Challenges Faced by Older Adults in Using Mobile Apps, and a Way Forward

Seoyeong Park
North Carolina State University
Raleigh, NC, USA
spark43@ncsu.edu

Munindar P. Singh
North Carolina State University
Raleigh, NC, USA
mpsingh@ncsu.edu

ABSTRACT

The low adoption of mobile apps by older adults exacerbates the digital divide. We examine the psychological and technological factors that influence app usage by older adults, drawing insights from app reviews to highlight the unmet needs of older adults and their expectations. We find that current accessibility guidelines emphasize physical impairments and rely on device-level assistive tools. Importantly, they don't address aging-specific factors pertaining to reduced motivation and physical, cognitive, and perceptual abilities. To bridge this gap, we introduce the Empathetic Senior Technology Acceptance Model (e-STAM), as a new model of technology adoption. We show how e-STAM can help refine accessibility guidelines for older adults and may be realized through empathetic AI agents.

KEYWORDS

Empathetic agents, Mobile apps, Human-agent interaction, Older adults

1 INTRODUCTION

The World Health Organization (WHO) states that one in six or 2.1 billion people globally will be aged 60 years or over by 2050.[1] People are living longer and the quality of life and independence while aging are increasingly important.

Mobile applications (apps) have penetrated virtually all aspects of life—Google Play reports over 2.26 million current apps[2] and Apple App Store over a million games and 3.83 million non-gaming apps in 2024.[3] Thus, mobile apps provide a viable path for autonomy and social connections among the elderly.

Beyond daily usage and personal purposes, mobile technologies are often used for nudging behavior, conducting studies, designing persuasive strategies, and many other operational purposes. Poorly designed apps that fail to account for diverse user needs may result in low engagement and diminish the positive impact of such interventions, not just causing inconvenience to users with a lack of personalization.

Unfortunately, developers don't consider older adults a target user group and apps often neglect their needs. Common problems not only include unintuitive interfaces but also include disruptive interactions that lead to frustration, anxiety, and disengagement.

Artificial Intelligence (AI) can model human behavior and predict user activities and interactions. Our objective is to explore how AI can lower the barriers to mobile technology adoption. Accordingly, we evaluate the limitations of existing accessibility guidelines and propose empathy-centric design principles leveraging AI.

The paper is structured around three major themes: (1) identifying the unique needs of older adults, (2) revisiting accessibility guidelines to address aging, and (3) proposing a conceptual framework (e-STAM) that incorporates empathy in accessible design via human-agent interaction.

SIDEBAR: CHALLENGES OF AGING

Gerontechnology—technology for older users—highlights how older adults perceive apps as tools for enhancing their quality of life [12]. Older users overlap with users with disabilities but are distinct from them. Even those without specific disabilities may experience natural declines in physical (e.g., vision, hearing, and fine-motor control) and cognitive abilities. Aging poses three challenges to technology adoption.

Physical. Physical problems include declines in vision (color discrimination) and motor control. Studies show visual acuity loss of 50%, hearing sensitivity loss of 20 dB, and short-term memory loss of 14% between the ages of 60 and 80 [7]. Mobile interface gestures such as swiping, tapping, and scrolling become difficult.

Cognitive. Cognitive abilities—attention, memory, executive function, language, and spatial abilities—decline with age [10]. Procedural knowledge and ability are key for apps. Cognitive declines affect comprehension and the perception of interface elements.

Motivational. Older people tend to resist change and maintain habits, behaviors, and lifestyles [11]. Motivation reflects beliefs, attitudes, anxiety, and fear. Three factors are key to motivation: *personal*, including functional capacity, experience with technology, and attitudes toward using technology; *technological*, involving poor usability and complexity; and *environmental*, including expense and social influences [8]. These problems are interconnected—e.g., complex designs may induce anxiety, which may harm learnability and confidence. Likewise, cost or peer pressure may increase or decrease motivation to accept new technology.

2 RESEARCH QUESTIONS

We now motivate our research questions.

RQ_{ux} addresses investigating how older adults experience mobile technologies to identify patterns and unmet needs that suggest design improvements and accessibility concerns.

[1] https://www.who.int/news-room/fact-sheets/detail/ageing-and-health
[2] https://www.statista.com/statistics/289418/number-of-available-apps-in-the-google-play-store-quarter/
[3] https://www.statista.com/statistics/268251/number-of-apps-in-the-itunes-app-store-since-2008/

RQ_{ux} What do app reviews reveal about how aging impacts older adults' experience with mobile usage?

$RQ_{accessibility}$ tackles inclusive design, including creating apps that are usable to the broadest range of users. Inclusion captures fairness (user groups get equal opportunities) and equity (each individual's unique challenges are addressed). Current accessibility guidelines, however, emphasize disabilities while deemphasizing age-related declines[9]. For example, designs often fail to accommodate cognitive declines.

$RQ_{accessibility}$ What should a model and guidelines for mobile accessibility include to tackle aging?

RQ_{ai} concerns using AI to support personalized and intuitive user experience. We envision empathetic AI that can help improve alignment with users' cognitive and emotional needs. For example, empathetic AI can adjust the pace of interaction by slowing down reaction times for users who require more time. Or, it can progressively introduce features to gradually increase the complexity of tasks to accommodate slower learning. From user interactions, empathetic AI can identify subtle differences among users and their hidden challenges and offer adaptive support for functional as well as emotional and cognitive needs, instead of merely predicting behavior. This approach fosters deeper engagement, empowering older adults to remain active participants.

RQ_{ai} How can we incorporate AI and empathy in mobile app design to improve accessibility and inclusivity?

3 FAILING OLDER USERS' EXPECTATIONS

Older adults dislike apps that use unfamiliar terminology or fast animations, increase the perception of complexity, lack accessibility features, or do not use color contrast effectively [1]. Good designs simplify the interface navigation and visualizations, limit the information provided to users to what is necessary, and provide a helpful guide that explains the features of the interface elements. Understanding these expectations is crucial for developers aiming to create inclusive and empathetic AI.

To empirically understand what characteristics affect older people's real-life mobile app usage, we turn to an analysis of app reviews. We retrieved 6,170,237 user reviews from various apps on the Google Play store. Only 3.5% of them specifically relate to accessibility (filtered with keywords such as *cognition, motivation, perception, physical operation*, and their respective subcategories) and authored by older adults. We focus on these 215,462 "accessibility" reviews. The details of the review analysis are in the supplementary materials.

Whereas over 50% of all reviews are positive (scoring 4 or 5), interestingly, more than 50% of the accessibility reviews are negative (scoring 1 or 2), indicating that the expectations of older adults and app design for accessibility mismatch. This discrepancy reflects widespread dissatisfaction among older users and implies how current mobile app designs fail to meet accessibility needs.

The reviews bring up the aging challenges described in the sidebar. The reviews express disappointment about the poor awareness of the cognitive and perceptual abilities of older users and discontent about user interfaces, representing older users' opinions. They reveal challenges such as confusion and difficulties in getting started due to complex designs. For instance, one user wrote *Much more difficult than the old one. Elderly people like myself won't like it at all. I had to ask an employee how to get products in my basket, there was no instruction on the app. I do not like it! Make it easy for everyone please!* about the ease of usage and no instructions. Another user wrote *I understand that improvements are important but your new system is way too confusing and time consuming! So sad for elderly customers too.*

We identified co-occurrence patterns between accessibility concerns within the same app. Apps lacking in one criterion are highly likely to lack others as well. For example, apps with annoying ads often overwhelm users in other ways too. Similarly, when one reviewer complains about navigation complexity, it is likely another reviewer complains about the learning curve or memory demand.

Our empirical analysis indicates that many apps neglect the needs of older users but instead offer complicated features without adequate support mechanisms.

4 E-STAM: EMPATHETIC SENIOR TECHNOLOGY ACCEPTANCE MODEL

Developers often hold stereotypes of older adult users, e.g., their alleged resistance to change, and don't treat them as a distinct user group. For these reasons, they treat older adults as passive receivers [3], either as general users or as users with disabilities.

Common assumptions about technology usage may not apply to older adults due to differences in their mental models [6]. Older adults have different attitudes and motivations than younger users. They may find mobile apps overly complicated or irrelevant to their needs. They may struggle with rapid change. Recognizing these differences is essential for addressing the barriers older adults face in their daily lives in adopting mobile apps.

Age-related cognitive factors, such as crystallized intelligence, influence how older adults perceive new technologies. Crystallized intelligence refers to acquired knowledge that grows with experience, while fluid intelligence, which includes memory, attention, problem-solving, and learning, declines with age [5].

4.1 Senior Technology Acceptance Model

We begin with the well-known Senior Technology Acceptance Model (STAM) [4], which outlines the key predictors of technology adoption among older adults. STAM considers the physical, psychological, and social dimensions of older adults, including health, attitudes, interpersonal relationships, cognitive abilities and physical limitations, age, gender, and economic status.

Usability. Usability concerns a user's ability to understand an app's features and achieve their goals. Usability comprises efficiency, learnability, memorability, effectiveness, satisfaction, and error prevention, and attributes such as attractiveness, simplicity, and understandability. Usability presumes mental resources, e.g., to figure out how to navigate an app, understand its functions, and complete necessary tasks without confusion. Thus, age-related cognitive decline exacerbates usability.

4.2 e-STAM

We propose e-STAM (empathetic STAM), an enhancement of STAM that is geared toward AI agents (Figure 1). STAM considers technology in general and doesn't address the rise of AI, which enables technology to function not just as an instrument but as a partner. However, technology is no longer passive; rather, it can dynamically respond to users.

STAM focuses on the user's subjective perceptions, which may be suitable for predicting acceptance but doesn't yield actionable design principles that enhance adoption. Empathy is key. Empathy is a multifaceted psychological process and involves understanding another's situation with more congruent feelings than one's own situation [2]. In designing apps for older adults, empathy helps both developers (at design time) and AI agents (at runtime) to form a more profound understanding of their unique needs and challenges.

As Figure 1 shows, e-STAM focuses on *partner* agents, not tools. It emphasizes self-efficacy, cognitive ability, social relationships, attitude, and anxiety. e-STAM proposes interventions to reduce frustration (*Recognizing and addressing anxiety*) such as clear explanations, malfunction handling, and predictive support that helps users before they encounter problems. It emphasizes *gentle learning curves, simplicity, and transparency* to ensure that users understand what is happening and why at every step. By *anticipating user needs*, it seeks to proactively adapt to user behaviors and preferences and gradually introduce functionalities. Via *adaptive feedback and tailored interaction*, it supports personalized interfaces. e-STAM includes *dynamic cognitive assistance* to help users manage tasks without overwhelming cognitive load. Throughout, e-STAM incorporates empathy. Since our objective is to promote adoption through concrete, empathetic design principles and improved guidelines for developers, we consider desired attributes for an agent, not merely the user's subjective view of those attributes.

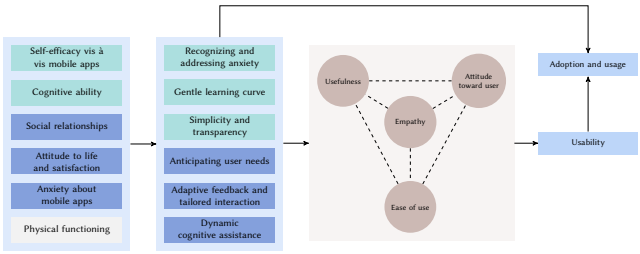

Figure 1: e-STAM (Empathetic Senior Technology Acceptance Model)

5 TOWARD EMPATHETIC AI FOR OLDER ADULTS

We propose higher-level criteria (colored rows in Figure 2) for e-STAM that go beyond mere physical considerations. These guidelines apply to early-stage design. However, apps must constantly evolve to remain aligned with the changing usage and cognitive capabilities of aging users.

Figure 3 presents a conceptual model and approach for tackling the (sometimes hidden) needs of older adults by leveraging AI and embedding empathy. Our design objective should be technology

Category	Subcategory	
Vision	Clear labels	Covered by - Google (Mobile) - Apple (Mobile) - BBC (Mobile) - WCAG (Web)
	Color contrast & Font size	
	Alternatives for images and texts	
Hearing	Alternatives for audio	
Motor	Simple gestures	
	Alternatives of gesture interaction	
	Touch target size	
Assistive tech	Navigation paradigm for assistive tools	
	Requirements for built-in assistive technology	
	Compatibility with assistive devices	
Cognitive support	Simplified navigation	e-STAM
	Error prevention and recovery (e.g., Clear error messages)	
	Easy access to instructions	
	Memory aids (e.g., reminders)	
	Readability	
	Minimize effort (e.g., learning curve)	
Self-efficacy	Adaptive user support	
	Easy troubleshooting malfunctions	
Anxiety reduction	Clear feedback	
	Progress indicator	
	Predictable behavior	
	Familiar interface	
Social connection	Participating interaction	
	Peer support	
	Interactive feedback	

Figure 2: Summary of accessibility guidelines and e-STAM elements. Most of each guideline covers supplementing minimum physical limitations. The gray background elements are what the current accessibility guidelines cover. The colored elements support cognition and indirect factors that help an app. Colors are accordingly mapped to Figure 1.

that is not only accessible but also resonates with the user's emotional and cognitive needs. This framework suggests the importance of supporting the holistic well-being of older adults by responding to their cognitive states relating to mental processes and behavioral states that reflect engagement patterns. Understanding these states can enhance motivation by reducing frustration, increasing confidence, and fostering a sense of autonomy.

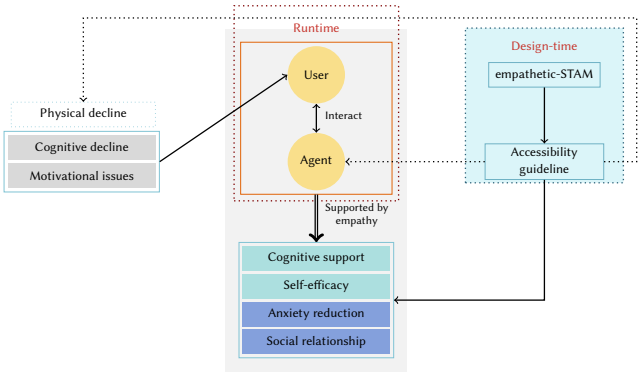

Figure 3: A conceptual model for identifying the impact of accessibility and an approach to resolution with e-STAM. e-STAM supports early design stages by guiding developers to consider inclusivity and influencing agents in learning key elements that foster empathy. During runtime, agents develop empathy through interactions with users, identifying areas where users experience difficulties.

5.1 Design Time: Embedding Empathy in Development

Traditional human-centered design approaches often rely on developer intuition and user studies. Whereas these methods provide valuable insights, these approaches may fail to capture the subtle nuances of user experience across different user groups and may inadvertently overlook the needs, especially accessibility, of aging users.

Previous studies have applied and assessed empathy primarily in conversational agents [2]. Its application in mobile apps remains underdeveloped. Leveraging empathy-driven user modeling in the design process can address the foregoing limitations of traditional approaches to creating more adaptive and inclusive experiences that lower technology barriers. For example, expanding longitudinal research with older adults beyond standard usability testing can provide richer insight into how aging users interact with technology over time. Conducting a participatory design process may help capture the specific struggles.

Empathy in mobile accessibility does not simply involve developers listening and passively observing users to gather insights to understand their needs. It involves active observation of users to gain insights into their limitations through their interaction with an app. It involves creating intelligent systems capable of perceiving, interpreting, and responding to user behaviors, thoughts, and emotions.

Two types of empathy can be applied during design. *Affective empathy* is the ability to share and respond to others' emotions. *Cognitive empathy* is the ability to understand others' perspectives and needs without necessarily sharing the emotional experience. AI agents designed with affective empathy can recognize and react to emotional responses, such as frustration and anxiety. For example, alleviating unnecessary panic caused by misunderstanding errors—*freezes up - actually went out looking for elderly spouse thinking they had collapsed on their walk when it was just the app freezing. scared me to death!*—can be handled. Another example reported by a user is frustration—*update won't work on my elderly mother's phone and she can't log on to online banking without using the app to verify. ridiculous. with no branches nearby, she's now got no way to regularly access her account. for a 'helpline' they're sadly not very helpful.* AI agents can detect these moments through users' behavior, such as long inactivity time, repeated tries, and rapid tapping, and respond with immediate actions. Furthermore, AI agents with cognitive empathy allow to anticipate usability challenges that older adults might face and proactively adapt interfaces. Cognitive empathy can handle common challenges such as complex features (e.g., *the new update is not good. need a comfortable update from which everyone can see properly especially senior citizens.*) and predictable friction (e.g., *to be honest, it could be more user friendly. the app itself still has some glitches when you try to reset the password. older people really find it difficult to access even when you press remember me on the password, it doesn't remember it. don't get me wrong, when its used by the right person then it works perfectly, but not always.*) that users go through while using essential services. Integrating empathy can make AI agents more supportive and foster confidence in using mobile technologies.

5.2 Runtime: AI Agent as Partner

Empathy should also be realized in the behaviors of AI agents through real-time adaptation based on how users interact. Here, empathy yields AI agents that deliver clear, user-friendly explanations accommodating accessibility by continually assessing older users' aging decline. Context-sensitive assistance, personalized interactions, and dynamic user support exemplify empathetic AI.

Tailored user modeling fosters greater empathy by adapting interfaces to users' behaviors and preferences. Empathetic AI can help improve usability and ease of use through personalized guidance and reduced complexity, thereby boosting confidence and motivation.

AI agents can interact empathetically and provide personalized, adapted, and assistive support. For example, an empathetic agent can adjust the timing of guidance, transition duration, frequency of notifications, and message formats to suit each user's needs and abilities, thereby producing a gentle learning curve. It can recognize frustration or confusion by inferring the cognitive and emotional states of users and reduce complexity when necessary. In contrast, nonempathetic AI disregards older user's needs and abilities. and offers generic solutions.

Moreover, empathetic AI can promote user's trust in apps and their developers [13]. It can also feed information back to developers to improve how apps are designed to serve users of a wider range of capabilities. Indeed, the lack of continual feedback from older adults is a shortcoming of current approaches.

6 DISCUSSION

Aging and disability studies share common concerns but address distinct populations. Extant approaches largely overlook the cognitive and motivational challenges faced by aging users. Current accessibility guidelines focus on physical limitations. However, users may suffer from mild cognitive decline, and built-in tools are not adequate for them. Addressing these gaps requires inclusive design recognizing and accommodating varying degrees of cognitive decline.

This paper fills an important gap since current methods and developer mindsets are not geared to supporting older users. We discuss challenges arising due to aging with an emphasis on cognitive support and motivation with the goals of reducing older users' anxiety and enhancing their self-efficacy. We highlight the importance of improving accessible and user-centric design by adopting a human-centered approach, integrating empathetic AI, and extending current accessibility guidelines.

Building on the proposed e-STAM, we propose a novel, empathy-centered framework leveraging AI agents to understand users' cognitive states and evolving needs that become important while aging. This integration enables personalized and adaptive experiences that foster inclusion by ensuring older adults feel understood and cared for, eventually promoting their acceptance and sustained use of mobile technologies.

Much work remains to be done in realizing e-STAM in practice. Important future themes are design guidelines and human-centered design processes that incorporate empathy as well as empathetic AI technologies to create inclusive mobile apps that better meet the needs of older adults.

ACKNOWLEDGMENTS

SP and MPS thank the NSF (grant IIS-2116751) for partial support.

REFERENCES

[1] Bilal Ahmad, Ita Richardson, and Sarah Beecham. 2021. Usability Recommendations for Designers of Smartphone Applications for Older Adults: An Empirical Study. In *Software Usability*, Laura M. Castro, David Cabrero, and Rüdiger Heimgärtner (Eds.). IntechOpen, Rijeka, Chapter 4, 251–264. https://doi.org/10.5772/intechopen.96775

[2] Andreas Brännström, Joel Wester, and Juan Carlos Nieves. 2024. A formal understanding of computational empathy in interactive agents. *Cognitive Systems Research* 85 (2024), 101203.

[3] Juan Carlos Briede-Westermeyer, Bélgica Pacheco-Blanco, Marianela Luzardo-Briceño, and Cristhian Pérez-Villalobos. 2020. Mobile Phone Use by the Elderly: Relationship between Usability, Social Activity, and the Environment. *Sustainability* 12, 7 (2020), 2690. https://doi.org/10.3390/su12072690

[4] Ke Chen and Alan Chan. 2014. Gerontechnology Acceptance by Elderly Hong Kong Chinese: A Senior Technology Acceptance Model (STAM). *Ergonomics* 57, 5 (03 2014), 635–652. https://doi.org/10.1080/00140139.2014.895855

[5] Sara J Czaja, Neil Charness, Arthur D Fisk, Christopher Hertzog, Sankaran N Nair, Wendy A Rogers, and Joseph Sharit. 2006. Factors Predicting the Use of Technology: Findings From the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and Aging* 21, 2 (2006), 333 – 352.

[6] Moojan Ghafurian, John Edison Muñoz, Jennifer Boger, Jesse Hoey, and Kerstin Dautenhahn. 2022. Socially Interactive Agents for Supporting Aging. In *The Handbook on Socially Interactive Agents:20 years of Research on Embodied Conversational Agents, Intelligent Virtual Agents, and Social Robotics Volume 2: Interactivity, Platforms, Application*, Birgit Lugrin, Catherine Pelachaud, and David Traum (Eds.). ACM Books, Vol. 48. ACM / Morgan & Claypool, 367–402. https://doi.org/10.1145/3563659.3563671

[7] Richard Harte, Leo Quinlan, Liam Glynn, Alejandro Rodriguez-Molinero, Paul Baker, Thomas Scharf, and Gearoid OLaighin. 2017. Human-Centered Design Study: Enhancing the Usability of a Mobile Phone App in an Integrated Falls Risk Detection System for Use by Older Adult Users. *JMIR mHealth and uHealth* 5 (05 2017), e71. https://doi.org/10.2196/mhealth.7046

[8] Alexis Kuerbis, Adina Mulliken, Frederick Muench, Alison Moore, and Daniel Gardner. 2017. Older Adults and Mobile Technology: Factors that Enhance and Inhibit Utilization in the Context of Behavioral Health. *Mental Health and Addiction Research* 2 (Jan. 2017), 1–11. https://doi.org/10.15761/MHAR.1000136

[9] Ittay Mannheim, Eveline J. M. Wouters, Hanna Köttl, Leonieke C. van Boekel, Rens Brankaert, and Yvonne van Zaalen. 2023. Ageism in the Discourse and Practice of Designing Digital Technology for Older Persons: A Scoping Review. *The Gerontologist* 63, 7 (2023), 1188–1200.

[10] Daniel Murman. 2015. The Impact of Age on Cognition. *Seminars in Hearing* 36 (08 2015), 111–121. https://doi.org/10.1055/s-0035-1555115

[11] Shahrokh Nikou. 2015. Mobile Technology and Forgotten Consumers: The Young-Elderly. *International Journal of Consumer Studies* 39 (04 2015), 294–304. https://doi.org/10.1111/ijcs.12187

[12] Inmaculada Plaza, Lourdes Martín, Sergio Martín, and Carlos Medrano. 2011. Mobile Applications in an Aging Society: Status and Trends. *J. Syst. Softw.* 84, 11 (2011), 1977–1988. https://doi.org/10.1016/j.jss.2011.05.035

[13] Amika M. Singh and Munindar P. Singh. 2023. Wasabi: A Conceptual Model for Trustworthy Artificial Intelligence. *IEEE Computer* 56, 2 (Feb. 2023), 20–28. https://doi.org/10.1109/MC.2022.3212022