Applying Cognitive and Cultural Frameworks to mHealth Application Design for Elderly Users

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Abstract: Information and communication technologies and mobile health applications are becoming more pervasive in healthcare. Although these technologies aim to be harmoniously ubiquitous, there are important design factors that user experience practitioners must consider for optimal utilization for elderly users. User's perceived usefulness is the driving factor for technology adoption. Incorporating cognitive and conceptual design principles such as information processing, mental models, external cognition, and emotional interaction based upon sociocultural determinants can improve the usefulness of mobile Health tools amongst elderly users. Data was obtained from a small sample (n=30) aged 75 years or older who use telehealth and mobile health apps. Findings show that users have a low perceived ease of use and usefulness of these applications based on the lack of sociocultural elements incorporated into the interface design. This paper aims to analyze the impact cognitive theories and conceptual frameworks have on mobile health design for elderly users, while bridging the gap of an existing digital divide. A qualitative study was conducted involving empirical research to define a correlational relationship between technology dissonance and elderly users for the purpose of identifying a thematic analysis.

1 INTRODUCTION

Mobile health (mHealth) applications have progressed in their original performance during the plight of a worldwide health emergency, with an expectation of rapid adaptability and acceptance. From an imperceptive standpoint, mHealth apps are beneficial based on system functionality, permitting users accessibility to medical personnel and resources remotely (i.e., mHealth apps); however, considering usability factors are equally important. There's a digital divide as it relates to technology adoption amongst older users. As the elderly population is continuously increasing, User Experience (UX) designers and researchers can pursue and create iterative designs that are tailored to this fast-growing population with the aim and focus on inclusivity. It is crucial that cultural society address issues regarding the impact of advances in technology on the daily life of the elderly (Li, & Perkins, 2007).

UX designers must conceptualize a design framework that overcome barriers leading to technology resistance, such as: socio-cultural determinants, cognitive theories, and conceptual frameworks. By closing the digital divide gap and making access to technologies equitable, favorable outcomes are within reach as digitally connected living has potential implications for poverty alleviation, improved education, social well-being, and health (Aruleba & Matarirano, 2022).

As UX researchers are analyzing the inclination of technology acceptance, findings show that user resistance does not rely solely based on technical unfamiliarity. Compared to 'middle aged' which they define as people between 55 and 64 years of age, young seniors (65–74 years) are only 63% as likely to use the Internet, while old seniors (75+) are only 30% as likely (Friemel, 2016). Besides the lack of technical devices to access the Internet for some, the main reasons for not using the Internet were found to be either motivational indifference (perceived uselessness of the information on the Internet or little relevance for one's life), or deficient knowledge (Friemel, 2016). This paper focuses on how to homologize user expectations and interface design within human computer interaction (HCI) by discovering inclusivity and sustainability gaps within telehealth applications to identify design

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opportunities that provide representation to the aging population.

This paper aims to further examine the following:

- Whether interface designs including cognitive theories increase perceived ease of use of telehealth applications within the elderly community.
- Whether interface designs including conceptual frameworks based on sociocultural determinants increase perceived usefulness in telehealth applications within the elderly community.

Using empirical research, data was obtained and analyzed from a sample (n=30) to identify existing challenges with mHealth apps from users within the aging community. Based on findings, a qualitative study was conducted by reviewing existing peer-reviewed literature to identify a thematic analysis to correlate cognitive theories, conceptual models, and user interface (UI) design to improve mHealth adoption.

2 METHODOLOGIES

In this study, a qualitative approach was undertaken using an exploratory model consisting of surveys, interviews, and observations to determine a thematic analysis in order to define a correlational relationship between technology dissonance and elderly users. A systematic literature review was conducted to identify a thematic analysis.

Data collection was conducted at a residential senior retirement community in the North East United States region. Figure 1 displays the survey used with the purpose of identifying inclusion and exclusion criteria, as the target audience for preliminary data set were elderly users with no information and technology background.

Survey Questions

1. What is your age group?
   a. < 55
   b. 55-60
   c. 60-65
   d. 70-75
   e. 75 >
   f. Prefer not to answer
2. What is your gender?
   a. Male
   b. Female
3. What is your race/ethnicity?
   a. American Indian or Alaska Native
   b. Asian
   c. Black or African American
   d. Native Hawaiian or Other Pacific Islander
   e. White
4. What is your highest level of education?
   a. Some high school
   b. College graduate
   c. Graduate degree or higher
5. Would you consider yourself 'tech savvy?'
6. Are you familiar with telehealth or telemedicine? If so, what type of device do you utilize (e.g., smartphone, computer, etc.,)?
7. Do you have any usability concerns when using technology today?

Figure 1: Survey questions used to conduct preliminary findings.

Qualifying participants resulted as (n=30). Over 20 participants indicated they had some level of college education. Provided that, it's myopic to consider an existing level of education with ease of use and technology adoption. However, from an HCI purview it can be advantageous to use that information to further asses and build upon cognitive aspects such as information processing to create a more intuitive UI. Furthermore, it was also important to analyze the responses from question #5 as it relates to users being tech savvy. For instance, it was observed that users who considered themselves "tech savvy" equated that to owning some technical device (e.g., smartphone, laptop, etc.,) However, it was discovered that while these users owned technology devices, by watching these users interact with specific devices (e.g., computers, laptops, smartphones, etc.,), the utilization were surface level capacities. For example, security features that allow users to save log in credentials to mitigate user input for future use was scarcely used because they did not know it existed or they didn't understand what it was. In addition, some users were not aware of speech-based interaction styles for text messages or note taking – hence, further bridging the gap between what tech savvy means to one demographic vs another.

Following the survey intake, an interview was conducted in a semi-structured format, asking open-ended questions, to allow participants to discuss their thoughts surrounding mHealth. During this dialogue, both verbal and non-verbal mechanisms such as hand gestures and movement, range of voice octaves, facial expressions, etc., were observed. It was important to observe these mechanisms as it also ties into UX evaluation. For example, when participants use a range of forceful hand gestures during the conversation, it can be resonated as a pain point within the technology. Figure 2 displays the consensus of responses that were documented from participants.

Participant Focus Group Responses
"Directions should be written by people who are not technical savvy."
"[The] key to less resistance is having clear instructions with screen prints."
"Following most instructions are a pain point."
"Telemedicine is less humane."
"I feel rushed when I am talking to my doctor for online appointments."
"There's no [emotional or social] connection with my provider."

Figure 2: Participant responses from focus group.

2.1 Literature Search Criterion

Using an exploratory method, secondary research was conducted via a systematic literature review (n=82) including: peer reviewed scholarly articles, literature

reviews and case studies. The following inclusion criteria was used:

1. Publication written in English
2. Scholarly peer-reviewed journal article
3. Published in academic journals or text
4. Full text
5. Aging/elderly/senior population

Quality Criterion Assessment

Criteria	Criteria Description
Validity/Creditability	The degree to which a research tool measures what it is intended to measure.
Replicability	The degree to which the same interpretation can be drawn if the study is repeated by different researchers with different participants following the same methods.
Reliability	The degree to which consistency within the research tool measures what it is intended to measure.
Generalizability	The degree to which external personnel can infer the findings from the research sample to the population.

Figure 3: Quality Criterion Assessment.

Criterion	Met Criteria	Did Not Meet Criteria
Does this study focus on qualitative research?	69	13
Is the qualitative approach clearly identified?	67	15
Is the approach clearly stated?	44	38
Is the sampling method clearly explained?	53	29
Is the method data collection clearly explained?	50	32
Is the method of data analysis free of bias or obstruction?	82	x
Are the findings supported by adequate evidence?	77	5

Figure 4: Qualitative Research Criterion.

Literature that included youths and adolescent age groups and users with sufficient technology background were excluded. Literature was analyzed to define a correlational relationship regarding cognitive theories such as: mental models, information processing, external cognition and emotional interaction aspects based on sociocultural factors within the aging community being incorporated into mHealth interfaces. The following sections summarize cognitive theories and conceptual frameworks to be embodied as it applying user-centered design approaches.

3 SOCIAL INFLUENCES AND MHEALTH

Sociocultural factors have an influence on the adoption rate of mHealth applications within the aging population. The function of mHealth services facilitates health care for elderly users and brings multiple benefits such as, providing prompting medication alerts, self-monitoring of biometrics indicators, support for telemedicine consultations, health care cost savings, and so on (Cao et al., 2020). Despite the potential benefits and opportunities for elderly people to use mHealth apps, they are found to be less innovative toward it and encounter various challenges and difficulties when they are using (Cao et al., 2020).

Based on internal factors, targeted audiences' culture and values are guiding factors in how resistant they will be to mHealth. To further illustrate, older adults' views and values of what it means to age successfully may shape their evaluations of preventive services (Butler et al., 2011). Models of successful aging often favor a biomedical or psychosocial perspective; models with a psychosocial perspective emphasize satisfaction with one's current and past life, social engagement, and personal growth (Butler et al., 2011). Literature details a study that was conducted with older adults aged 65 years or older that highlighted their initial perception of technology. Participants reported they were bored with digital technologies because sometimes the technology was very complex and easily broken (Li & Luximon, 2016). Direct manipulation and exploring interaction types may be advantageous for improved perceived usefulness and perceived ease of use. By paying close attention to how people actually exploit real environments, and describing those phenomena in appropriate theoretical terms, we can see how to go beyond the simple replication of felicitous features of the real world (Hollan et al., 2000). An important research issue for the field of human-computer interaction is how to move beyond current direct-manipulation interfaces (Hollan et al., 2000).

Elderly customs surround a sense of community and collectiveness. Figure 5 displays the correlation of both internal and external socio-cultural determinants that influence technology adoption. Rather than operating in different silos, this community embraces more collaborative and shared practices. Such as, when there is a positive and high adoption within users of the community, projected users will be more prone to assimilation opposed to natural resistance. Higher adoption rates amongst this group can be achieved as professionals and individuals within the community begin to adapt to the changes and demonstrate advantages, as they have a positive perception of usefulness and usage. Community health workers and volunteers see themselves as agents of change who accompany the members of the community as they change their lives (Mohajer & Singh, 2018). They use their local knowledge to explain health in simple terms and can address traditional false beliefs (Mohajer & Singh, 2018). Expressing the benefits of technology utilization in simplistic methods are in alignment with older user's mental capacity and values as new concepts are approaching them.

It must be remembered, during the plight of COVID-19 technology was forced upon users as the main source of continuing healthcare services. Approaching the adoption of mHealth apps should be

built upon a user-centered foundation that incorporates user needs at the core to reduce dissonance and anxiety disassociated with utilization during the pandemic.

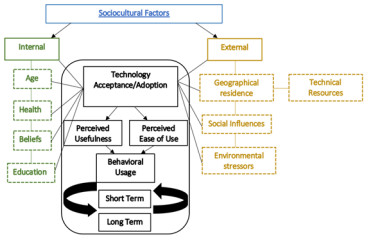

Figure 5: Socio-cultural factors related to technology adoption.

3.1 Social Interaction

Communication and being social are fundamental aspects of everyday life. The various ways people socialize and interact with other beings can be reflective of the type of culture they were emersed in and traditional upbringing. For instance, younger adults tend to use telecommunication devices to socialize via non-verbal modes while older adults are more vocal, using verbal communication modes. They prefer the richness of face-to-face communications and authenticity. In today's technologically advanced world, social networks have the potential to exclude loneliness in one's life, but the current social media platforms which cater to the biggest number of users do not take into consideration the needs of seniors around the world (Embarak et al., 2021).

In an effort to combat the issue of loneliness and social isolation among the elderly community, creating UI designs within telehealth applications that encompass direct manipulation interaction styles not only provide a benefit by allowing the user to be in full control, additionally it is creating a communication mode between user and the device/technology (Embarak et al., 2021). Human beings are inherently social; people will always need to collaborate, coordinate, and communicate with one another, and the diverse range of applications, web-based services, and technologies that have emerged are enabling them to do so in more extensive and diverse ways (Preece et al., 1994).

UX practitioners can begin building upon a conceptual framework for UI design. Conceptual models not only aid in being an effective communicative tool between designer and user, but it also allows a sense of transparency and trust to build with an aim of decreasing technology rejection within this population.

4 COGNITIVE THEORIES

Elderly adults' cognitive abilities may be affected with age, resulting in a decline in visual, auditorial or dexterity function. Coupled with their physical abilities, cognition also embodies user learning styles, attention span, perception and their memory. UI designs that embed interaction styles such as a metamorphic approach would be instrumental. Using interface metaphors can result in a higher adoption of mHealth tools as it can aid in reducing their cognitive load along with creating a sense of independency while using this technology. Using metaphors can be an effective way to communicate an abstract concept or procedure to users, as long as the metaphor is used accurately (Card, 2018).

Conceptually illustrating system functions in a relatable way can reduce the cognitive load and strain of learning new technology. Metaphors rely on a user's familiarity with another concept, as well as human affordances, to help users understand the actions they can perform with their data based on the form it takes (Card, 2018). Metaphors can provide cues to users how to understand products: to orient and personify as they provide us with the means to understand our complex digital devices (Saffer, 2005).

Metaphors aren't particularly about language, but rather about thought "in the way that we conceptualize one domain in terms of the other" - helping us to conceive and understand abstract concepts like time, usually by making reference to more concrete objects (Saffer, 2005). Using cognitive theories to provide a conceptual framework in UI design, centered around the user, can improve the perception of ICTs in the elderly community. When designers and researchers apply a user-centered approach, these factors can be used as a fundamental basis for a conceptual model design inclusive of cognitive factors such as: mental models, information processing, external cognition and emotional interaction.

4.1 Mental Models

A principle of the modern theory of mental models is that a model has the same structure as the situation that it represents (Johnson-Laird, 2004). Users will begin to form their own mental model surrounding a concept based on how often they interact with such.

One can reasonably assume that elderly users may have limited interaction with ICTs if there's no requirement to use them to perform daily tasks. Characteristics of mHealth app users suggest they tend to be younger, white, have an educational level greater than high school, have a higher income, are employed, have insurance coverage, live in urban areas, are not current smokers, are more often obese, and report excellent health (Smahel et al., 2019).

With this in mind, elderly users are not identified as primary users of these ICTs which can result is a limited mental model. Provided that, with technology advances being rolled out with UIs that do not incorporate sociocultural and cognitive elements of elderly users, they can be overwhelmed with these tools. Therefore, inadvertently creating a negative mental model. There is accordingly a many-to-one mapping from possibilities in the world to their mental model (Johnson-Laird, 2004).

4.2 Information Processing

Human Information Processing (HIP) Theory describes the flow of information from the world, into the human mind, and back into the world (Card, 2018). Perception is critical as it pertains to information processing, guiding the user to initially rely on the representation of what is being presented to them. Contextual perception is also a key factor as well. For instance, if UX practitioners are deploying new technology using technical jargon amongst the elderly population without the proper education background, this advancement may be processed as unfamiliar and overwhelming. The way information is displayed can also greatly influence how easy or difficult it is to attend to appropriate pieces of information (Preece et al., 1994).

While the information presented of mHealth apps may demonstrate needed benefits, their contextual perception can be a barrier. Some users demonstrate that they were too old to learn new things while others complained that they had bad memories and less patience to learn new technologies (Li & Luximon, 2016). On the other hand, others state that they had the confidence to learn new technology only when the technology was simple enough (Li & Luximon, 2016). Perception refers to how information is acquired from their environment via the different sense organs – eyes, ears, fingers – and transformed into experiences of objects, events, sounds and tastes (Preece et al., 1994). Vision is the most dominant sense for sighted persons; with respect to interaction design it is important to present information in a way that can be readily perceived in the manner intended (Preece et al., 1994).

Education background also relates to how users process information given. Users with a certain level of digital literacy may process UI design with more ease that novice users.

4.2.1 Digital Literacy and Education

Uncontrollable factors and challenges such as technical resources are one aspect of technology barriers; however, learning challenges are also critically important. Changes in cognitive, psychomotor, and affective areas of behavior influence learning as each component is affected by the normal aging process (Best, 2001). It must be remembered that learning new concepts can be overwhelming for people who are not braced for such impact of change. To emphasize, consider the contextual difference of individuals learning in a college classroom in contrast to individuals learning on their own without sufficient guidance. In an academic setting, individuals are prepared to learn new ideas and concepts, as intended. On the other hand, individuals who are learning new concepts and ideas based on society and the direction that civilization is moving towards may face more challenges. UI design aspects that include and display an inviting and simplified approach will engage elderly users. Nevertheless, UX practitioners should be cognizant of creating a UI design that is 'too' simple in respect to the sensitivities related to lack of education.

4.3 External Cognition

One of the main benefits of incorporating cognitive factors such as external cognition is reducing end user's memory load. External cognition is concerned with explaining the cognitive processes involved when we interact with different external representations (Hartson, R & Pyla, 2012). For example, users would be able to understand how to directly manipulate a file by dragging it to the embedded trash can icon, representing the action of deletion. This is an example of a mirrored realization, just as a person in the real world would physically pick up an item, walk to the trash can to dispose of it.

A main goal of this framework is to explicate the cognitive benefits of using different representation for different cognitive activities and the processes involved (Hartson, R & Pyla, 2012). The main goals include:

• Externalizing to reduce memory load

• Computational offloading
• Annotating and cognitive tracing
(Hartson, R & Pyla, 2012).

Distributed cognition is important in UI design as we move to a more ubiquitous culture. The theory of distributed cognition, like any cognitive theory, seeks to understand the organization of cognitive systems; it extends the reach of what is considered cognitive beyond the individual to encompass interactions between people and with resources and materials in the environment (Hollan et al., 2000). Distributed cognition looks for cognitive processes, wherever they may occur, on the basis of the functional relationships of elements that participate together in the process (Hollan et al., 2000). When the UI design for mHealth can illustrate a parallel design to the physical world and allow interaction between those artifacts (i.e., clicking on a letter icon to send a message to a healthcare professional) and the user can increase the information processing of performing specific tasks.

4.4 Emotional Interaction

Applying emotional design aspects that elicit a desire to engage with mHealth tools must be considered. Given the cultural, or higher-level nature of these designs – people needing to learn about design in order to associate it with e.g., values, actions or functions – it should be understood that design cognition and experience is always dependent on social processes (Saariluoma, 2020). Reliability and functionality are fundamental considerations of UX, yet emotional aspects including desirability and satisfaction also influence users' perceptions of their experience and should also be captured in a comprehensive evaluation (Richardson et al., 2021).

When designers apply factors that relate what features and aspects elicit desirable emotions by researching these elements by communicating with the targeted audience, perception can be positively impacted. Desirable speaks to the attractiveness and appealing nature of the app design (Richardson et al., 2021). Guidelines to promote attractive designs and techniques for emotional engagement were adapted to create the criteria for this principle (Richardson et al., 2021).

Emotions influence both the way that users perceive a technology and how they interact with it, (Dupré & Sinclair, 2021) which can impact PU within the initial stages of its introduction. For example, literature show that users' satisfaction in using a computer laptop for work-related tasks was better predicted by amusement than by utility (Dupré & Sinclair, 2021). Thus, the more that users feel positive and experience intense emotions, the greater the probability that they will use the technology again (Dupré & Sinclair, 2021).

Considering the discussed cognitive aspects of user design, this information is imperative to use as a foundation in creating conceptual models of UI design.

5 CONCEPTUAL MODELS

Conceptual models in interaction design serve as a useful communicative tool for both designers and end users. This modeling tool is an interconnecting piece that enables UI practitioners and researchers to communicate and connect with end users via a framework they can process. A framework that is effective at taking account of the nature of the technology as well as the social context of use is essential (Wolff-Piggott et al., 2018). In addition, a sociotechnical approach asserts that an understanding of existing ways of working is important – this implies that the actual conditions under which work is carried out (Wolff-Piggott et al., 2018).

Figure 6 illustrates a high-level conceptual model for a future telehealth/mHealth prototype, intended to be used in subsequent usability testing related to this study. The model is intended to use a range of graphical representations built upon external cognition as they relate to system functionality, with the aim of creating a more intuitive user interface for the aging population. Applying cognitive theories can significantly reduce overload when approaching technology advances, particularly within demographics with respective dissonance. Therefore, a more systematic approach is needed for evaluating the merits of different kinds of graphical representations, one that is theoretically-driven and which accounts for the cognitive processing when people interact with them (Scaife & Rogers, 1996). Furthermore, the basis of the conceptual model illustrated in figure 6 will be used to simulate real-world interactions between patient and healthcare personnel. For example, creating a parallel interface aims to increase expectation management, ensuring that system features and functionality are in alignment with both internal user expectations and their thought process in addition to external real-world interactions. For example, using a pharmacy illustration to represent medication management, one can reasonably predict that a cognitive association of actions such as: refilling prescriptions, monitoring medications, reviewing prescriptions, etc., with an

aim of mitigating ambiguity. Also, system-user dialogue is also an important feature in collaboration with incorporating external cognition into a UI that is parallel to real-world scenarios. The value of this is to focus our attention more on the cognitive processing involved when interacting with graphical representations, the properties of the internal and external structures and the cognitive benefits of different graphical representations (Scaife & Rogers, 1996).

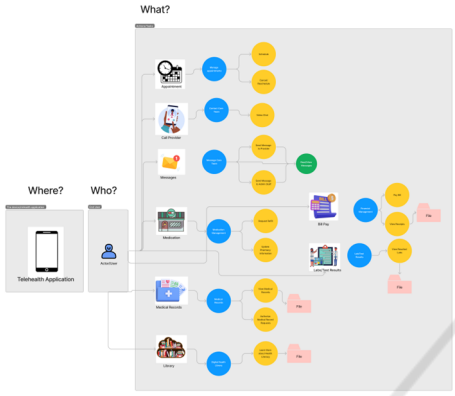

Figure 6: Telehealth (mHealth) Conceptual Model.

6 DIGITAL INCLUSION

As technology is predominately growing amongst the middle-to-high socioeconomic areas, accessibility challenges still exist within the lower-class and rural locations. Factors related to available resources within the environment, must be considered to create a conducive environment for ICT implementation and use (Ratshidi et al., 2022). Therefore, UX practitioners have the opportunity to combine more theoretical and practical approaches to technology adoption of telehealth applications via mHealth and ICTs. Implementing mHealth technologies across cultures, critically where medical resources are less accessible, would be logical. Although this may be, this is an opportunity to reduce the usability gaps to create and forecast an optimal and positive user experience for inclusivity and sustainability for all users who are also not readily accepting to technology.

7 KEY FINDINGS

Findings show that participants (n=30) were antipathetic towards the idea of connecting with healthcare professionals online and via computer applications. The core of these feelings was due to lack of sociocultural aspects being incorporated into the design. One can conclude that as this generation values in-person connections, UIs will need to mirror a sense of connection that reflects the physical realm as close as possible for patient-provider relationships. In addition, it was found that users were able to navigate through certain applications with little help, identifying that technology adoption goes beyond instructing how to use technology, but rather socio-cultural aspects of embracing new non-traditional concepts.

8 DISCUSSIONS

With attention to the aging population's growth, coupled with cognitive aspects, mHealth technology should be designed using cognitive frameworks as its basis during development phases, particularly surrounding design aspects reflective of an invisible computer. Most compelling evidence, participant responses from the focus group in this study suggests a hypothesis of current UI designs leave some users feeling ambivalent. Older users are aware of the vast growth of technology; so undoubtedly, they attempt to grow and adapt to the change. Hundreds of thousands of mHealth apps are available in the marketplace; yet, few have been tested for UX, and fewer still have been successfully integrated into healthcare systems (Kirkscey, 2021). The systemic development and UX evaluation of an mHealth app for older adults developed in a case study conducted by (Kirkscey, 2021) emphasize the need for researchers to consider several stakeholders. The healthcare system creates an interconnected web that must integrate contextual awareness as an essential element of the test plan (Kirkscey, 2021). Notably, patients, physicians, and healthcare personnel in the previously mentioned case study emphasizes the need to consider the embodied contexts of the older adults as they navigate the sociocultural and economic features of using technology deployed from a healthcare system (Kirkscey, 2021).

While there are existing studies that highlight the development process of mHealth applications, there's limited research accentuating user requirements in both UI development and UX evaluation from a cognitive perspective. In existing user-centered design approaches, the goal is to derive what the users need to do and their objectives based on the gathered context and then set a clear statement of user requirements for the solution designs (Nimmanterdwong et al., 2022). These requirements

are often created along with other requirements of the product such as the requirements of the system stating that the system needs to be able to do a certain task because it will help users accomplish their goals (Nimmanterdwong et al., 2022). Currently, mHealth applications tend to underscore system requirements leaving a narrowed focus on achieving user needs on a multitude of cognitive levels in conjunction with contextual factors – point often overlooked. During a case study represented by (Kirkscey, 2021) of a mHealth app for older adults, it highlights performative phenomenology assists in defining the relationships and contextualizing the needs not only of the patient but also of the caregivers, healthcare providers, IT workers, and external stakeholders involved in the process. This emphasizes the importance of coupling multifaceted aspects of both user and system requirements within UI design – noting that one is no more important than the other for optimal utilization. Through this process of discovery, researchers may also expose and even shift some power relationships by giving voice to patients or research participants in different and more forceful ways (Kirkscey, 2021). Giving user's a voice early in the design can have a significant impact on usability, as it provides these users with a sense of ownership tied to the application and UI development opposed to forcibly adapting to what has been created for them. Involving users early in the process proves vital in crafting a health care technology that matches actual older adult user needs, with elderly friendly user interfaces (Nimmanterdwong et al., 2022).

9 CONCLUSION AND FUTURE WORKS

Findings in this study aim to create future development of mHealth UIs encompassing traditional elements of healthcare by using cognitive frameworks such as external cognitional and emotional interaction, to a name a few, in creating a parallel simulation of real-world interactions within technology. Adapting face-to-face intervention and its contents into a suitable mobile experience for middle-aged and older patients is key (Nimmanterdwong et al., 2022). For example, simulating an UI that mirrors social interactions that traditionally take place in-person may decrease the dissonance that older users feel while engaging with telemedicine., via virtual social agents. Human–computer interaction applications increasingly deploy intelligent agents to support the social aspects of the interaction (Van Erp & Toet ,2015). Social agents (either embodied or virtual) already employ vision and audition to communicate social signals but generally lack touch capabilities (Van Erp & Toet ,2015). Designing these applications while using an iterative and user-centered design approach may display an increasing adoption rate of mHealth. For any interesting real-world domain of design, there cannot be any global synthesis function that maps requirements into a structure (Card, 2018). Design, as all designers know, is not a simple top-down or bottom-up process of synthesizing a design solution from requirements; rather an open process, in the sense that the design problem is constantly being redefined (Card, 2018). It's important to note that mHealth applications were reintroduced in the plight of a global pandemic, yet this paper serves as a basis to continually redefine the UI of these applications that go beyond patients simply reaching their healthcare team, but rather creating a sense of inclusiveness.

With the assistance of design processes derived from Card's work noted in "The psychology of Human-Computer Interaction", future work aims to achieve a more inclusive mHealth design that includes a multifaceted cognitive frameworks and models. There's limited research on creating inclusive technology that encompasses such cognitive aspects. It is expected that future UX designers and researchers continue to investigate inclusive UI design aspects that includes as many users as possible. However, collecting data from overlooked groups within technology assimilation must be initiated if this gap intends to decrease. ICT infrastructure plays a pivotal role in the elderly's healthcare (Fotoyi, 2021). As an agent of change, ICT enables the provision of proactive, personalized healthcare to the elderly living at home (Fotoyi, 2021). Stressing the importance of mHealth applications via ICTs within the aging population will continue to keep the goal of universal usability at the forefront for UX designers and researchers.

9.1 Limitations

While this study was conducted with a small sample size (n=30) for preliminary findings, these key findings were able to identify important usability concerns that are still not widely incorporated into UX design. Participants in this study primarily focused on elderly users in the United States in an urban region. Further cross-cultural studies will need to be conducted to determine a direct correlation

between American elderly users compared to this demographic in other regions.

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