note-taking tool.

5.3 Suggestions for Participatory Design with Senior Informal Caregivers

We collected three primary lessons learned that researchers should pay attention to when conducting participatory design sessions with seniors. First, be attentive to seniors' facial and gestural reactions. It's important to use appropriate terms based on their age and background during communication, prepare easy explanations of technology terms, and help participants recall the key statements they said throughout the process. Second, both paper and digital prototypes are found useful for different purposes in the redesign tasks. Paper ones helped facilitate communication and interaction while digital ones provided more detailed and realistic representations of seniors' design decisions. Last but not least, it is helpful to provide participants appropriate amount of the pre-designed UI elements to engage them in the UI component collage activity. It worked better to invite participants to compose their collage freely compared to asking participant to make design changes based on existing UI interface.

6 Limitations, Conclusion and Future Work

Our study examines the mHealth interface design guidelines that conforms to Taiwan's cultural tendency based on Aaron Marcus's matrix of culture-centric interface design, and we investigated how Taiwanese culture impacts on senior informal caregivers' interface preference. Our results indicated that there were some design traits participants shared in common that conform to Taiwanese culture design principles. We also provide suggestions for conducting participatory design with senior participants and several design implications for mHealth app. Our study has two primary limitations. Aaron Marcus's design guidelines are mainly for web, so the design guidelines may not be applicable on mobile in some cases. In addition, the transition from Culture Interface Design Matrix to design decision is interpreted by the research team. Thus, potential bias may exist. Our future work includes iterating the design of mHealth app, and conduct co-design sessions with more samples to generalize our findings.

Acknowledgement. We thank our study participants for their participation and feedback. This work was supported by the Ministry of Science and Technology in Taiwan (MOST grant 109-2221-E-007–063-MY3).

References

1. United Nations Department of Economic and Social Affairs. (2020). World Population Ageing 2019. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Report.pdf
2. Ghahramani, F., Wang, J.: Intention to adopt mHealth apps among informal caregivers: cross-sectional study. JMIR Mhealth Uhealth **9**(3), e24755 (2021)
3. Donovan, R., Williams, A.M.: Caregiving as a Canadian-Vietnamese tradition: 'It's like eating, you just do it.' Health Soc. Care Community **23**(1), 79–87 (2015)
4. Grossman, M.R., Zak, D.K., Zelinski, E.M.: Mobile apps for caregivers of older adults: quantitative content analysis. JMIR Mhealth Uhealth **6**(7), e162 (2018)
5. Skolik, K.: Mobile applications for informal caregivers: a systematic review of existing mobile applications (Master's thesis, University of Twente) (2018)
6. Lindsay, S., Jackson, D., Schofield, G., Olivier, P.: Engaging older people using participatory design. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1199–1208 (2012)
7. Saidin, N., Singh, D., Drus, Z.A.M.: Culture centered design: reviews on cultural factors influencing interface design elements. Pertanika J. Schol. Res. Rev. **3**(1) (2017)
8. Reinecke, K., Bernstein, A.: Improving performance, perceived usability, and aesthetics with culturally adaptive user interfaces. ACM Trans. Comput.-Hum. Interact. **18**(2), 1–29 (2011)
9. Hofstede, G.: Dimensionalizing cultures: the Hofstede model in context. Online Read. Psychol. Cult. **2**(1), 2307–2919 (2011)
10. Marcus, A., Gould, E.W.: Crosscurrents: cultural dimensions and global Web user- interface design. Interactions **7**(4), 32–46 (2000)
11. Marcus, A.: User-interface design, culture, and the future. In: Proceedings of the Working Conference on Advanced Visual Interfaces, pp. 15–27 (2002)
12. Compare countries- Taiwan vs. United States: Hofstede Insights. https://www.hofstede-insights.com/product/compare-countries/. Accessed 7 Mar 2022