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Technology: An Underutilized Late-Life Resource

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TECHNOLOGY: AN UNDERUTILIZED LATE-LIFE RESOURCE

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Innovative Uses of Technology to Benefit Older Adults

Eva Kahana, PhD, *Editor-in-Chief*

Welcome to the post pandemic edition of the *Journal of Elder Policy* (JEP). This issue is focused on technology use as an underutilized resource among older adults. The articles address perceptions of technology use among older adults, barriers to engagement, and the adoption of various programs to enhance technology use. Computers and assistive devices are central to late life technology use (Burdick & Kwon, 2005). Internet use and digital literacy can be classified as modern set of tools that can help the elderly achieve the three pillars of successful aging: positive affective states, meaning in life, and maintenance of valued activities and relationships (Kahana et al., 2012). The Pandemic created a context where technology had to be utilized as an alternative to physical human contact. To the extent that older adults had access to technological resources they were able to maintain social contact with friends and family and engage in commercial transactions which enhanced their mental health (Drazich et al., 2023; Elliot et al., 2014). At the same time, lack of skill in utilizing available technology contributed to further social isolation.

Although older adults have been relative latecomers to technology use (Hulur & Mcdonald, 2020), the opportunities offered by technology have, nevertheless, have altered their lives and offer great promise. The benefits older adults derive from constructive engagement with technology are valuable and meaningful even after the pandemic. Indeed, interest continues to be directed at further technological innovations that may transform society in even more dramatic ways. The articles included in this issue of *JEP* are based on submitted abstracts to our call for papers related to technology and aging. It is worthwhile to note that most of the submissions we received are based on special projects and programs that incorporate technologies in late life. There were few submissions that considered spontaneous technology use among community dwelling elders. Rather, many of the submissions we received related to technology use in special settings and programs that are initiated by others for older adults.

There is an important message of reliance on others, conveyed by the choice of topics. Although the value of technology use is confirmed by the articles we include, the initiative and motivation are generally coming from those who designed and evaluated technological interventions (Oppenauer, 2009). This is also understandable if we consider funding opportunities for research on the subject. Research grants that support technological interventions are the most likely source

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for funding research supporting this new literature. Such grants are typically implemented in institutional or community service settings. Technology is thus offered and introduced to service participants. There is less attention to spontaneous technology use in late life. My musings about the selective nature of our articles point to a need for diversification of this literature.

Technology can play a very important role in maintaining good quality of life in advanced old age and closer to the end of life. Electronic communication enables older adults to maintain ties with distant friends and family. As such, it can enhance quality of late life. During the pandemic, technology played a very important role in securing medical care through Telehealth (Doraiswamy et al., 2020). Additionally, consumers secured food, medications, and other important home supplies through Instacart. Indeed, empirical data obtained during the pandemic confirms increase in use of technology including greater use of technology in health care communication. Data pointing to increasing technology use in late life were obtained from the 2020 National Health Survey Questionnaire (Drazich et al., 2023).

Experiential perspectives on topics covered in the current issue of *JEP*

I want to follow my tradition established in prior volumes of *JEP* linking contributions by authors to my lived experience as an older person. Indeed, consideration of the literature on technology use among older adults made me reevaluate my own facility with technology. My conclusion is that my reliance on technology at age 82 years is pretty narrow and specific and mostly limited to basic computer skills.

Currently, the news is centered on both the promise and dangers of artificial intelligence (AI) (Nadikattu, 2016). I find it fascinating to learn about the potential of AI in everyday life. My younger son Michael, who is a professor of neuroscience at the University of Pennsylvania, called my attention to the immediate benefits of using AI. My initial introduction to AI related to discussions of technical papers about human memory that my son has written. I was impressed and excited to find a thoughtful and relevant discussion of this technical work by simply accessing AI. Enamored by this new opportunity, I decided to look up my own work that is less technical in nature. To my surprise, I got a far less well differentiated discussion including confusing elements. I thus realized that everyday use of the technical miracles such as AI still requires patience and practice in anticipation of better future results.

Regarding my own technology use, I am comfortable with using the Dragon dictation tool to assist with my writing. I regularly check email and keep a calendar of events on my computer. Indeed, every morning, after being awakened by my alarm on my iPhone, I grab a cup of coffee and go to check my e-mail along with my calendar for the day. However, I am less comfortable in being introduced to unfamiliar, new technology such as navigating commerce using computers. For instance, I can order supplies online but, I am much less skilled in returning items that did not work out. As a recent widow, I can no longer rely on my late husband's greater facility with technology. This loss of technology knowhow among widows and widowers poses an important disadvantage to those who lose a spouse in late life. As I reevaluate my own limitations in technology use, I realize that ongoing help and instruction are needed to ensure older adults' responsiveness to new opportunities and new needs relevant to technology use (Rogers et al., 2004).

I am still actively engaged in in working on my recovery from my hip surgery that took place last July. Finally, after three unsuccessful tries, I found a competent physical therapist in the local hospital in my neighborhood, and I work with her twice a week. I also try to do exercises outside of my physical therapy sessions, but my performance in doing so is spotty. For the most part I walk with a cane and for longer distances still utilize a walker. I do not have pain, but feel insecure about my balance. I also have difficulty driving, especially after dark. One positive observation that I can make related to my disability has to do with unanticipated kindness of strangers who see me struggle with mundane tasks like opening doors while carrying books or other large objects.

Thankfully, my physical difficulties have not hindered my and scholarly social interactions, in-part due to technology. Many conferences and community meetings are now conducted by Zoom or in Hybrid format. An important and meaningful innovation in this realm relates to religious services being available online. Given that there are very few Holocaust survivors remaining to share their experiences, I have continued to receive speaking invitations and enjoy interacting with audiences, including children.

I have recently celebrated my 82nd birthday and organized an in-person lunch for my graduate students in a nice Italian restaurant near my University. This has been my tribute to life in the post Covid era. I no longer wear a mask, except in doctor's offices where masks are required. I participate in a lot of departmental activities. I was initially granted permission to use Zoom in my classes due to my physical disabilities, and I am hopeful that the permission will be renewed, as my mobility is still limited, and my teacher's ratings remain excellent.

Although there is frequent lament in a university context of the intrusion of technology, such as Zoom, that supplants face to face interactions, there are many benefits and beneficiaries of online interactions. Indeed, students often enjoy and even prefer online classes. In my own situation, the opportunity to offer classes by Zoom enabled me to teach, even while coping with physical disabilities. I find it encouraging and a noteworthy benefit of technology, that students can rate online classes favorably.

The articles submitted to this issue of *JEP* confirm prior ideas (Czaja et al., 2006) about both barriers and facilitators of technology use in late life. Accordingly, computer anxiety and intellectual abilities and functioning play important roles in reluctance of older adults to adopt technology. The authors of articles we publish in the current issue of *JEP* provide arguments for improving training that can facilitate technology use. The articles we received also emphasize the importance of including older adults in planning of interventions that use technology.

Turning to the literature on technology and aging it is noteworthy that the majority of recent articles appear in European Journals (Hülür & Macdonald, 2020; Nowland et al., 2018; Wilson et al., 2023). We are pleased to share with our readers progress made in this realm in the U.S. The articles featured in this issue of *JEP* come from contributors from many applied fields and generally involve multiple contributors. Below we review significant messages shared by our authors. In summarizing messages of the articles in this issue we note authors' diverse disciplinary backgrounds.

1. AI companion robot data sharing: Comfort and preferences of an online cohort with policy implications by authors **Clara Berridge, PhD, MSW, Yuanjin Zhou, PhD, MA, Julie M. Robillard, PhD,** and **Jeffrey Kaye, MD** takes an important look at older adults' perspectives of Artificial Intelligence (AI) technology in relation to companion robots that speak using natural language processing. They explored participants' comfort level with robots in the home and their perceptions of Al issues related privacy and data collection. Specifically, the authors were interested if respondents would be comfortable allowing facial expressions and conversations to be recorded and shared. This study was unique as it was able to examine perceptions during the pandemic and also during "normal" times. Findings revealed that participants who were male, younger, and had lower formal education felt most comfortable with companion robots in their home. Of those comfortable with their data being collected and recorded, many did not want their information shared with third party or health insurance companies, but were open to the data being shared with a medical provider, a spouse/partner, and themselves. Policy implications echo the sentiment of the participants that safeguards should be in place to ensure user privacy and promote consumer trust.

2. Technology use, digital competence, and access to community resources among older participants in the University of Rhode Island Engaging Generations Cyber-Seniors digiAGE Pilot Study by **Skye N. Leedahl, PhD, FGSA, FAGHE, Kristin Souza, MEd, Alexandria Capolino, MS, Melanie Brasher, PhD, Emma Pascuzzi1, MS, Christina Azzinaro, BA, Tyler-Ann Ellison, BS, Erica Estus, PharmD, BCGP** and **Maureen Maigret, RN, BS, MPA** provides an overview of a pilot study aimed to bridge the digital divide. Using an innovative, intergenerational approach, their study matched older, Spanish- and English-speaking adults from senior centers with college student mentors. Findings revealed that the older adults improved their digital competence and technology use. The respondents also reported that they felt more confident and capable when using the internet and devices as they were able to locate activities and resources online, and were better able to access health care information and book appointments. This article provides an excellent roadmap that can inform state and university collaborations that want to promote digital equity. Authors suggest policies that support broadband equity and advocate for trainings that can improve digital literacy and equity for older adults.

3. "Connect it down to the person": Perspectives on technology adoption from older Angelenos by **Kelly Marnfeldt, MSG, Sindy Lomeli, MPH, Sheila Salinas Navarro, MPA, Lilly Estenson, MSW, Kate Wilber, PhD** takes a step back and explores the perspectives of older adults about facilitators and barriers to their technology use. Their qualitative study included a sample of Spanish and English-speaking older adults from the Los Angeles area. Their findings allow the reader to get inside the minds of the participants. For example, their results indicate that family and friends are the main motivators for the uptake of technology and also the main source of tech support for older adults. The authors state that family and friends function as "buffers, preventing the lack of know-how, technical difficulties, or other secondary barriers from discouraging participants from using digital devices." Despite being the go-to resource for support, older adults expressed concern about being an annoyance or burden to their families. Other themes relate to perceptions of negative aspects of technology and preferred learning methods for digital training. Potential policy recommendations relate to decreasing barriers to technology (subsidized access to internet and devices) and training that can improve confidence and provide much needed support.

4. Digital health games for older adults: Development, implementation, and programmatic implications of health game use in senior centers by **Elizabeth Orsega-Smith, PhD, Laurie Ruggiero, PhD, Nancy Getchell, PhD, Roghayeh Leila Barmaki, PhD, Amy Nichols, BS, Joshua Varghese, Rachel DeLauder, MS,** and **Reza Koiler, PhD** walks readers through the development of an exergame prototype which encourages older adults to engage in healthy eating, physical activity, and social connection, while also stimulating cognitive function. Next, the multi-disciplinary group of scholars in computer science, psychology/behavioral science, and kinesiology sought to develop an exergame designed to promote healthy aging. Their results revealed high rates of acceptability and qualitative feedback confirmed that participants enjoyed the game. Since the pilot was only two weeks long, there was not much movement in behavioral change. Nevertheless, participants indicated that the game impacted their knowledge and motivation related to healthy behaviors. Considering the favorable results, the authors suggest that exergames should be implemented in senior center programming.

5. Negotiating technological engagement: Use and non-use among older adults in assisted living by **Jennifer L. Snyder, PhD** considers the processes involved in engaging in technology use among older persons residing in assisted living. The approach is unique as the author conceptualizes use and non-use as a choice and situational rather than a consequence. Data were collected through interviews with residents of assisted living, family members and staff in the facility. The paper presents types of technologies that are used by older adults and delves into the decision-making process of why adults engage in technology use or non-use. For example, one participant regularly listened to the radio instead of watching TV. This was not because he didn't like TV, he simply preferred the radio. Without Snyder's qualitative approach, these nuances would have been missed. Using her findings, Snyder proposes an Interaction Approach to Technology Use.

Conclusion

All in all, this issue offers a useful glimpse of how and why older adults utilize technology, in addition to newly developed interventions to facilitate technology use by older adults. The articles included point to the acceptability of interventions to enhance technology use by older adults. The value of implementing participatory design and the use of mixed methods to evaluate effectiveness of interventions are confirmed (Rogers et al., 2022). Technological advances must meet older adults' needs, capabilities and preferences in order to ensure acceptance and utilization.

Usos innovadores de la tecnología en beneficio de los adultos mayores

Eva Kahana, PhD, *Editora en Jefe*

Le damos la bienvenida a la edición posterior a la pandemia del Journal of Elder Policy (JEP). Este número está enfocado en el uso de la tecnología como un recurso subutilizado entre los adultos mayores. Los artículos abordan las percepciones del uso de la tecnología entre los adultos mayores, las barreras para la participación y la adopción de varios programas para mejorar el uso de la tecnología. Las computadoras y los dispositivos de asistencia son fundamentales para el uso de la tecnología en la vejez (Burdick & Kwon, 2005). El uso de Internet y la alfabetización digital se pueden clasificar como un conjunto moderno de herramientas que pueden ayudar a las personas mayores a lograr los tres pilares del envejecimiento exitoso: estados afectivos positivos, significado en la vida y mantenimiento de actividades y relaciones valiosas (Kahana et al., 2012). La pandemia creó un contexto en el que la tecnología debía utilizarse como alternativa al contacto humano físico. En la medida en que los adultos mayores tuvieron acceso a recursos tecnológicos pudieron mantener contacto social con amigos y familiares y realizar transacciones comerciales que mejoraron su salud mental (Drazich et al., 2023; Elliot et al., 2014). Al mismo tiempo, la falta de habilidad para utilizar la tecnología disponible contribuyó a un mayor aislamiento social.

Aunque los adultos mayores han llegado relativamente tarde al uso de la tecnología (Hulur & Mcdonald, 2020), las oportunidades que ofrece la tecnología, sin embargo, han alterado sus vidas y ofrecen una gran promesa. Los beneficios que los adultos mayores obtienen del compromiso constructivo con la tecnología son valiosos y significativos incluso después de la pandemia. De hecho, el interés continúa dirigiéndose a más innovaciones tecnológicas que pueden transformar la sociedad de formas aún más dramáticas. Los artículos incluidos en este número de JEP se basan en resúmenes enviados a nuestra convocatoria de artículos relacionados con la tecnología y el envejecimiento. Vale la pena señalar que la mayoría de las presentaciones que recibimos se basan en proyectos y programas especiales que incorporan tecnologías en la vejez. Hubo pocas presentaciones que consideraran el uso espontáneo de la tecnología entre los ancianos que viven en la comunidad. Más bien, muchas de las presentaciones que recibimos estaban relacionadas con el uso de la tecnología en entornos y programas especiales iniciados por otros para adultos mayores.

Hay un mensaje importante de confianza en los demás, transmitido por la elección de los temas. Si bien el valor del uso de la tecnología se confirma en los artículos que incluimos, la iniciativa y la motivación provienen generalmente de quienes diseñaron y evaluaron las intervenciones tecnológicas (Oppenauer, 2009). Esto también es comprensible si consideramos las oportunidades de financiación para la investigación sobre el tema. Las becas de investigación que apoyan las intervenciones tecnológicas son la fuente más probable para financiar la investigación que respalda esta nueva literatura. Tales subvenciones se implementan típicamente en entornos institucionales o de servicios comunitarios. Por lo tanto, la tecnología se ofrece y se presenta a los participantes del servicio. Hay menos atención al uso espontáneo de la tecnología en la vejez. Mis reflexiones sobre la naturaleza selectiva de nuestros artículos apuntan a la necesidad de diversificar esta literatura.

La tecnología puede desempeñar un papel muy importante para mantener una buena calidad de vida en la vejez avanzada y más cerca del final de la vida. La comunicación electrónica permite a los adultos mayores mantener lazos con amigos y familiares distantes. Como tal, puede mejorar la calidad de vida en la vejez. Durante la pandemia, la tecnología jugó un papel muy importante para asegurar la atención médica a través de Telesalud (Doraiswamy et al., 2020). Además, los consumidores obtuvieron alimentos, medicamentos y otros suministros importantes para el hogar a través de Instacart. De hecho, los datos empíricos obtenidos durante la pandemia confirman un aumento en el uso de la tecnología, incluido un mayor uso de la tecnología en la comunicación del cuidado de la salud. Los datos que apuntan a un mayor uso de la tecnología en la vejez se obtuvieron del Cuestionario de la Encuesta Nacional de Salud de 2020 (Drazich et al., 2023).

Perspectivas experienciales sobre los temas tratados en el número actual de *JEP*

Quiero seguir mi tradición establecida en volúmenes anteriores de JEP vinculando las contribuciones de los autores con mi experiencia vivida como persona mayor. De hecho, la consideración de la literatura sobre el uso de la tecnología entre los adultos mayores me hizo reevaluar mi propia facilidad con la tecnología. Mi conclusión es que mi confianza en la tecnología a la edad de 82 años es bastante limitada y específica y en su mayoría se limita a las habilidades informáticas básicas.

Actualmente, las noticias se centran tanto en la promesa como en los peligros de la inteligencia artificial (IA) (Nadikattu, 2016). Me resulta fascinante aprender sobre el potencial de la IA en la vida cotidiana. Mi hijo menor, Michael, que es profesor de neurociencia en la Universidad de Pensilvania, me llamó la atención sobre los beneficios inmediatos del uso de la IA. Mi introducción inicial a la IA se relacionó con discusiones de artículos técnicos sobre la memoria humana que ha escrito mi hijo. Me impresionó y me entusiasmó encontrar una discusión reflexiva y relevante de este trabajo técnico simplemente accediendo a AI. Enamorado de esta nueva oportunidad, decidí buscar mi propio trabajo que es de naturaleza menos técnica. Para mi sorpresa, obtuve una discusión mucho menos diferenciada que incluía elementos confusos. Así me di cuenta de que el uso diario de los milagros técnicos como la IA aún requiere paciencia y práctica en previsión de mejores resultados futuros.

Con respecto a mi propio uso de la tecnología, me siento cómodo usando la herramienta de dictado Dragon para ayudarme con mi escritura. Regularmente reviso el correo electrónico y mantengo un calendario de eventos en mi computadora. De hecho, todas las mañanas, después de despertarme con la alarma de mi iPhone, tomo una taza de café y voy a revisar mi correo electrónico junto con mi calendario del día. Sin embargo, me siento menos cómodo cuando me presentan tecnología nueva y desconocida, como navegar por el comercio usando computadoras. Por ejemplo, puedo pedir suministros en línea, pero soy mucho menos hábil para devolver artículos que no funcionaron. Como viuda reciente, ya no puedo confiar en la mayor facilidad de mi difunto esposo con la tecnología. Esta pérdida de conocimientos tecnológicos entre las viudas y los viudos plantea una desventaja importante para quienes pierden a un cónyuge en la vejez. A medida que reevalúo mis propias limitaciones en el uso de la tecnología, me doy cuenta de que se necesita ayuda e instrucción constantes para asegurar que los adultos mayores respondan a las nuevas oportunidades y nuevas necesidades relacionadas con el uso de la tecnología (Rogers et al., 2004).

Todavía estoy trabajando activamente en mi recuperación de mi cirugía de cadera que tuvo lugar en julio pasado. Finalmente, después de tres intentos fallidos, encontré una fisioterapeuta competente en el hospital local de mi vecindario, y trabajo con ella dos veces por semana. También trato de hacer ejercicios fuera de mis sesiones de fisioterapia, pero mi desempeño al hacerlo es irregular. La mayor parte del tiempo camino con un bastón y para distancias más largas todavía utilizo un andador. No tengo dolor, pero me siento inseguro acerca de mi equilibrio. También tengo dificultad para conducir, especialmente después del anochecer. Una observación positiva que puedo hacer en relación con mi discapacidad tiene que ver con la amabilidad inesperada de los extraños que me ven luchar con tareas mundanas como abrir puertas mientras llevo libros u otros objetos grandes.

Afortunadamente, mis dificultades físicas no han obstaculizado mis interacciones sociales y académicas, en parte debido a la tecnología. Muchas conferencias y reuniones comunitarias ahora se llevan a cabo por Zoom o en formato híbrido. Una innovación importante y significativa en este ámbito se relaciona con los servicios religiosos que están disponibles en línea. Dado que quedan muy pocos sobrevivientes del Holocausto para compartir sus experiencias, he seguido recibiendo invitaciones para hablar y disfruto interactuando con el público, incluidos los niños.

Recientemente celebré mi cumpleaños número 82 y organicé un almuerzo en persona para mis estudiantes de posgrado en un agradable restaurante italiano cerca de mi universidad. Este ha sido mi tributo a la vida en la era post Covid. Ya no uso una máscara, excepto en los consultorios médicos donde se requieren máscaras. Participo en muchas actividades departamentales. Inicialmente, me dieron permiso para usar Zoom en mis clases debido a mis discapacidades físicas y espero que se renueve el permiso, ya que mi movilidad aún es limitada y las calificaciones de mi maestro siguen siendo excelentes.

Aunque es frecuente el lamento en un contexto universitario de la intrusión de la tecnología, como Zoom, que suplanta las interacciones cara a cara, son muchos los beneficios y beneficiarios de las interacciones en línea. De hecho, los estudiantes a menudo disfrutan e incluso prefieren las clases en línea. En mi propia situación, la oportunidad de ofrecer clases por Zoom me permitió enseñar, incluso mientras enfrentaba discapacidades físicas. Me parece alentador y un beneficio notable de la tecnología, que los estudiantes puedan calificar favorablemente las clases en línea.

Los artículos presentados en este número de JEP confirman ideas previas (Czaja et al., 2006) sobre las barreras y facilitadores del uso de la tecnología en la vejez. En consecuencia, la ansiedad por la computadora y las habilidades intelectuales y el funcionamiento juegan un papel importante en la renuencia de los adultos mayores a adoptar la tecnología. Los autores de los artículos que publicamos en el actual número de la JEP aportan argumentos para mejorar la formación que puede facilitar el uso de la tecnología. Los artículos que recibimos también enfatizan la importancia de incluir a los adultos mayores en la planificación de intervenciones que utilizan tecnología.

En cuanto a la literatura sobre tecnología y envejecimiento, cabe destacar que la mayoría de los artículos recientes aparecen en European Journals (Hülür & Macdonald, 2020; Nowland et al., 2018; Wilson et al., 2023). Nos complace compartir con nuestros lectores el progreso realizado en este ámbito en los EE. UU. Los artículos que se presentan en esta edición de JEP provienen de colaboradores de muchos campos aplicados y generalmente involucran a múltiples colaboradores. A continuación, revisamos mensajes significativos compartidos por nuestros autores. Al resumir los mensajes de los artículos en este número, notamos los diversos antecedentes disciplinarios de los autores.

1. Intercambio de datos de robots acompañantes de IA: Comodidad y preferencias de una cohorte en línea con implicaciones políticas por los autores **Clara Berridge, PhD, MSW, Yuanjin Zhou, PhD, MA, Julie M. Robillard, PhD,** y **Jeffrey Kaye, MD,** analiza de manera importante las perspectivas de los adultos mayores sobre la tecnología de inteligencia artificial (IA) en relación con los robots acompañantes que hablan utilizando el procesamiento del lenguaje natural. Exploraron el nivel de comodidad de los participantes con los robots en el hogar y sus percepciones de los problemas de AI relacionados con la privacidad y la recopilación de datos. Específicamente, los autores estaban interesados en saber si los encuestados se sentirían cómodos al permitir que las expresiones faciales y las conversaciones se grabaran y compartieran. Este estudio fue único ya que pudo examinar las percepciones durante la pandemia y también durante tiempos "normales". Los hallazgos revelaron que los participantes que eran hombres, más jóvenes y con una educación formal más baja se sentían más cómodos con los robots acompañantes en su hogar. De aquellos que se sentían cómodos con la recopilación y el registro de sus datos, muchos no querían que su información se compartiera con terceros o compañías de seguros de salud, pero estaban abiertos a que los datos se compartiesen con un proveedor médico, un cónyuge/pareja y con ellos mismos. Las implicaciones de política hacen eco del sentimiento de los participantes de que se deben implementar salvaguardas para garantizar la privacidad del usuario y promover la confianza del consumidor.

2. Uso de tecnología, competencia digital y acceso a recursos comunitarios entre participantes mayores en el estudio piloto digiAGE de Engaging Genera-

tions Cyber-Seniors de la Universidad de Rhode Island por **Skye N. Leedahl, PhD, FGSA, FAGHE, Kristin Souza, MEd, Alexandria Capolino, MS, Melanie Brasher, PhD, Emma Pascuzzi1, MS, Christina Azzinaro, BA, Tyler-Ann Ellison, BS, Erica Estus, PharmD, BCGP** y **Mau reen Maigret, RN, BS, MPA** proporciona una descripción general de un estudio piloto destinado a cerrar la brecha digital. Utilizando un enfoque intergeneracional innovador, su estudio emparejó a adultos mayores de habla hispana e inglesa de centros para personas mayores con mentores de estudiantes universitarios. Los resultados revelaron que los adultos mayores mejoraron su competencia digital y el uso de la tecnología. Los encuestados también informaron que se sentían más seguros y capaces cuando usaban Internet y los dispositivos, ya que podían ubicar actividades y recursos en línea, y podían acceder mejor a la información de atención médica y programar citas. Este artículo proporciona una excelente hoja de ruta que puede informar las colaboraciones estatales y universitarias que desean promover la equidad digital. Los autores sugieren políticas que apoyen la equidad de la banda ancha y aboguen por capacitaciones que puedan mejorar la alfabetización digital y la equidad para los adultos mayores.

3. "Conéctelo a la persona": Perspectivas sobre la adopción de tecnología de los angelinos mayores por **Kelly Marnfeldt, MSG, Sindy Lomeli, MPH, Sheila Salinas Navarro, MPA, Lilly Estenson, MSW, Kate Wilber, PhD** da un paso atrás y explora las perspectivas de los adultos mayores sobre los facilitadores y las barreras para el uso de la tecnología. Su estudio cualitativo incluyó una muestra de adultos mayores de habla hispana e inglesa del área de Los Ángeles. Sus hallazgos permiten al lector adentrarse en la mente de los participantes. Por ejemplo, sus resultados indican que la familia y los amigos son los principales motivadores para la adopción de tecnología y también la principal fuente de apoyo tecnológico para los adultos mayores. Los autores afirman que la familia y los amigos funcionan como "amortiguadores, evitando que la falta de conocimientos, las dificultades técnicas u otras barreras secundarias disuadan a los participantes de usar dispositivos digitales". A pesar de ser el recurso de referencia para el apoyo, los adultos mayores expresaron su preocupación por ser una molestia o una carga para sus familias. Otros temas se relacionan con las percepciones de los aspectos negativos de la tecnología y los métodos de aprendizaje preferidos para la capacitación digital. Las posibles recomendaciones de políticas se relacionan con la disminución de las barreras a la tecnología (acceso subsidiado a Internet y dispositivos) y la capacitación que puede mejorar la confianza y brindar el apoyo que tanto se necesita.

4. Juegos de salud digitales para adultos mayores: desarrollo, implementación e implicaciones programáticas del uso de juegos de salud en centros para personas mayores por Elizabeth Orsega-Smith, PhD, Laurie Ruggiero, PhD, Nancy Getchell, PhD, Roghayeh Leila Barmaki, PhD, Amy Nichols, BS, Joshua Varghese, Rachel DeLauder, MS y **Reza Koiler, PhD** guía a los lectores a través del desarrollo de un prototipo de exergame que alienta a los adultos mayores a participar en una alimentación saludable, actividad física y conexión social , mientras que también estimula la función cognitiva. Luego, el grupo multidisciplinario de académicos en informática, psicología/ciencias del comportamiento y kinesiología buscó desarrollar un exergame diseñado para promover un envejecimiento saludable. Sus resultados revelaron altas tasas de aceptabilidad y los comentarios cualitativos confirmaron que los participantes disfrutaron del juego. Dado que el piloto solo duró dos semanas, no hubo mucho movimiento en el cambio de comportamiento. Sin embargo, los participantes indicaron que el juego impactó su conocimiento y motivación relacionados con comportamientos saludables. Teniendo en cuenta los resultados favorables, los autores sugieren que los exergames deberían implementarse en la programación de los centros de mayores.

5. Negociación del compromiso tecnológico: uso y no uso entre adultos mayores en viviendas asistidas por **Jennifer L. Snyder, PhD,** considera los procesos involucrados en la participación en el uso de la tecnología entre las personas mayores que residen en viviendas asistidas. El enfoque es único ya que el autor conceptualiza el uso y el no uso como una elección y una situación más que como una consecuencia. Los datos se recopilaron a través de entrevistas con residentes de viviendas asistidas, miembros de la familia y personal del establecimiento. El documento presenta los tipos de tecnologías que utilizan los adultos mayores y profundiza en el proceso de toma de decisiones de por qué los adultos se involucran en el uso o no uso de la tecnología. Por ejemplo, un participante escuchaba regularmente la radio en lugar de ver la televisión. Esto no era porque no le gustara la televisión, simplemente prefería la radio. Sin el enfoque cualitativo de Snyder, estos matices se habrían perdido. Usando sus hallazgos, Snyder propone un enfoque de interacción para el uso de la tecnología.

Conclusión

En general, este número ofrece una visión útil de cómo y por qué los adultos mayores utilizan la tecnología, además de las intervenciones desarrolladas recientemente para facilitar el uso de la tecnología por parte de los adultos mayores. Los artículos incluidos apuntan a la aceptabilidad de las intervenciones para mejorar el uso de la tecnología por parte de los adultos mayores. Se confirma el valor de implementar el diseño participativo y el uso de métodos mixtos para evaluar la efectividad de las intervenciones (Rogers et al., 2022). Los avances tecnológicos deben satisfacer las necesidades, capacidades y preferencias de los adultos mayores para garantizar su aceptación y utilización.

技术的创新运用使老年人受益

Eva Kahana博士，主编

欢迎在大流行后期阅读新一期的《老年政策杂志》(JEP)。本期聚焦于技术使用，这是老年人未充分利用的资源。本期收录的文章研究了老年人对技术使用的看法、参与障碍、以及为加强技术使用而采纳的不同计划。计算机和辅助设备是晚年技术使用的核心(Burdick & Kwon, 2005)。互联网使用和数字素养可以被归类为一套现代工具，后者能帮助老年人实现成功老龄化的三大支柱：积极的情感状态、生活的意义、以及维持有价值的活动和关系(Kahana et al., 2012)。大流行创造了一个必须利用技术来替代人类身体接触的环境。如果老年人能够获得技术资源，他们就能够与朋友和家人保持社会联系并参与商业交易，从而增强其心理健康(Drazich et al., 2023; Elliot et al., 2014)。与此同时，在利用现有技术方面欠缺技能，则为进一步的社会孤立作贡献。

尽管老年人在技术使用方面是相对较晚的使用者(Hulur & Mcdonald, 2020)，但技术提供的机会已经改变了他们的生活并带来了巨大的希望。即使在大流行之后，老年人从“与技术的建设性接触”中获得的好处也是有价值且有意义的。的确，人们继续关注进一步的技术创新，这些创新可能以更巨大的方式改变社会。本期JEP收录的文章基于我们在技术和老龄化主题论文征集中收到的摘要。值得注意的是，我们收到的大部分稿件都基于“融合晚年技术”的特殊项目和计划。一小部分稿件考量了社区老年人自发的技术使用。相反，我们收到的许多稿件都与“特殊背景下的技术使用以及其他人为老年人发起的项目”有关。

通过主题的选择传达了一个关于依赖他人的重要信息。尽管我们收录的文章证实了技术使用的价值，但倡议和动机通常来自那些设计和评价技术干预措施的人(Oppenauer, 2009)。如果我们考虑该主题研究的资助机会，这也是可以理解的。支持技术干预的研究经费是用于支持这一新文献研究最有可能的资金来源。此类经费通常在机构或社区服务环境中实施。因此，技术被提供给服务参与者。对晚年自发的技术使用的关注则较少。我对挑选本期文章的思考表明，该文献需要多样化。

对高龄和临终老年人而言，技术能在维持良好的生活质量方面发挥非常重要的作用。电子通信使老年人能够与远方的朋友和家人保持联系。因此，它能提高晚年生活质量。在大流行期间，技术在通过远程医疗保障医疗服务方面发挥了非常重要的作用(Doraiswamy et al., 2020)。此外，消费者还可以通过Instacart（美国配送服务公司）获得食品、药品和其他重要的家居用品。其实，大流行期间获得的实证数据证实了技术使用的增加，包括在医疗保健通信中更多地使用技术。从2020年美国国民健康调查问卷中获得的数据表明，晚年的技术使用有所增加(Drazich et al., 2023)。

关于本期JEP主题的经验视角

我想遵循我在JEP前几卷中使用的惯例，将作者的文章与我作为老年人的生活经历联系起来。事实上，对老年人技术使用文献的思考让我重新评价了自己的技术使用能力。我的结论是，82岁的我对技术的依赖相当狭隘和具体，并且主要限于基本的计算机技能。

目前，新闻主要集中在人工智能(AI)的前景和危险上(Nadikattu, 2016)。我发现，了解AI在日常生活中的潜力是很有趣的。我的小儿子Michael是宾夕法尼亚大学的一名神经科学教授，他让我关注AI使用的直接好处。我对AI的最初理解源于我儿子撰写的有关人类记忆的技术论文讨论。通过简单地使用AI，就可以对这篇技术论文进行深思熟虑且相关的讨论，这让我印象深刻且兴奋不已。我被这个新机会迷住了，决定用AI分析我自己撰写的技术性较低的研究。令我惊讶的是，AI得出的差异化讨论的质量差得多，其中包括令人困惑的要素。我因此意识到，日常使用AI等技术奇迹仍然需要耐心和实践，以期待更好的未来结果。

就我自己对技术的使用而言，我很喜欢使用Dragon听写工具来辅助我的写作。我定期检查电子邮件并在计算机上保存活动日历。事实上，我每天早上被iPhone闹钟叫醒后都会喝杯咖啡，然后查看电子邮件和当天的日历。不过，我不太愿意接触不熟悉的新技术，例如使用计算机进行商业活动。例如，我可以在线订购用品，但是，我在退货方面的技能要差得多。作为一个新近丧偶的人，我不能再依赖已故丈夫，他的技术能力比我要好。寡妇和鳏夫缺乏技术知识，这对那些晚年失去配偶的人来说是一个严重的不利因素。当我重新评价自己在技术使用方面的局限性时，我意识到需要持续的帮助和指导，以确保老年人能够响应与技术使用相关的新机会和新需求(Rogers et al., 2004)。

我仍在积极参与去年七月进行的髋关节手术后的康复工作。最后，经过三次失败的尝试，我在附近的当地医院找到了一位称职的物理治疗师，我每周和她进行两次康复训练。我也尝试在物理治疗之外进行锻炼，但我的表现参差不齐。大多数情况下，我拄着拐杖行走，而对于较长的距离，我仍然使用助行器。我没有感到疼痛，但对自己的平衡感到不安。我开车也有困难，尤其是天黑后。与我的残疾相关的一个积极观察则是陌生人出乎意料的善意，当看到我艰难地完成日常任务，例如一边拿着书或其他大件物品，一边开门时，他们会施以援手。

值得庆幸的是，我的身体困难并没有妨碍我的学术社交互动，这部分归因于技术。许多会议和社区会议现在都通过Zoom或混合形式举行。该领域的一项重要且有意义的创新与在线提供宗教服务有关。鉴于很少一部分大屠杀幸存者继续分享其经历，我继续收到演讲邀请，并享受与包括儿童在内的受众互动。

我最近庆祝了自己的82岁生日，并为我的研究生组织了一顿午餐，地点是我所就职的大学附近的一家不错的意大利餐厅。这是我对后新冠时代生活的致敬。我不再佩戴口罩，但要求戴口罩的医生办公室除外。我参加了很多部门活动。由于我的身体残疾，我最初获得了在课堂上使用Zoom的许可，我希望这一许可能继续下去，因为我的行动能力仍然有限，并且我的教师评分仍然很高。

尽管在大学环境中经常有人抱怨Zoom等技术的入侵取代了面对面的互动，但在线互动也有很多好处和受益者。事实上，学生通常喜欢甚至偏好在线课程。就我自己的情况而言，通过Zoom提供课程的机会使我能够教学，即使在应对身体残疾的情况下也是如此。我发现，学生可以对网络课程给予好评，这是技术带来的令人鼓舞且值得注意的好处。

本期JEP收录的文章证实了关于“晚年技术使用的障碍和促进因素”的以往观点(Czaja et al., 2006)。照此，计算机焦虑、智力能力和功能在老年人不愿采用技术方面发挥着重要作用。本期JEP的作者提供了用于改善培训以促进技术使用的论据。这些文章还强调了让老年人参与技术干预计划的重要性。

就有关技术和老龄化的文献而言，值得注意的是，近年来大多数文章都出现在欧洲期刊上(Hülür & Macdonald, 2020; Nowland et al., 2018; Wilson et al., 2023)。我们很高兴与读者分享美国在这一领域取得的进展。本期JEP收录的文章来自许多应用领域的贡献者，并且通常涉及多个贡献者。下面我们述评一下这些作者分享的重要信息。在总结本期文章的信息时，我们注意到作者的不同学科背景。

1. 《人工智能伴侣机器人数据共享：网络群体的舒适度、偏好以及政策启示》的作者是Clara Berridge、Yuanjin Zhou、Julie M. Robillard和Jeffrey Kaye。文章研究了老年人对人工智能(AI)技术（即使用自然语言处理进行对话的伴侣机器人）的看法。作者探究了参与者对家庭机器人的舒适程度以及他们对“与隐私和数据收集相关的AI问题”的看法。具体而言，作者研究了受访者是否愿意允许面部表情和对话被记录和分享。这项研究是独特的，因为其能够检验大流行期间以及“正常”时期关于AI的看法。调查结果显示，男性、年轻且受过较少正规教育的参与者对家庭伴侣机器人感到最舒适。在那些愿意进行数据收集和记录的人中，许多人不希望他们的信息被分享给第三方或健康保险公司，但愿意将数据共享给医疗服务提供者、配偶/伴侣和他们自己。政策启示与参与者的情绪相呼应，即应采取保障措施以确保用户隐私并促进消费者信任。

2. 《提高老年参与者的技术使用、数字能力、以及社区资源获取：罗德岛大学的代际参与网络-老年人digiAGE试点研究》的作者是Skye N. Leedahl、Kristin Souza、Alexandria Capolino、Melanie Brasher、Emma Pascuzzi1、Christina Azzinaro、Tyler-Ann Ellison、Erica Estus、和

Maureen Maigret。文章概述了一项试点研究，后者旨在填补数字鸿沟。通过使用一项创新的代际方法，作者的研究将来自老年中心的说西班牙语和英语的老年人与大学生导师进行匹配。研究结果显示，老年人提高了他们的数字能力和技术使用。受访者还报告称，他们在使用互联网和设备时感到更加自信和有能力，因为他们能够在线查找活动和资源，并且能够更好地获取医疗保健信息和进行在线预约。文章提供了一个出色蓝图，为致力促进数字公平的州-大学合作计划提供信息。作者提出了支持宽带公平的政策，并倡导培训以提高老年人的数字素养和数字公平。

3.《“将其与人联系起来”：洛杉矶老年人对技术采用的看法》的作者是Kelly Marnfeldt、Sindy Lomeli、Sheila Salinas Navarro、Lilly Estenson和Kate Wilber。文章将视角退后一步，探究了老年人对“其技术使用的促进因素和障碍”的看法。作者的定性研究包括来自洛杉矶地区讲西班牙语和英语的老年人样本。作者的发现使读者能够了解参与者的想法。例如，他们的结果表明，家人和朋友是技术使用的主要动力，也是老年人技术支持的主要来源。作者指出，家人和朋友发挥了“缓冲作用，防止因专业知识缺乏、技术困难或其他次要障碍而阻碍参与者使用数字设备”。尽管家人是老年人寻求支持的首选资源，但他们仍担心会给家人带来烦恼或负担。其他主题涉及对技术负面影响的看法以及数字培训的首选学习方法。潜在的政策建议有关于减少技术障碍（对互联网和设备的获取提供补贴）及培训障碍，这些技术和培训能提高信心并提供急需的支持。

4.《老年人数字健康游戏：老年中心的健康游戏开发、实施以及计划启示》的作者是Elizabeth Orsega-Smith、Laurie Ruggiero、Nancy Getchell、Roghayeh Leila Barmaki、Amy Nichols、Joshua Varghese、Rachel DeLauder和Reza Koiler。文章带领读者了解一项运动游戏原型的开发，该原型鼓励老年人进行健康饮食、体育活动和社交联系，同时刺激认知功能。随后，来自计算机科学、心理学/行为科学和运动学领域的多学科研究小组试图开发一款旨在促进健康老龄化的运动游戏。他们的结果显示了很高的接受度，并且定性反馈证实了参与者对这款游戏的喜爱。由于试点计划仅持续了两周，行为改变方面并没有太大进展。尽管如此，参与者表示，游戏影响了他们在健康行为方面的知识和动机。考虑到良好的结果，作者建议老年中心项目应实施运动游戏。

5.《技术参与协商：老年人对辅助生活技术的使用和不使用》的作者是Jennifer L. Snyder博士。文章研究了让“需要辅助生活的老年人”参与技术使用一事所涉及的过程。采用的方法是独特的，因为作者将技术的使用和不使用概念化为一种选择和情境而不是结果。通过采访辅助生活机构的居民、家庭成员和工作人员，对数据进行了收集。文章介绍了老年人使用的技术类型，并研究了老年人为何使用或不使用技术一事所涉及的决策过程。例如，一名参与者经常听广播而不是看电视。这并不是因为他不喜欢电视，他只是更喜欢广播。如果没有Snyder的定性方法，这些细微差别就会被忽视。Snyder利用她的发现，就技术使用提出了一种交互方法。

结论

总而言之，除了新开发的促进老年人使用技术的干预措施之外，本期还介绍了老年人如何以及为何使用技术。这些文章指出了为提高老年人的技术使用而采取的干预措施的可接受性。已有研究证实了实施参与式设计的价值和使用混合方法来评价干预措施的有效性(Rogers et al., 2022)。技术进步必须满足老年人的需求、能力和偏好，以确保技术接受和技术利用。

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AI Companion Robot Data Sharing: Preferences of an Online Cohort and Policy Implications

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Abstract

Policymakers have recognized the urgent need to create AI data protections, yet the interests of older adults have thus far not been well represented. We report peoples' perspectives on small AI companion robots for older adults, along with attendant issues related to facial expression and conversation data collection and sharing. Data are from a cross-sectional survey of an online cohort of the Oregon Center for Aging & Technology at Oregon Health & Science University, with a response rate of 45% and analytic sample of 825 (mean age: 63.9, rang: 25-88). Logistic regressions examined relationships between comfort and data sharing preferences with socio-demographic characteristics. Just over half (52.3%) were somewhat or very comfortable with an artificial companion robot during the pandemic and 45.2% were under normal circumstances.

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In adjusted models, being younger, male, and having lower formal education and greater confidence in computer use were associated with greater likelihood of being comfortable with a companion robot. Those who were at least somewhat comfortable with robots recording their conversations (15%) or reported that they would probably want their facial expressions read for emotion detection (52.8%) also selected with whom they want these data shared. Free text comments were thematically analyzed. Primary themes were that robot-based data collection constitutes over monitoring and invasion of privacy, with participants predicting data privacy, security, and use issues. These findings about the importance potential users place on data protection and transparency demonstrate a need for law and policy to act to enable trustworthy, desirable companion robots.

Keywords: robotics, artificial intelligence, natural language processing, emotion detection, privacy

Intercambio de datos de robots complementarios de IA: preferencias de una cohorte en línea e implicaciones de política

RESUMEN

Los formuladores de políticas han reconocido la necesidad urgente de crear protecciones de datos de IA, pero los intereses de los adultos mayores hasta ahora no han estado bien representados. Informamos las perspectivas de las personas sobre los pequeños robots acompañantes de IA para adultos mayores, junto con los problemas relacionados con la expresión facial y la recopilación y el intercambio de datos de conversación. Los datos provienen de una encuesta transversal de una cohorte en línea del Centro de Oregón para el Envejecimiento y la Tecnología en la Universidad de Salud y Ciencias de Oregón, con una tasa de respuesta del 45 % y una muestra analítica de 825 (edad media: 63,9, rango: 25-88). Las regresiones logísticas examinaron las relaciones entre la comodidad y las preferencias de intercambio de datos con características sociodemográficas. Un poco más de la mitad (52,3 %) se sintió algo o muy cómodo con un robot de compañía artificial durante la pandemia y el 45,2 % se encontraba en circunstancias normales. En modelos ajustados, ser más joven, hombre y tener una educación formal más baja y una mayor confianza en el uso de la computadora se asociaron con una mayor probabilidad de sentirse cómodo con un robot compañero. Aquellos que se sentían al menos algo cómodos con los robots grabando sus conversaciones (15 %) o informaron que probablemente querrían que se leyeran sus expresiones faciales para la detección de emociones (52,8 %) también seleccionaron con quién querían compartir estos datos. Los comentarios de texto libre se analizaron temáticamente. Los temas principales fueron que la recopilación de datos basada en robots constituye un control excesivo y una invasión de la privacidad, y los participantes predijeron problemas de privacidad, seguridad y uso de datos. Estos hallazgos sobre la importancia que los usuarios potenciales le dan a la protección de datos y la transparencia demuestran la necesidad de que la ley y la política actúen para habilitar robots de compañía deseables y confiables.

Palabras clave: robótica, inteligencia artificial, procesamiento de lenguaje natural, detección de emociones, privacidad

人工智能伴侣机器人数据共享：络群体偏好与政策启示

摘要

政策制定者已经认识到建立人工智能(AI)数据保护这一迫切需求，但迄今为止，老年人的利益尚未得到充分代表。我们报告了人们对为老年人服务的小型AI伴侣机器人的看法，以及随之而来的一系列问题，后者与面部表情、对话数据收集及共享相关。对俄勒冈健康与科学大学的俄勒冈老龄化与技术中心的一个网络群体进行横断面调查并收集数据，调查响应率为45%，分析样本为825人（平均年龄：63.9岁，年龄范围：25-88岁）。逻辑回归分析了舒适度、数据共享偏好与社会人口特征之间的关系。在大流行期间，仅超过一半(52.3%)的人对AI伴侣机器人感到有些舒适或非常舒适，而45.2%的人则对AI伴侣机器人感到不舒适。在调整后的模型中，年轻、男性、正规教育程度较低以及对计算机使用更有信心等因素与“更有可能对伴侣机器人感到舒适”一事相关。那些对机器人记录对话一事至少感到些许舒适的人(15%)或报告称其可能希望读取其面部表情以用于情绪检测的人(52.8%)也选择了其希望与谁共享这些数据。对自由回答的文本评论进行了主题分析。基本主题是，基于机器人的数据收集构成了过度监控和隐私侵犯，并且参与者预测会出

现关于数据隐私、安全和使用的问题。这些关于“潜在用户对数据保护和透明度的重视”的调查结果表明，需要法律和政策采取行动，以创造值得信赖的理想伴侣机器人。

关键词：机器人，人工智能，自然语言处理，情绪检测，隐私

Introduction

The COVID-19 pandemic has heightened awareness of loneliness and social isolation among older adults. The pandemic has also motivated further exploration of acceptance of companion robots (Ghafurian et al., 2021; Samuel, 2020; Shen et al., 2021) with the goal of mitigating loneliness (Berridge et al., 2021; Coghlan et al., 2021; Engelhart, 2021; Jackson, 2019; Jecker, 2021; Portacolone et al., 2020). Implementation has also been jump-started in response to the isolating effects of the pandemic. By 2021, 21 states had moved forward with distribution of small robots to support older adults who may be lonely, some paid for by pandemic relief funding (Engelhart, 2021).

Various forms of telepresence, human-voiced or AI-voiced avatars, and other robots have different ethical implications and may be differently assessed by potential users (Robillard et al., 2020), so it is important to specify the type of companion robot when discussing implications and desirability. This study is focused on non-human artificially intelligent companions that speak using natural language processing. Most of the published research on robots used with older adults features those that do not use natural language processing—those that cannot interact verbally—particularly plush pet-like robots (Sekhon et al., 2022). We report findings from a relatively large U.S. survey on comfort and data sharing preferences for small artificial companion robots and compare responses by various socio-demographic factors. We assess how participants perceive that the pandemic impacts their comfort, and we address the question of whether participants want facial expression and conversation data collected by an artificial companion robot and with whom they want those data shared.

A recent Delphi study with gerontechnology experts in the U.S. and Canada identified predominant potential benefits and risks of using AI robots for this purpose of companionship. The range of reported potential uses included easing loneliness, enabling auto check-ins and the collection of self-report data for assessing health, cognition, and well-being, and the opportunity for a person living with dementia to use their language functions (Berridge et al., 2021). Risks include shaping expectations with misleading marketing materials that imply that use can "roll back" symptoms of dementia, as well as deception and confusion about who is behind the AI voice—issues frequently raised in the literature (Berridge et al., 2021; Robillard et al., 2020; Wangmo et al., 2019). As reported elsewhere, most of the survey participants reported on in this current paper did not believe that an artificial companion robot would help them feel less lonely if they were feeling lonely and expressed discomfort with the idea of being allowed to believe an AI voice is human should they have dementia (Berridge, Zhou, et al., 2023). As others have discussed, there are significant open efficacy and ethics questions (for example, see Samuel, 2020 and Vallor, 2011) about using robots for care companionship.

Perhaps because the ethical issues are so compelling, data collection through companion robots receives less attention in the literature, though it is also a central issue. In addition to mitigating loneliness, another desired function of companion robots that use AI to interact conversationally is to enable remote monitoring (Berridge et al., 2021; Shen et al., 2021). Environmental data may also be needed for robot navigation, and additional data are likely to be collected by AI companion robots. Artificial companions have monitoring capability with cameras and microphones and there is excitement over the potential capability of detecting cognitive change using predictive linguistic markers (Parsapoor et al., 2023). Privacy violation is possible if the robot records conversations. Users may not be made aware that a robot is recording and possibly sharing these recordings with others (Carver, 2020; Vandemeulebroucke et al., 2018). Further, the inference about emotional states through analysis of facial expressions is anticipated, yet emotion detection is a scientifically and ethically controversial and unregulated practice (Barrett et al., 2019; Crawford, 2021; Stark & Hoey, 2021), leading experts in AI to raise serious concerns over emotion recognition technology and call for its regulation (Crawford, 2021) and prohibition in decision making that impact people's lives and opportunities (Crawford et al., 2019). In 2022, Microsoft stopped using emotion analysis, citing "reliability concerns" and lack of clarity regarding whether "facial expression is a reliable indicator of your internal emotional state" (Hill, 2022).

Studies on data sharing preferences have explored adults' and older adults' perceptions and willingness to share personal and health information through health and wellness information technology (Beach et al., 2009; Kavandi & Jaana, 2020), such as in-home monitoring technology (Boise et al., 2013) and Electronic Health Records (EHR) (Krahe et al., 2019). They found high rates of reported acceptance that health information collected by in-home monitoring technologies be shared with medical doctors or family members (Boise et al., 2013) and low willingness to share their health information with researchers, government agencies, device developers/corporations, or insurance companies (Kim & Choi, 2019). People tend to be more comfortable sharing health data with third party commercial companies if it is for patient purposes as compared to business purposes (Trinidad et al., 2020). In addition to purpose and recipient of data, there are many other factors that might impact people's willingness to share personal health data, such as personal characteristics (e.g., education, age, gender, race/ethnicity, health conditions), characteristics of the data (e.g., relevance, requirement, amount/extent, accuracy), perceived risks (e.g., privacy concerns), characteristics of the data sharing systems (e.g., transparency of the data sharing systems), and regulations and norms about information sharing (e.g., public health emergency) (Abdelhamid et al., 2017; Beach et al., 2009; Buckley et al., 2011; Frik et al., 2020; Grande et al., 2015; Ivanov et al., 2015; Kim et al., 2017; Krahe et al., 2019; Trinidad et al., 2020). A study comparing adults with mild care impairment (MCI) with those without found no difference in their willingness to share data with doctors or family members; however, most respondents reported privacy concerns, which increased after one year of use (Boise et al., 2013).

The aim of this study is to begin to understand and compare peoples' anticipated comfort with small artificial companion robots and facial expression and conversation data collection and sharing across a range of health and socio-demographic factors. Free text comments offered by survey participants provide nuance and further insight into a range of feelings people express about this use, data collected in the process, and potential sharing of those data. Due to the relatively technologically resourced, online nature of this cohort, the findings are not intended to be generalized to the larger population, but this analysis takes advantage of the fact that this online cohort is well-characterized and thus allows us to ask questions that have not yet been thoroughly studied, such as how might having perceived memory problems or having parents with a history of dementia impact feelings about an artificial companion robot.

Methods

Study Design and Population

The 19-item survey was organized in three sections: Scenarios, Options, and Artificial Companionship. In this paper, we present analyses of the small artificial companionship robot questions about comfort and data preferences (see Appendix A). Responses to questions about perceived potential impact on loneliness and comfort with deception are reported in Berridge, Zhou, et al. (2023). Participants were also asked about their comfort with a companion robot in the form of a larger, human-shaped robot; however, neither of the visual examples used in the survey are currently available on the market, and as such we focus our reporting on findings from questions about the smaller, better-developed robots that are available. The survey was administered using Qualtrics and disseminated by email in June of 2020 to the online survey cohort of the Research via Internet Technology and Experience (RITE) program of the Oregon Center for Aging & Technology (ORCATECH) at Oregon Health & Science University. This survey is one of quarterly topical surveys these volunteers are asked to complete regarding health, wellness, and technology. The cohort's inclusion criterion was being over the age of 18. The current study used the full sample of 2,434 volunteers registered as active in 2020.

All 2,434 members of the RITE cohort were sent the online survey and 1,082 completed it for a response rate of 45%. As described in further detail in Berridge, Zhou, et al. (2023), respondents were excluded if they were not living in the community (n=2) and if they did not have data for four core variables of interest, gender (missing=72), age (missing=4), education (missing=150), or memory problem history missing=179), leaving a total of 825 included in the analysis. The gender variable recorded as part of the initial intake for the RITE cohort was a limited binary response option of male and female with a write-in option. For this analysis, we coded binary transgender individuals with their reported gender (those who wrote in trans female were coded as women and we coded as men those who wrote in trans male). Because we omitted from our analytic sample the 16% of participants who had missing values for the key variable of interest, reported history of memory problems, we conducted sensitivity analyses that indicated that our assumption that responses to the questions about memory problems are missing at random does not impact our findings.

Dependent Variables

The variables of interest represent the constructs of comfort and acceptability. Two sets of Likert response options were used to measure these [Very Uncomfortable, Somewhat Uncomfortable, Somewhat Comfortable, Very Comfortable] or [Definitely No, Probably No, Probably Yes, and Definitely Yes]. These Likert response options were all labeled to ensure that participants interpret the middle options in the same way.

Participants were asked about their comfort level with small, table-top form artificial companion robots in scenarios of "during normal circumstances" compared with "unusual times when someone cannot come to your home such as during the coronavirus pandemic." Questions assessed comfort and acceptability of facial expression and conversation data sharing. For the subsample of the total participants who reported desire or comfort to have conversations or facial expression data recorded, we further analyzed with whom respondents are willing to share these data [me, my spouse/partner, child(ren), a medical provider, a hired home aide, a technology developer, a health insurance company, no one]. For these seven eight options, entities were adapted from Kim and Choi (2019) and Beach et al. (2009).

Independent Variables

Personal health and demographic information were pre-collected through the RITE cohort surveys. Characteristics that have been shown to be associated with comfort and preferences for digital technologies and data sharing were included in bivariate analysis and multivariate regression models. These include age (Beach et al., 2009; Ivanov et al., 2015; Kim & Choi, 2019; Thordardottir et al., 2019; Trinidad et al., 2020), gender (Beach et al., 2009; Gell et al., 2015; Kim & Choi, 2019; Lai et al., 2010; Trinidad et al., 2020), formal education (Beach et al., 2009; Gell et al., 2015; Kim & Choi, 2019; Kim et al., 2017; Lai et al., 2010), number of chronic conditions (Abdelhamid et al., 2017; Chappell & Zimmer, 1999; Ivanov et al., 2015; Kim & Choi, 2019; Lai et al., 2010), marital status (Abd-alrazaq et al., 2019; Gell et al., 2015), living status (Lai et al., 2010), confidence of using computer (Czaja et al., 2006), and social support (Baisch et al., 2017), defined for our purposes as level of social activity using the Brief Assessment of Social Engagement scale (0-20) (Morgan et al., 1985). We also included memory problem history in our analytic models (Charness & Boot, 2009), which is a dichotomous yes/no variable for a yes response to one of two questions about 1) presence of self-reported current memory problems or 2) if the participant has been seen by a physician for memory problems. Due to our access to a range of pre-collected data about this cohort, we also chose to examine the unstudied relationships between our outcome variables and presence of a living pet, as well as history of dementia in parents because this might indicate respondents' perceived risk of acquiring dementia (Kessler et al., 2012) and because the perspective gained about dementia may be influential on these questions of interest. There is insufficient variability for analysis by race or ethnicity: 95.9% of respondents were white and 98.5% were non-Hispanic.

Analysis

Descriptive analyses were performed using R software (R Core Team, 2013). The Wilcoxon Signed-rank test (Woolson, 2008) was used to determine whether there are differences between participants' comfort level towards artificial companions under normal circumstances compared with unusual pandemic times. Bivariate and multivariate ordered logistic regression (Bilder & Loughin, 2014) were performed using the R package "MASS" (Ripley, 2011) and "ordinal" (Christensen & Christensen, 2015) to determine whether there were relationships between independent variables and dependent variables that are ordinal (Long & Freese, 2006). We used brant tests (Brant, 1990) based on separately-fitted cut-point equations (Fullerton & Xu, 2012) to test the assumption of proportional odds; the proportional odds assumption is that no input variable has a disproportionate effect on a specific level of the ordinal variable (McNulty, 2021). Only one statistically significant variable in one regression model violated the assumption using a .03 p-value cut-point and is discussed below. This indicates that this analytic choice was appropriate (UCLA: Statistical Consulting Group, n.d.).

Finally, 315 (38%) participants provided optional free text comments upon completion of the survey section on artificial companion robots. Two members of the research team conducted thematic analysis of these comments to identify themes. They separately developed initial codebooks and met to merge their codes into a single codebook and refine it. Then, they separately coded the comments and reconvened to discuss all discrepancies where codes were differently applied and were able to reach consensus about final coding. The most prominent themes are presented to help understand why participants felt what they reported in the survey questions.

Results

Participants

Table 1 provides the description of the sample in relation to each independent variable. Compared to the general national population, the study sample is older, whiter, and more formally educated. Ninety-five percent of respondents are white. The respondents' ages range from 25 to 88 years with a mean age of 63.93 (SD=13.17). Sixty percent of respondents are 65 or older. The majority (75.6%) have a college degree or more education—far higher than the 32.1% of the U.S. general population. Sixty-five percent of this sample identify as female. Because our sample skews older than the general population, nearly one quarter (24.4%) of our sample report either current memory problems and/or that they have been seen by a physician for memory problems, which is a far greater percentage than the general population.

This sample is also far more technologically experienced and resourced than the general U.S. population. Most of our sample (84.3%) rated their confidence using the computer as high. Ninety-five percent of our respondents report using the computer daily while 81% of the general population reports going online daily (Pew Research Center, 2019b). Our sample also differs dramatically from the general population in their greater access to wireless internet (95% and 73%, respectively) (Pew Research Center, 2019b). Only 73% of the general 65+ population uses the internet (Pew Research Center, 2019b) and 42% do not have wireless broadband at home (Humana Foundation and Oats, 2021). While our sample skews older, among those 65+, 93.3% have wireless internet and 100% use the internet.

Comfort Level with Artificial Companion Robots in Normal and Pandemic Times

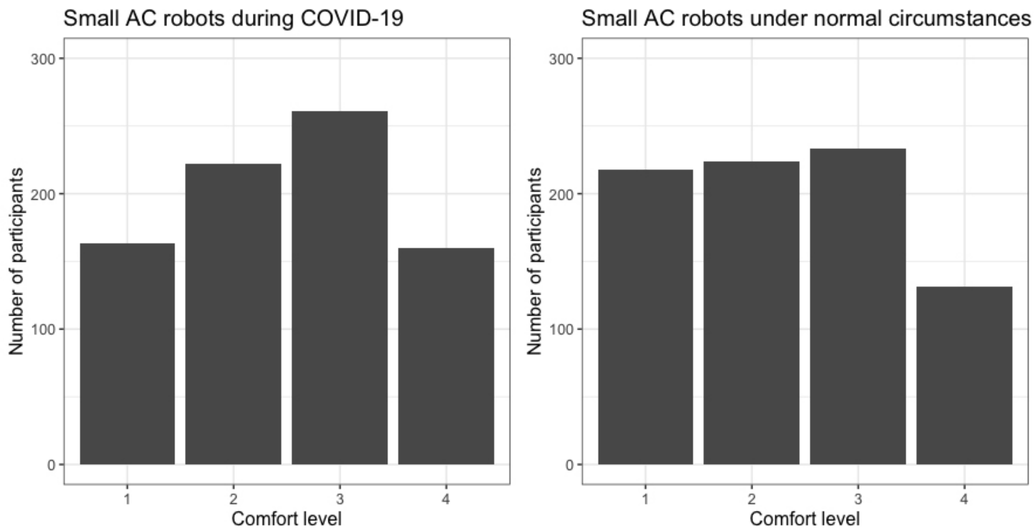
Response frequencies to each question are presented in Table 2 and discussed below. Just over half (52.3%) of the respondents felt somewhat or very comfortable with a small robot artificial companion during unusual pandemic times, and less than half (45.2%) felt that way during normal times. That greater comfort reported for pandemic compared with normal times is significant; however, the effect size is very small.

Table 1. Participant characteristics

Category	Subcategories	Mean/SD/ Frequencies	Percentage
Age (n=825)	Range: 25-88	Mean=63.93 SD=13.17	
Gender (n=825)	Female	534	64.7%
	Male	291	35.3%
Marital status (n=820)	Married/living as if married	577	70.4%
	Not married	243	29.6%
Living status (n=824)	Living alone	162	19.7%
	Living with others	662	80.3%
Education (n=825)	No college degree	202	24.5%
	College degree	276	33.5%
	Master's degree and above	347	42.1%
Memory problem history (n=825)	Memory problem reported	201	24.4%
	No memory problem reported	624	75.6%
Number of chronic conditions (n=790)	3+	540	68.4%
	0-2	250	31.6%
Confidence using computer (n=792)	Highly confident	668	84.3%
	Low-moderately confident	124	15.7 %
History of dementia in parents (n=750)	History of dementia in either of parents	226	30.1%
	No history of dementia in either of parents	524	69.9%
Interaction with pet (n=812)	Often Interact with pet (daily, weekly, monthly)	503	61.9%
	Not often Interact with pet (yearly, rarely, or never)	309	38.1%
Social activity level score (n=800)	Range: 0-17 (out of 20)	Mean:8.47 SD=2.82	

Table 2. Response frequencies: Comfort with small artificial companion robots and data collection

Question	**Very Uncomfortable n (%)**	**Somewhat Uncomfortable n (%)**	**Somewhat Comfortable n (%)**	**Very Comfortable n (%)**
Please think about unusual times when someone cannot come to your home such as during the coronavirus pandemic. In these times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot, like the examples below? (N=806)	163 (20.2%)	222 (27.5%)	261 (32.4%)	160 (19.9%)
In normal times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot? (N=806)	218 (27.0%)	224 (27.8%)	233 (28.9%)	131 (16.3%)
If you had an artificial companion, how comfortable would you be with it recording your conversations? (N=804)	439 (54.6%)	244 (30.3%)	108 (13.4%)	13 (1.6%)
	Definitely No n (%)	**Probably No n (%)**	**Probably Yes n (%)**	**Definitely Yes n (%)**
If you had an artificial companion, would you want it to be able to know how you are feeling by reading your facial expression? (N=806)	175 (21.7%)	206 (25.6%)	347 (43.1%)	78 (9.7%)



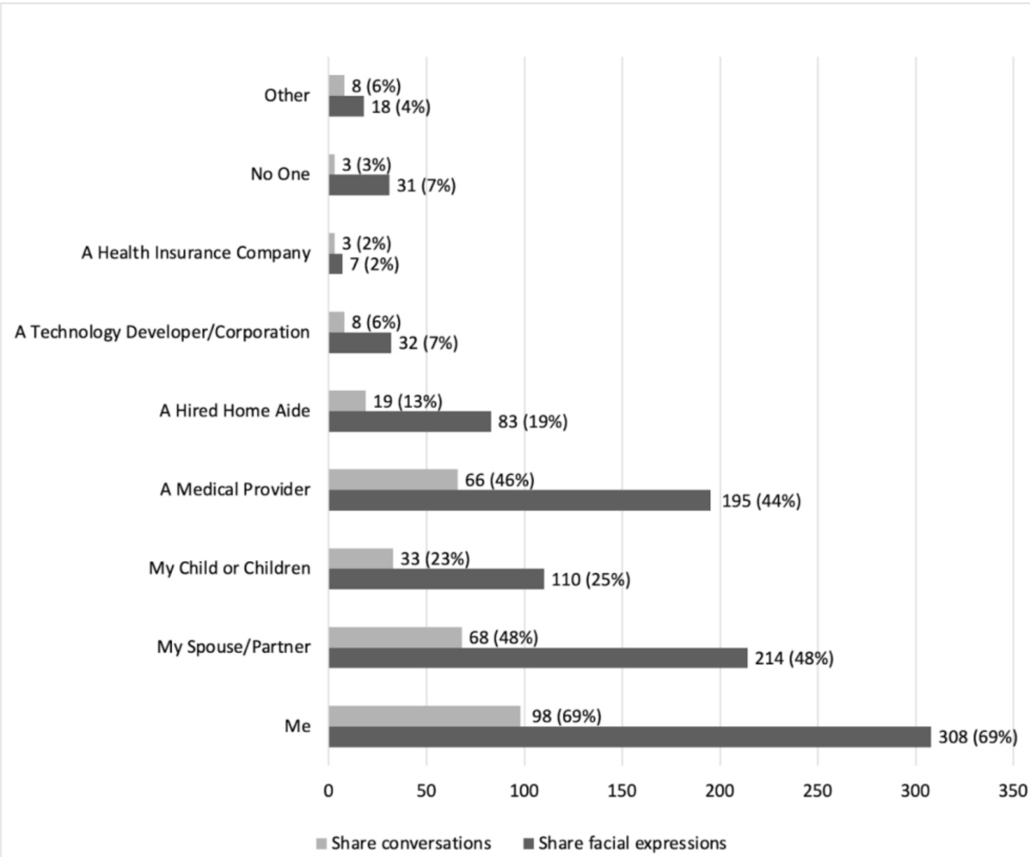
Legend: 1: Very uncomfortable, 2: Somewhat uncomfortable, 3: Somewhat comfortable, 4: Very comfortable.

Fig.1. Comfort with small artificial companion robots in normal and pandemic times

Conversation and Facial Expression Data Sharing Preferences

As depicted in Table 2, about half (52.8%) of the participants reported that they either probably or definitely would want their facial expressions to be read by an artificial companion to infer their feelings, while a minority (15%) were at least somewhat comfortable with artificial companions recording their conversations. Those who responded "Somewhat Comfortable" or "Very Comfortable" with recording conversations and those who "Probably" or "Definitely" would want an artificial companion to read their facial expressions were asked with whom they wanted that information about them shared. Figure 2 illustrates with whom participants who were somewhat or very comfortable with having these data collected would like those data shared. Those who were not amenable to having facial expressions (47.3%) or conversations (84.9%) recorded were not asked with whom they'd want those data shared. Among those asked, the most common entity participants wanted both conversation and facial expression data to be shared with is "me" (98/142; 69% and 308/444; 69.4%, respectively), followed by my spouse/partner (68; 47.9% and 214; 48.2%) and a medical provider (66; 46.5% and 195; 43.9%). Far fewer—about one in four—would like to share conversation data (23.2%; 33) and facial expression data (24.8%; 110) with their child/children.

Less than 20% would like to share their conversation data (19) or facial expression data (83) with hired home aides. Less than 10% want data shared with technology developers (8 and 32). Only two percent wanted conversation data (3) or facial expression data (7) shared with a health insurance company. Three percent (3) wanted conversation data and 7% (31) wanted facial expression data shared with no one. Categories written in as "other" by at least two participants each were a close friend, pastor/priest, and my power of attorney.



Note: Those who reported that they were somewhat or very uncomfortable with these data capture capacities were not asked these questions about entities with whom they'd want these data shared. Percentages are of the two subsamples who reported somewhat comfortable or very comfortable with an artificial companion robot collecting emotive data (n=444), and of those who were somewhat or very comfortable with collecting conversation data (n=142).

Fig. 2. Entity with whom conversation and facial expression data could be shared among those responding somewhat comfortable or very comfortable with these data being captured

Multivariate Analysis for Comfort with Artificial Companion Robots and Data Sharing

In multivariate adjusted analyses, the characteristics that are significantly associated with comfort with artificial companion robots and the two data sharing preferences are age, gender, confidence using computers, and education. No significant differences were detected between those reporting a memory problem history and those without. Greater age is negatively associated with comfort with small artificial companion robots under normal circumstances (odds ratio [OR]=0.99; 95% confidence interval [CI]= [0.97, 1.00], p=0.022) and during pandemic times (OR=0.99; [0.97, 1.00], p=0.045), and comfort with an artificial companion robot reading facial expression (OR=0.99; [0.97, 1.00], p=0.041). This means, for example, that with each one year of additional age, people have a 1% lower likelihood of being comfortable at any level of comfort with small artificial companion robots; that is, lower likelihood of reporting report very comfortable versus somewhat comfortable, somewhat comfortable versus somewhat uncomfortable, and somewhat uncomfortable versus very uncomfortable. For example, compared to a 62-year-old, a 63-year-old has a 1% greater likelihood of reporting feeling somewhat uncomfortable versus somewhat comfortable, and this difference continues to increase by 1% with each year of age.

Participants who identified as female were 28% more likely than were males to report one level of lower comfort with small artificial companion robots in normal times (OR=0.72; [0.53, 0.97], p=0.029). Females were also 34% more likely to feel uncomfortable with artificial companion robots recording their facial expressions (OR=0.66; [0.48, 0.90], p=0.008) and 39% more likely to not want conversations recorded (OR=0.61; [0.44,0.84], p=0.002). Having the highest level of education (master's degree) was associated with a 33% greater likelihood of reporting one lower level of comfort with small artificial companion robots in normal times (OR=0.67; [0.46, 0.96], p=0.030).

Participants who reported high confidence using computers were 68% more likely than those reporting low-moderate confidence to feel comfortable with small artificial companion robots during normal times (OR=1.68; [1.15, 2.47], p=0.007) and 80% more likely during pandemic times (OR=1.80; [1.23, 2.65], p=0.003). They were also 87% more likely to report one level greater comfortable with facial expression (OR=1.87; [1.27, 2.77], p=0.002) and 78% more likely for conversation data collection (OR=1.78; [1.16, 2.77], p=0.009).

Also in adjusted models, being married (OR=0.50; [0.31, 0.83], p=0.007) and living alone (OR=0.51; [0.28, 0.92], p=0.025) were associated with 50% and 51% lower comfort with artificial companion robots recording conversations, respectively. In the model for comfort with artificial companion robots recording conversations, the variable for marital status violates the

Table 3. Statistically significant variables for bivariate and multivariate ordinal logistic regression

Predictors	**Small artificial companion robots during pandemic**	**Small artificial companion robots during normal times**	**Comfort with artificial companion robots reading facial expression**	**Comfort with artificial companion robots recording conversation**
Predictors based on bivariate ordinal logistic regression	Age: 0.98 (0.98-0.99) **	Age: 0.98 (0.97-0.99) ***	Age: 0.98 (0.97-0.99) ***	Female: 0.64 (0.48-0.84) **
	Highly confident about using computer [a]: 1.84 (1.30-2.61) ***	College degree [b]: 0.71 (0.51-0.99) *	Memory problem reported: 1.36 (1.01-1.83) *	Highly confident about using computer: 1.62 (1.10-2.41) *
		Master's degree or above [b]: 0.61 (0.45-0.84) **	3+ chronic conditions: 0.64 (0.48-0.84) **	
		Highly confident about using computer: 1.73(1.23-2.45) **	Highly confident about using computer: 1.98 (1.39-2.83) ***	
			History of dementia in either of parents: 0.73 (0.55-0.98) *	
Predictors based on multivariate ordinal logistic regression	Age: 0.99 (0.97-1.00) *	Age: 0.99 (0.97-1.00) *	Age: 0.99 (0.97-1.00) *	Female: 0.61 (0.44-0.84) **
	Highly confident about using computer: 1.80 (1.23-2.65) **	Female: 0.72 (0.53-0.97) *	Female: 0.66 (0.48-0.90) **	Married/living as if married: 0.50 (0.31-0.83) **
		Master's degree or above: 0.67 (0.46-0.96) *	Highly confident about using computer: 1.87 (1.27-2.77) **	Living alone: 0.51 (0.28-0.92) *
		Highly confident about using computer: 1.68 (1.15-2.47) **		Highly confident about using computer: 1.78 (1.16-2.77) **

Note:

a. Reference group: Low-moderate confidence of using computers.

b. Reference group: No college degree.

c. Reference group: have 0-2 chronic conditions.

*p<0.05; **p<0.01; ***p<0.001

proportional odds assumption based on a brant test result of p=0.01. We relaxed this assumption using a generalized ordinal logistic regression model and found ORs of 1|2: OR=0.54; [0.32-0.90], p=0.002; 2|3: OR=0.41; [0.23-0.82], p=0.002; 3|4: OR: 1.29, [0.27-6.13], p=0.753.

Free-text Comments

At the conclusion of the survey section on artificial companion robots, a prompt was given to ask for written comments that participants would like to share. While our survey questions did not probe as to the reasons people had for indicating their comfort levels with artificial companion robots, these written responses provide some helpful insights.

The most raised issue was that of the invasion of privacy and perception that artificial companion robot-based data collection is excessive monitoring. The related issues of data security, third party use, or exploitation of data were also specifically noted by numerous participants. For example, a participant explained, "Overall I like the idea of an AI companion or device to check-in on a family member. Particularly to alert medical services and family if an emergency arises. However, I have concerns about how that data is being stored and used by third party companies. Far too often that data is not being stored securely and being sold to third party companies for data aggregation." Another wrote, "My mood is not a piece of data like my temperature or blood pressure. Yet, people tend to accept as information things which are stated with authority. There is huge opportunity for intrusion into privacy and for action taken in reliance on mechanical intelligence against the wishes of the patient." Interestingly, all six participants who self-identified as current or former tech industry workers expressed aversion and strong concerns about data security and privacy. Some participants noted that artificial companion robots' appeal would be contingent on their ability to maintain control over it, adjust it, and enable privacy when wanted. Other common sentiments were a preference for a robot to complete physical tasks rather than provide companionship, and many specified that use of artificial companion robots should not be a substitute for human contact in elder care.

Discussion

Like previous studies that have found less interest among older than younger adults in digital technologies like sensors and wearables (Thordardottir et al., 2019), greater age in this survey was associated with lower comfort with small artificial companion robots. Lower comfort among female compared with male participants and greater comfort with higher computer confidence are also consistent with the literature on other forms of data-intensive technologies with regard to gender (Gell et al., 2015; Lai et al., 2010) and computer self-efficacy (Czaja et al., 2006; Kavandi & Jaana, 2020). In contrast to numerous findings that greater education is associated with higher receptivity to technologies like telecare and electronic health records (Abd-alrazaq et al., 2019; Chappell & Zimmer, 1999; Gell et al., 2015; Lai et al., 2010), those with a master's degree or more education were the least comfortable with artificial companion robots during normal times. Greater education may be associated with greater financial resources to access alternatives to companion robots, such as hired support in the home. Another possible but untested interpretation of this finding is that if formal education is also associated with awareness of a lax data security environment outside of the healthcare system, people with graduate degrees may be more likely to have knowledge that would give them pause regarding personal comfort with robots. Misconceptions about data use are widespread among the U.S. public (Turow et al., 2015). A question for future work is whether formal education serves as a buffer against misconception or resignation to privacy or security risks.

Our finding of statistically significantly greater comfort with a robot during pandemic times when in-person human interaction is limited indicate that new forms of engagement are desired during a pandemic. Artificial companion robots may not be viewed as acceptable substitutes for in-person human interaction except by some in situations such as a pandemic. This cross-sectional survey of perceived comfort could not assess actual sustained or temporary fluctuations in adoption and use.

Facial Expression and Conversation Data Preferences

The wording of the data collection questions was chosen to optimize clarity around complex devices and to reflect realistic decision-making scenarios. Audio collection, we presumed, would be more likely to be recommended by a care provider; hence the more passive question about "comfort with" for that type of data. Comfort with an artificial companion robot recording conversations was very low. We would expect the low comfort ratings for conversation data to be even lower had we worded the question in relation to desirability, as we did with the facial expression data question. The different questions we used limits our ability to directly compare preferences between the two types of data.

About half of the respondents were interested in the possible collection of facial expression data, which suggests interest in enhanced interaction capabilities with an artificial companion robot. It is important to note that this initial survey question did not elaborate on the use of data beyond inferred emotional states or suggest that these data would be shared with anyone in particular or for a specific use apart from the robot "knowing how you are feeling." In light of ethical debate regarding uses of these data for nudging and influencing behavior, we acknowledge that our line of questioning was limited. Martin and Nissenbaum (2016) have shown that responses to questions about preference for data sharing tend to fail to match peoples' actual sharing behaviors because contextual variables matter, such as the specific entity with whom data are shared or the purpose. Our findings of differences between entities with whom respondents want their data shared—discussed below—support this observation that information flow matters (Martin & Nissenbaum, 2016). Future research should also assess how different framings, parameters, and presented uses of such data may impact desirability. For example, in their work on dishonest anthropomorphism, Selinger and Leong (2019) raise a specific question of relevance to this inquiry: "To what extent should a robot be permitted to "read" facial expression, and then act/react based upon its analysis? For example, if a robot decides its user is relaxed or receptive to the current exchange, should it be allowed to make different recommendations than if it perceives tension or anxiety?" (Seling & Leong, 2019, p. 305). Previous research has highlighted concerns held by some older adults about threats to their autonomy with ElliQ—a voice assistant robot that uses a human-sounding voice. The suggestions and reminders ElliQ offered were interpreted as interfering in autonomous decision making and concerns were raised about paternalistic coercion (Coghlan et al., 2021). Future research should provide such details to study participants regarding use scenarios.

Male gender and higher confidence using the computer were the strongest predictors in adjusted analysis of preferences for conversation or facial expression data sharing, and greater age was associated with lower comfort with facial expression data collection. An implication of these findings in demographic context is that if both being older and female are associated with lower comfort with collection of emotive data, it may be worth rethinking targeting older adults as a very early adopter population for artificial companion robots with this capability. At the very least, it may require that opportunities not to engage with these forms of data collection in artificial companion robots be taken seriously as an issue of equity based on potentially differential impact or concerns by age and gender (Berridge & Grigorovich, 2022).

Our findings of no difference in adjusted models between people reporting memory problems and those who did not suggests that this is not a predictive factor as might be expected given the focus on use of other forms of robots (i.e., pet-like) in dementia care. A possible but untested explanation is that perceived vulnerability and desire for monitoring may be counteracted by increased sensitivity to life intrusions, given the threats and eventual reductions in one's autonomy that dementia causes. There may exist a tension between recognition of one's vulnerability with symptoms of memory problems and the expectation that this makes one vulnerable also to reduced autonomy, paternalism, or challenge one's self-concept (McNeill et al., 2017). One study of technology engagement by people living with dementia found that desire to use AI to assist with self-management was contingent on their ability to have total control over the technology, and with awareness of their greater vulnerability to being controlled by rather than controlling AI devices, some decided not to use them at all (Dixon et al., 2021). Other qualitative research has found perception of threat to dignity when a robot appears toy-like or designed for children, which may be the case for one of our two small robot examples (Coghlan et al., 2021). That research also revealed perceptions among some older adults that robots that have human voices and emulate human companionship are patronizing, demeaning, or condescending (Coghlan et al., 2021). It is possible that for these reasons, new forms of monitoring or cartoon-like companion robots may be less appealing to those concerned about their memory than one might expect given their purported benefit for people living with dementia. These concerns may in effect cancel out potential greater appeal for people experiencing memory issues. These are important questions for future research.

Data Sharing Preferences

Findings regarding with whom participants wanted to share each type of data are consistent with previous research about people's relative willingness to share personal and health information with a spouse or partner (Ivanov et al., 2015) and medical provider (Beach et al., 2009; Boise et al., 2013; Kim & Choi, 2019). The finding that a number of participants who were at least somewhat comfortable with this data collection wanted to access those data themselves suggests the potential interest in this approach for participants to learn from, assess accuracy, or use these data to manage their emotional or cognitive health and well-being.

It is interesting that thirty-one of the participants who wanted a robot that could read their facial expressions wanted inferred feelings from these data shared with no one because it is extremely unlikely that data would be collected but not reported to or accessed by anyone. This finding reflects option preferences among potential consumers that are unaligned with prevalent data practices.

This finding may also be indicative of the need for an emphasis on clear communication and consumer education about what happens with their data, particularly given how few participants endorsed sharing with tech developers or health insurance companies. It is clear that sharing of conversation and facial expression data with these two entities is not desirable, yet problems of data sharing and security abound in adjacent technologies such as smart home devices and voice-assistants. In fact, most health apps focused on dementia lack a privacy policy and admit to possible data sharing with outside parties (Rosenfeld et al., 2017). Research has highlighted barriers to adoption by older adults of potentially useful technologies when preferences about information sharing are not accounted for (Frik et al., 2023). Another consideration that others have noted is that in general, older adults may be less familiar than are younger adults with devices that enable constant surveillance, which could negatively impact their privacy (Carver, 2020). Consumer education and evidence-based personalized tools to assist or walk-through the adoption value and risks of AI companion robots could help people and families discuss the nuances of acceptance, conditional acceptance, or rejection of such tools (Berridge, Turner et al., 2023).

Policy and Regulation

The outstanding ethical, regulatory, and policy questions that require attention for appropriate AI robotics use for companionship are many and complex. Where artificial companion robot function depends on the collection of data, there is an inevitable tension between necessary functionalities and control over what else happens with that data, particularly absent AI regulation, data privacy law, and transparency in the United States. Older adults' interests are thus far not well represented in the larger AI and data privacy policy discourse (Stypińska, 2021; WHO, 2022). It is critical that these interests be surfaced and represented given the diverse values, demand for data, its commercialization, and the range of harms that have been identified among other marginalized communities (Green, 2021; Greene et al., 2019; Hoffmann, 2019; Miceli et al., 2022). Optional comments offered by 38% of our participants provide some additional insight into concerns about artificial companion robots that are largely consistent with those expressed by gerontechnologists and geriatric care professionals (Berridge et al., 2021; Wangmo et al., 2019). They emphasized the need for human interaction and patient authority over their own experiences ("My mood is not a piece of data like my temperature or blood pressure"), with many describing privacy and data security threats. These findings suggest the critical need for data use transparency policy and enforcement. Under the Health Insurance Portability and Accountability Act (HIPAA) regulations, device companies are not considered covered entities, despite the use of health information (Ho, 2023). Despite use of direct-to-consumer device data for commercial purposes, there is no requirement that developers provide privacy policy statements in the U.S., let alone make them widely comprehendible (Ho, 2023; Lupton & Jutel, 2015). Data sharing practices matter to people but are inadequately communicated to them (Lupton & Jutel, 2015).

In a recent survey, the majority of 65+-year-olds, including those with MCI, felt that "it is critical to have new privacy regulations on Voice Assistant Systems [e.g., Amazon Alexa, Google Assistant] data in place" (Spangler et al., 2022). This may be particularly important where consumer technologies have health implications, such as early detection of cognitive change proposed through conversation data. Misuse or inappropriate access of such economically valuable, sensitive data about people have serious potential implications for important aspects of their lives, such as employment. These kinds of data vulnerabilities to AI harms should put companion robots and other consumer home care technologies for older adults on the map for policy makers with the power to regulate commercial surveillance and data security.

Participants' concerns over what happens with their data and their low comfort sharing it with certain entities further support the call for broader stakeholder engagement in AI policy making (Green, 2021; Ho, 2023; Stark & Hoey, 2021). Policy making that is informed by democratic, inclusive deliberation is an appropriate level to begin to address security and privacy concerns over artificial companion robot use and data sharing. The U.S. has no equivalent to the European Union's General Data Protection Regulation (GDPR) and its regulation is lax. The perception that policy cannot keep pace with technology like AI robots can lead to a counterproductive fatalism, but in addition to limited state movement (the California Consumer Privacy Act in addition to other state laws), there is expectation that the U.S. will soon have federal AI privacy regulation. Recent proactive policy moves in the U.S. signal that protections for people can be prioritized. The new Blueprint for an AI Bill of Rights produced by the Office of Science and Technology Policy and published by the Biden Administration sets forth, for the first time, principles to guide protections for people (Hendrix, 2022). It includes "a set of five principles and associated practices to help guide the design, use, and deployment of automated systems to protect the rights of the American public in the age of artificial intelligence" (The White House, 2022). These five principles promote systems that are safe and effective; that protect us from algorithmic discrimination; that protect our data privacy, that allow insight into when and how they are being used; and that offer viable alternatives for opting out of their use. For example, the Data Privacy principle is that "You should be protected from abusive data practices via built-in protections and you should have agency over how data about you is used." (The White House, 2022). Of direct relevance to consumer technologies for older adults, the Federal Trade Commission recently sought comments on a proposed rulemaking related to commercial surveillance and data security. This survey's findings suggest that engagement of gerontologists is needed in these broader conversations about disparate impacts, harms, and vulnerabilities to draw attention to the unmet privacy, transparency, and data security expectations of older consumers (University of Washington Privacy and Security Researchers, 2022).

Viral adoption of large language models (i.e., ChatGPT) on the heels of growth in use of machine learning has further spotlighted need for AI regulation in the U.S. to protect data and privacy. White House science office leaders have called for public participation and action by lawmakers and policy makers, noting that "In this window of public intrigue, anxiety, and scrutiny, there is an unprecedented opportunity for political engagement" (Nelson, 2023, para 10). AI, it is noted, is no longer an abstraction. Meaningful regulation of consumer products used at home should be a priority within gerontology and professional and advocacy organizations such as the Gerontological Society of America and AARP, as older adults are often the focus of new forms of data collection. Organizations that are already vocal advocates for privacy, data security and regulation, and addressing AI harms could direct far more attention to the interests of older adults and the age tech industry, which has largely been out of focus (Stypińska, 2021). This study's findings and others suggest that these are important priorities for older adults.

Limitations

This study has several limitations. The survey respondents are not representative of the general population regarding racial diversity or technological or formal education experience (for greater detail see Berridge, Zhou et al., 2023). Future work needs to emphasize examining these issues in more racially diverse and resource-diverse populations, as well as among older adults living with diagnoses of MCI or Alzheimer's disease or related dementias. Having relied on pre-collected gender data and having not oversampled non-binary or transgender participants, our analysis of gender differences is exclusionary as it is limited to comparisons between those who identify as male or female, including trans men and women. For this analysis, we coded transgender individuals with their reported gender when that was written in (those who wrote in trans female were coded as female and we coded as male those who wrote in trans male). Research is needed that oversamples people with diverse non-binary gender identities to reach adequate sample size for comparative quantitative analysis. The wording of the questions was chosen to optimize clarity around complex devices. This may have introduced enough variability between the questions about data collection to render incomparable. Further, in accordance with COVID-appropriate protocols, we did not provide participants with devices to allow them to physically interact, which makes attitude assessment towards them challenging. Studies of implementation of AI-based robots over time are needed to understand actual impact, perception, and experiences (Berridge, 2017; Pols, 2012).

Conclusion

Roughly half of our relatively tech savvy participants thought they would be at least somewhat comfortable using an artificial companion robot at home, but often cited preference for it to complete tasks for them and cautioned against reduction of human contact in elder care. In adjusted models, factors associated with greater likelihood of reporting greater comfort were being male, younger, with lower formal education, but with greater confidence in computer use. There was moderate interest in having a robot use facial expression data and very low comfort with conversation data collection, which raises questions that need to be resolved before widespread implementation due to the high likelihood of audio recording by artificial companion robots and possibility that older adults may not be given opportunities for informed consent in practice (Berridge, 2018; Berridge & Wetle, 2020). Desire to share these data also differed across age, gender, and other factors. As a group, sharing with technology developers or health insurance companies was not desired, while nearly half of those who reported comfort or desire for such data collection wanted it shared with a medical provider and spouse/partner, with the highest number wanting to access these data themselves.

Specific concerns expressed by gerontologists and researchers in fields engaging ethical AI were shared by this online cohort of potential consumers. Participants predicted privacy, security, and data use issues that are not addressed by the weak regulatory landscape in the U.S. (Ho, 2023; Portacolone et al., 2020). Addressing the concerns raised by study participants and enabling protections and transparency to are likely to promote trust in data practices (Frik et al., 2023) and thus contribute to the appeal of companion robots. Concerns expressed by study participants and lower comfort with greater age and among female-identified participants indicate that policies and regulations should be informed by the needs of older women who represent the majority of older adults, particularly in higher age groups where adoption of companion robots is often targeted. These findings support the observation that processes that meaningfully engage older adults to inform practice and policy are overdue (Robillard et al., 2019; Sekhon et al., 2022). Companion robots, which are designed to be animated and appealing, are also poised to extend digital surveillance and analysis into the home. Data collection through artificial companion robots is primed to be wide-ranging and includes practices on which there is no scientific or ethical consensus (Stark & Hoey, 2021). It is important that what guides practice is older adult-engaged research, design that is responsive to that research, and policy to protect the rights and interests of older adult users.

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Conflicts of Interest/Competing Interests

The authors have no conflicts or competing interests to disclose.

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Appendix A

Online Resource 1: Survey introduction and questions on artificial companion robots

Intro

Technology for In-Home Care: These questions ask you about some new technologies used in home care. The questionnaire should take no more than 10 minutes of your time. We are interested in the opinions of people of all ages, regardless of your experience or lack of experience with care. Some of the questions will ask you to think of your primary support person. Your "primary support person" is someone who would be most likely to step in if you needed care or help. We know you may not have a primary support person now but please think about it in terms of your family member or friend who would care for and look out for you.

Start of Block: AI Companionship

Q9 Interest is growing in artificial intelligence that is built into robots. Robots can be made to look like animals or humans. One use for these robots is to provide companionship because these robots can hold conversations with people. Please answer the following questions about your comfort with this kind of technology.

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q9_a Please think about unusual times when someone cannot come to your home such as during the coronavirus pandemic. In these times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot, like the examples below? [two images of products GenieConnect and ElliQ were presented]

- ○ Very Uncomfortable
- ○ Somewhat Uncomfortable
- ○ Somewhat Comfortable
- ○ Very Comfortable

q9_b Now please imagine that we are again living under normal circumstances so that you are able to spend time in person with other people.

In normal times, how comfortable would you be with an artificial companion that can talk with you to keep you company that is in the form of a small robot?

- Very Uncomfortable
- Somewhat Uncomfortable
- Somewhat Comfortable
- Very Comfortable

q12 Robotic technology is getting more advanced. For example, robots are now able to read your facial expression and know what emotion you're expressing.

If you had an artificial companion, would you want it to be able to know how you are feeling by reading your facial expression?

- Definitely No
- Probably No
- Probably Yes
- Definitely Yes

Display This Question:

If q12 = 3

Or q12 = 4

q12_b If an artificial companion could read your facial expressions, who would you want it to share this information about your feelings with? (Check all that apply)

- ☐ Me
- ☐ My spouse/significant other/partner
- ☐ My child or children
- ☐ A medical provider (hospital, nurse, or doctor)
- ☐ A hired home aide
- ☐ A technology developer/corporation
- ☐ A health insurance company
- ☐ No one - I wouldn't want my facial expressions to be recorded
- ☐ Other (please describe) ____

---

q13 If you had an artificial companion, how comfortable would you be with it recording your conversations?

- ○ Very Uncomfortable
- ○ Somewhat Uncomfortable
- ○ Somewhat Comfortable
- ○ Very Comfortable

Display This Question:

If q13 = 3

Or q13 = 4

q13_b If you had an artificial companion that recorded your conversations, who would you want it to share those with? (Check all that apply)

☐ Me

☐ My spouse/significant other/partner

☐ My child or children

☐ A medical provider (hospital, nurse, or doctor)

☐ A hired home aide

☐ A technology developer/corporation

☐ A health insurance company

☐ No on - I wouldn’t want my conversations to be recorded

☐ Other (please describe) ____

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q15. Do you have any comments you’d like to share?

(Open box write-in response)

Improving Technology Use, Digital Competence, and Access to Community Resources Among Older Participants in the University of Rhode Island Engaging Generations Cyber-Seniors digiAGE Pilot Study

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Abstract

This pilot study aimed to bridge the digital divide between older and younger adults. The goal was for older people in the state to become digitally literate by engaging them in a program that provides digital devices (i.e., Apple iPads), internet connectivity (i.e., through HotSpots), and training from supervised university student mentors. This project, funded as a key policy initiative through the state's unit on aging, specifically promoted social and economic equity by targeting participants from lower-income communities and areas hit hardest by the COVID-19 pandemic. Our university partnered with senior/community centers to recruit and support English- and Spanish-speaking adults 50 years of age and older (age range: 55-100, *M*=72.3, *SD*=8.5). For this paper, we examined changes in technology use and digital competence from the pre- to the post-survey (collected over the phone) from older participants (N=145), and we examined how the program contributed to new ways for participants to connect to community resources. Based on statistical analyses, participants improved in digital competence (pre=2.06, post=2.74), technology use (pre=1.99, post=2.70), tablet use (pre=1.53, post=4.08), and the number of purposes in which participants used technology (pre=4.09, post=5.55; *p*'s<.01). Themes that arose from the qualitative data included feeling more capable and confident in searching out new information, now knowing where to find activities and resources, and meeting with doctors and booking health appointments. This program addressed a significant community need during the pandemic and had success working with community partners. Policies for state grants that support broadband equity, digital literacy and digital equity initiatives should utilize this research to inform their efforts to address digital inclusion needs for older adults.

Keywords: intergenerational technology program, social and economic equity, technology use, digital competence, digital divide

Mejora del uso de la tecnología, la competencia digital y el acceso a los recursos de la comunidad entre los participantes mayores en el estudio piloto digiAGE de University of Rhode Island

Resumen

Este estudio piloto tuvo como objetivo cerrar la brecha digital entre adultos mayores y jóvenes. El objetivo era que las personas mayores en el estado se alfabetizaran digitalmente involucrándolos en un programa que proporciona dispositivos digitales (es decir, iPads de Apple), conectividad a Internet (es decir, a través de HotSpots) y capacitación de mentores de estudiantes universitarios supervisados. Este proyecto, financiado como una iniciativa de política clave a través de la unidad estatal sobre el envejecimiento, promovió específicamente la equidad social y económica al enfocarse en participantes de comunidades de bajos ingresos y áreas más afectadas por la pandemia de COVID-19. Nuestra universidad se asoció con centros comunitarios/para personas de la tercera edad para reclutar y apoyar a adultos de habla inglesa y española de 50 años o más (rango de edad: 55-100, M=72.3, SD=8.5). Para este documento, examinamos los cambios en el uso de la tecnología y la competencia digital desde la encuesta previa a la posterior (recolectada por teléfono) de los participantes mayores (N=145), y examinamos cómo el programa contribuyó a nuevas formas para que los participantes se conectaran a los recursos de la comunidad. Con base en análisis estadísticos, los participantes mejoraron en competencia digital (pre=2.06, post=2.74), uso de tecnología (pre=1.99, post=2.70), uso de tabletas (pre=1.53, post=4.08) y el número de propósitos en los que los participantes usaron la tecnología (pre=4.09, post=5.55; p <.01). Los temas que surgieron de los datos cualitativos incluyeron sentirse más capaces y confiados en la búsqueda de nueva información, saber ahora dónde encontrar actividades y recursos, y reunirse con médicos y programar citas médicas. Este programa abordó una importante necesidad de la comunidad durante la pandemia y tuvo éxito al trabajar con socios de la comunidad. Las políticas para las subvenciones estatales que apoyan la equidad de banda ancha, la alfabetización digital y las iniciativas de equidad digital deben utilizar esta investigación para informar sus esfuerzos para abordar las necesidades de inclusión digital de los adultos mayores.

Palabras clave: programa tecnológico intergeneracional, equidad social y económica, uso de tecnología, competencia digital, brecha digital

提高老年参与者的技术使用、数字能力、以及社区资源获取：罗德岛大学的代际参与网络-老年人digiAGE试点研究

摘要

本试点研究旨在填补老年人和年轻人之间的数字鸿沟。研究目标是让罗德岛州的老年人参与一项提高其数字素养的计划，该计划提供数字设备（即Apple iPad）、互联网连接（即通过HotSpots）以及大学生导师培训。该项目作为一项关键政策倡议，由该州老龄化部门资助，专门用于促进社会和经济公平，目标对象为来自低收入社区和受新冠疫情大流行影响最严重地区的参与者。我们的大学与老年人/社区中心合作，招募并支持50岁及以上的、讲英语和西班牙语的成年人（年龄范围：55-100，M=72.3，SD=8.5）。本文中，我们研究了老年参与者(N=145)从调查前到调查后（通过电话收集）在技术使用和数字能力方面的变化，并分析了该计划如何为参与者提供新的方式来连接社区资源。根据统计分析，参与者在数字能力（调查前=2.06，调查后=2.74）、技术使用（调查前=1.99，调查后=2.70）、平板电脑使用（调查前

=1.53，调查后=4.08）以及参与者使用技术的用途数量（调查前=4.09，调查后=5.55；p<.01）方面都有所提高。定性数据提取的主题包括：在搜索新信息方面感觉更有能力和信心，现在知道在哪里可以找到活动和资源，以及与医生会面和完成健康预约。该计划应对了大流行期间的重大社区需求，并与社区合作伙伴取得了成功。支持宽带公平、数字素养和数字公平倡议的州拨款政策应利用本研究，为用于满足老年人数字包容性需求的相关举措提供信息。

关键词：代际技术计划，社会及经济公平，技术使用，数字能力，数字鸿沟

According to the National Digital Inclusion Alliance (NDIA) (2022), the digital divide is defined as the "gap between those who have affordable access, skills, and support to effectively engage online and those who do not" (p. 1), and the digital divide disproportionately impacts people of color, Indigenous individuals, households with lower income, people with disabilities, people in rural areas, and older adults. On the other hand, digital inclusion "refers to activities necessary to ensure that all individuals and communities, including the most disadvantaged, have access to and use of information and communication technologies (ICTs)" (p. 1). Nemer (2015) further described digital inclusion as the process of democratization of access to ICTs. This includes computers and the internet, which ensures that individuals, particularly those from disadvantaged groups, have access to digital literacy training and quality technical support. These trainings and supports ensure that these individuals are able to participate in and benefit from the electronic-mediated and growing knowledge within our information society (Hache & Cullen, 2009; Nemer, 2015). Recognizing digital inclusion as a social determinant of health, Sieck et al. (2021) described digital literacy and internet connectivity as the "super social determinants of health" because they address all other social determinants of health.

When the COVID-19 pandemic shut down communities across the country, older adult advocates in our state quickly recognized that many older adults were experiencing digital exclusion and enhanced levels of social isolation, which was particularly enhanced due to society's increased reliance on technology for information and communication. Following a series of meetings, the state unit on aging, as part of their new digiAGE Initiative, funded our university team to implement a pilot program. This pilot program aimed to ensure digital inclusion among older adults in the state and bridge the digital divide between older adults and younger generations (referred to throughout the report as the iPad pilot program). The goal for this iPad pilot program was for older adults to become digitally literate by engaging them in a formal program that provides digital devices (i.e., Apple iPads), connectivity (i.e., internet connection through HotSpots), and training by supervised university student mentors. This project specifically promoted social and economic equity by targeting participants from lower-income communities and areas hit hardest by the COVID-19 pandemic for recruitment. This paper details findings from a study conducted as part of this pilot project that: 1) examined pre- and post-survey changes related to technology use and digital competence for program participants, and 2) examined how the program contributed to new ways for participants to connect to community resources.

Technology Adoption Among Older Adults

Technology use has become a fundamental aspect of society, with work, education, communication, leisure, healthcare, and health promotion activities all utilizing technology in some way in order for people to fully participate. Although technology is becoming embedded in society, older adults are adapting to technology at a slower rate compared to younger individuals (Anderson & Perrin, 2017). For instance, 90% of all American adults have used the internet; however, only 73% of older adults report having used the internet (Anderson & Perrin, 2017). Though the share of those 65 and older who use technology has grown, there continues to be generational differences related to social media use and broadband access (Faverio, 2022). Lack of technology adoption, known as the digital divide (van Dijk, 2006), can create disparities and disenfranchisement among older adults, especially for those with low incomes. Low levels of digital competence, age-related cognitive and physical decline, and negative attitudes can influence technology adoption among older adults (Czaja et al., 2006; Laguna & Babcock, 1997; Yagil et al., 2013).

Additionally, many older adults are affected by structural inequities that limit access to technology (Dassieu & Sourial, 2021; Nguyen et al., 2021). Utilizing findings from the Pew Research Center (Anderson & Perrin, 2017), an estimated 41% of the state's older adults are not broadband users and 27% are not internet users. Access to technology can be even harder for racial/ethnic minority groups as there may be language or cultural barriers that inhibit them from finding the technology accessible (Mitchell et al., 2019). For older adults with lower socioeconomic statuses, being able to afford technology (e.g., the device and monthly fees) is a large barrier (Drazich et al., 2022). Technology access can be seen to have a trickle-down effect, meaning that those who can afford it find it accessible in their language or within their culture and thus often learn how to utilize it first (Mitchell et al., 2019). Older adults within racial/ethnic minority groups, particularly those with lower income, may be introduced to technologies later than their White counterparts and thus encounter barriers to utilization of the technology (Mitchell et al., 2019). Disparities in access to technology for Spanish-speaking older adults may be due to language barriers, as differences in the use of communicative technology such as email, phone calls, and texting are less prevalent than utilization of informative based technology such as health resources (Orellano-Colon et al., 2016; Uchechi et al., 2019). This became an increasingly alarming problem when the COVID-19 pandemic came upon our society (Buffel et al., 2021), and testing and vaccine appointments for COVID-19 needed to be made online; current health information was made available online most frequently as well.

At the beginning of 2020, the COVID-19 pandemic forced many people to isolate and socially distance themselves to manage the rapid spread of the virus. For most people, this meant staying home, wearing a mask, and social distancing as much as possible when needing to go out. For older adults, however, the news of the pandemic came with extra concerns as older adults, especially those with medical conditions or those considered immunocompromised, were encouraged to stay home as much as possible to avoid getting COVID-19 (Brooke & Jackson, 2020; Garcia et al., 2021). Older adults with more intense forms of anxiety or depression were more likely to take isolation seriously and to isolate themselves for longer than necessary. For the younger generations, social media, video conferencing, texting, and calling were used to stay connected and combat anxiety and loneliness (Drazich et al., 2022; Garcia et al., 2021). For older adults, the technological divide was more prevalent than ever before, which motivated many older adults to use technology in ways that were new to them (Drazich et al., 2022; O'Connell et al., 2021).

Even prior to the pandemic, many barriers prevented older adults from fully engaging with technology, such as access issues, lack of interest or motivation, lack of knowledge, cost, and perceived issues due to physical limitations (Wagner et al., 2010). For many older adults, technology may also not be easily accessible. Oftentimes technology can be too expensive, or individuals may not have all the tools necessary to use the technology, such as a strong WiFi connection (Drazich et al., 2022; Garcia et al., 2021; Greenwald et al., 2018). With the pandemic came increased awareness of these barriers and new motivation among older adults to obtain access to technological devices and adopt technology (Drazich et al., 2022; Greenwald et al., 2018; O'Connell et al., 2021). One concern raised in a research study by Wu and colleagues (2015) is that older adults often find gerontechnologies (i.e., assistive information and communication technologies designed specifically for older adults, such as simplified tablets or assistive robots) to be stigmatizing. These devices are perceived to mostly be for people with major cognitive impairment or who are physically frail. Most older participants would seemingly prefer to learn the latest technology used by the general public rather than these specially designed devices for "older" people. Therefore, based on this research, we specifically developed this pilot project to provide devices and internet connection in order to remove access barriers while also offering commercially available, highly-desirable devices and free internet connection to older adults.

Digital Competence

Digital competence is one's confidence and ability to use technology for communication, information, and problem solving in various aspects of life (Olofsson & Lindberg, 2008). Digital competence was defined by the European Parliament and the European Council in 2006 as: the confident and critical use of Information Society Technology (IST) for work, leisure, learning and communication. It is underpinned by basic skills in ICTs (Information and Communication Technologies), such as use of computers to retrieve, access, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

As technology becomes more integrated into everyday life, digital competence is increasingly important for older adults (Czaja et al., 2006). Unfortunately, older adults are unable to learn at the rate technology is developing (Charness et al., 2002). Older adults' initial technology experiences and how they are taught to use technology can greatly influence ongoing technology adoption (Peek et al., 2016). In addition, computer anxiety is an obstacle to digital literacy (Laguna & Babcock, 1997). However, technology training can mitigate this anxiety (Czaja et al., 2006), improve computer skills, increase usage, and foster social connectedness and social participation (Gardner, 2010).

Older adults can benefit from technology use through increasing access to health information, promoting social connectedness, improving quality of life, preventing cognitive decline, and maintaining independence (Czaja et al., 2006; Tun & Lachman, 2010). Training older adults on technology to increase digital competence can help them recognize added benefits from using technology and change behavior and attitudes toward technology (Hill et al., 2015). While some older adults may be hesitant to adopt new technology or use technology in different ways, such as engaging in social media or having telehealth appointments, their hesitation can stem from the anxiety of learning something new and not knowing what they are engaging in rather than simply not wanting to engage (O'Connell et al., 2021). Furthermore, when older adults are using technology, they are more likely to be using it in a functional sense rather than as a way to connect with the world (Greenwald et al., 2018). They may also fear being scammed or having their information stolen off of the internet, limiting their confidence in participating in virtual social connection activities such as social media, online classes, and getting in communication with family and friends (O'Connell et al., 2021). The conditions that the COVID-19 pandemic brought outweighed the technological hesitation for many older adults who may have been previously hesitant to learn. Many started taking telehealth appointments and doing social activities online, essentially learning how to adapt to the pandemic world (O'Connell et al., 2021). For older adults with disadvantages due to income, the pandemic may have contributed to increased motivation to learn, but they needed access to devices and training to make this possible, which this pilot project addressed.

Best Practices for Teaching Older Adults

Technology training is an important component to digital inclusion. For learning technology, research has shown that a positive initial experience combined with interactive teaching modalities can help promote continual use of technology among older adults (Rogers et al., 2000). Further, programs that create a friendly and supportive environment (Gagliardi et al., 2008; Hickman et al., 2007) and that cover topics relevant to older adults tend to work most effectively (Segrist, 2004). Best practices also suggest providing one-on-one training for older adults with step-by-step, direct instructions (Dauz et al., 2004; Leedahl et al., 2018), and that repetition is an important aspect of technology training for older learners (Delollo & McWorter, 2017; Tsai et al., 2017). Providing written materials (Gardner, 2010) and finding a balance of self-directed versus instructor-directed learning is also suggested (Dickinson et al., 2005; Xie & Bugg, 2009). Tsai et al. (2017) found most older adults learn how to use tablet devices through exploratory, self-directed learning using a "trial and error" or "playing around" approach.

A reverse mentoring, service-learning program can create a mutualistic, open relationship where mentors and mentees share knowledge and experiences (Spreitzer, 2006). Reverse mentoring, where younger adults provide support and knowledge to older adults, can be a vehicle to teach older adults about technology and bring generations together (Leedahl et al., 2018; Meister & Willyerd, 2010; Murphy, 2012). Reverse mentoring is a newer model of intergenerational programming in which the younger adult provides the support and knowledge to the older adult, instead of the typical gerontocratic model where elders assist younger generations (e.g., Andreoletti & Howard, 2016). This approach provides the opportunity for younger adults to practice leadership skills and for older adults to learn new skills usually associated with youth (Murphy, 2012), such as social media. Service-learning is an organized community service activity to promote experiential education for students in higher education while they also earn course credit (Underwood & Dorfman, 2006). As implied by its name, service-learning is meant to enhance course material through completion of a related service, with an emphasis on learning for students and benefits for those receiving services (Furco, 1996). Young adults participating in service-learning have shown increased ageism sensitivity and more positive attitudes towards older adults, particularly in regard to working with them (Augustin & Freshman, 2016).

Intergenerational connection through "reverse mentoring" is a way to combat social isolation and increase digital competence in older adults. By pairing young adult mentors with older adults, technological knowledge and skills for older adults can be learned to enhance communication and social involvement (Leedahl et al., 2020). Intergenerational learning programs provide educational benefits and meaningful social interaction. Other benefits for older adults through these connections are enhanced feelings of self-worth, improved self-esteem, and overall satisfaction, with the idea that their life has meaning and importance (Underwood & Dorfman, 2006). These programs can not only change the older adults' perspective but the younger generation as well. Research has shown the intergenerational model used by the University of Rhode Island Engaging Generations Cyber-Seniors Program can help reduce ageist stereotypes and increase interest in working with older adults for the students involved (Leedahl et al., 2020).

Intergenerational programs have shown to be beneficial for all involved. For older adults, intergenerational programs can help to combat loneliness, depression, dementia, and overall cognitive decline (e.g., Juris et al., 2022; Martins et al., 2019). Younger adults often gain a sense of autonomy and agency when participating in intergenerational programs with reverse mentoring models because the typical mentorship roles are reversed (Gamliel, 2017; Juris et al., 2022). For both generations, intergenerational work can help reduce the stigmatization of the other generation (Brown & Strommen, 2018). Brown and Strommen (2018) found that one of the main reasons older adults may not be engaging in technology use is because older adults perceive technology as something that just young people use. Older adults may be skeptical when adopting new technology because they are unsure how relevant it will be in their lives, or they may view the technology as inaccessible because they do not know how to use it (Brown & Strommen, 2018). Intergenerational programs can help to bridge that gap by having the younger generation mentor older adults on how to use technology in a way that is accessible to them (Brown & Strommen, 2018). By nature of intergenerational programs, connectivity is increased, depression, cognitive decline, and anxiety about aging decrease, and overall participants from both generations gain a sense of belonging when going through the programs (Dorfman et al., 2003; Juris et al., 2022).

Program Background

The University of Rhode Island Engaging Generations Cyber-Seniors (URI eGen Cyber-Seniors) Program is an intergenerational program that serves to teach older adults about technology, increase digital use and digital competence, and increase social connectedness among older adults. The program uses reverse mentoring and a service-learning approach, where university students help older adults learn about technology for experiential education while also developing communication and leadership skills. This program helps older adults learn how to use technology in a person-centered way, as research indicates older adults prefer to learn about technology through personalized one-on-one sessions (Betts et al., 2019). Since its launch in 2016 through the Spring 2022 semester, the program has served over 1,150 older adults in the state with about 450 university students providing 6,280 hours of assistance (URI Human Development & Family Science, 2023).

The URI eGen Cyber-Seniors Program began in 2015 when an interdisciplinary group of faculty members became inspired to connect university students and older adults using the reverse-mentoring model after viewing the Cyber-Seniors® documentary (Leedahl et al., 2018). The documentary highlighted a program in Canada that connected high school students and older adults at a retirement community so that the older adults could learn about using technology. With the URI eGen Cyber-Seniors intergenerational technology program, university students work together with older adults to help them learn about technology, and students gain communication and teaching skills. This program is part of the university's Age-Friendly University (AFU) efforts. AFUs across the world are focused on strengthening intergenerational bonds through innovative programming that involves younger and older adults both engaging and learning (Talmage et al., 2016), and URI sees this program as a key element to their AFU strategy. The program integrates service-learning components into existing courses/curricula within multiple majors and programs, develops University partnerships with community organizations providing services to older adults, and collects quantitative and qualitative information for program evaluation and research. While supporting university student needs, the program is also designed to benefit older adults in the state, specifically by improving social connectedness for older adults and thus influencing outcomes related to health and well-being.

Prior to implementing this pilot project, the URI team had a strong history of implementing intergenerational technology programming in the state. Before the pandemic, in a typical semester, we often worked with 5–8 organizations (mostly senior centers) and included approximately ten university students who conducted in-person sessions with older adults. Older adult participants would bring their own devices to one-on-one or small group appointments with university student mentors at senior centers or other community sites. When the lockdown due to the COVID-19 pandemic occurred in March 2020, most senior/community centers closed, and university classes and internships moved to remote experiences. A recent publication details the events and partnerships during this time (Jarrott et al., 2022). The state unit on aging identified the funding mechanisms that could be used to fund a new digiAGE initiative, and this pilot project as one of the signature projects for the initiative.

digiAGE Initiative

The COVID-19 pandemic dramatically impacted the health of older adults in the state as evidenced by the high proportion of deaths and hospitalizations among those age 65 and over (Rhode Island State Department of Health, 2020). The pandemic also highlighted the significant digital divide among older adults, particularly marginalized groups, negatively impacting their quality of life in regards to maintaining social contacts, connecting to family and community resources, accessing healthcare, and delivery of food and other essentials (Buffel et al., 2021). Research showed significant disparities in internet use for older adults living in poorer communities of the state; statewide, one out of four persons aged 60 and over did not use the internet. In several areas, only 55% of older adults had used the internet in the last month (Healthy Aging Data Reports, 2020). These findings led the state unit on aging to begin the digiAGE initiative, a component of Project Hello, a broad initiative aimed at addressing increased social isolation due to the COVID-19 pandemic and its stay-at-home restrictions. The digiAGE initiative was the Office's first effort to specifically address the digital divide for older adults.

Conceptual Framework

Social exchange theory guides the overall URI eGen Cyber-Seniors Program due to its emphasis on how relationships between individuals are often being guided by the pursuit of rewards and benefits and the avoidance of costs and difficulties. This program offers mutual benefits to both generations—older participants learn technology; younger participants gain professional experience and service-learning hours. This ensures reciprocity across generations and ideally helps everyone involved learn from and about those with diverse perspectives from their own (Wan & Antonucci, 2016). Specific to older adult learning and development, this program and this research is also guided by Knowles theory of andragogy (drawing on personal experience and knowledge), sociocultural learning theory (providing social interaction personally tailored to people's interests and capabilities) and contact theory (building trust and confidence across generations) (Fink & Beck, 2015; Martins et al., 2019; Vygotsky & Cole, 1978). These respective theories guided our development of the student training, written materials, and the intergenerational learning approach.

Pilot Program Elements

To implement the iPad pilot program, we worked with five senior/community centers. Since the cost for a device and internet connectivity is a barrier for many older adults, especially those with lower income, we developed the iPad pilot program to provide a new device and a Hotspot, if needed, for internet connection. To offer self-directed and one-on-one support, a binder of resources for participants was provided, and each person was assigned to a university student mentor to work with them individually. Student mentors joined the program to meet internship, service learning, or experiential education requirements. Students were trained and provided resources to help them learn about technology and working with older adults. Future research will detail the student mentor experience and outcomes data.

Partnerships with senior/community centers. The state unit on aging specifically chose the pilot communities to be involved in this pilot program because they had higher COVID-19 rates than other parts of the state when the project began. The five communities also had strong senior/community centers willing to support their participants, and these communities represented a mix of communities geographically. Furthermore, the goal for the project was to promote social and economic equity by targeting the project within communities with higher low-income populations and that represented racially/ethnically diverse communities (both English- and Spanish-speaking).

Intergenerational meetings. Student mentors connected with the older participants in several ways for the pilot project including phone calls, through online meeting platforms such as Zoom, and in-person meetings (when safe and possible). While student mentors were trained to tailor each appointment according to the participant's technology knowledge and goals, each mentor utilized a checklist of learning goals to measure progress for each older participant. The goal was for each participant to have 4–5 meetings with their student mentor during the semester in which they joined the program.

iPads. Based on previous experience in assisting older adults with technology, we chose to purchase Apple iPads for participants in this pilot program due to past experience with older participants finding them more intuitive, reliable, and longer-lasting than other devices; university students tending to have more knowledge of Apple products than other types; and Apple iPads simply making people happy and excited to learn. After receiving the first order of iPads, we identified the first template of apps and links to load onto the iPads prior to delivery after consulting with the Cyber-Seniors Organization, Assistive Technology Access Partnership/Adaptive Telephone Equipment (ATAP/ATEL) in the state, and older adults who were previous participants in the program. We chose this over attempting to personalize based on community resources or individual needs, as this greatly simplified the tracking systems, iPad preparatory systems, and initial training protocols. Individuals were able to tailor their iPads to meet their personal needs once they received them; however, we wanted to have them all begin from the same interface. We made sure to include links to specific state resources. We did slightly change the interface over time based on participant experiences and site updates. We purchased iPad covers, screen protectors, and styluses for each participant. Additionally, university and the state unit on aging stickers were included on the back of the iPads.

Hotspots. To obtain the Hotspots for study participants, the university entered into a legal agreement with Mobile Beacon. Mobile Beacon is a company that provides high-speed, low-cost mobile internet access to nonprofit organizations, schools, libraries, and healthcare providers (Mobile Beacon, 2023). With the Hotspot (already set-up), we provided an easy-to read instruction sheet for using the Hotspots, which was included in the binder of each participant who received a Hotspot.

Binder. We provided each participant with a binder that included the following:

1) introductory letter from the PI; 2) liability sheet regarding device damage; 3) checklist of learning goals; 4) iPad Information Sheet with details about the iPad and the pre-loaded resources; 5) password management sheet; 6) copy of the Informed Consent Form; 7) internet safety tips from Attorney General; 8) common technology terms & definitions; 9) Cyber-Seniors Participant Handbook; 10) notebook paper for taking notes. We modified some of the documents after the first two semesters when we learned about issues or needs. We created binders in both English and in Spanish, ensuring both types had the same resources.

Optional Weekly Zoom Meetings. We held weekly Zoom meetings throughout the duration of the project for older adult participants and student mentors. Throughout the meetings, approximately 10–20 older individuals attended the Zoom calls, and approximately 3–5 university students attended each week. This was an excellent leadership opportunity for many of the students, as many of them lead parts of the calls. We often chose a technology-related topic, such as avoiding e-mail scams; utilizing Facebook and Facebook Messenger to communicate; and exploring music, TV, or movie apps, or we scheduled a speaker from one of the organizations in the state that offers resources for older adults. We utilized a similar agenda each week so that participants became familiar with the plan. We kept these meetings optional, as many older adults communicated apprehension towards participating in these types of meetings, even after learning how to use Zoom with the help of their student mentor.

Data & Methods

As part of implementing the iPad pilot program, our research questions were as follows: 1) For older participants in the program, were significant improvements detected in technology use and digital competence from the pre- to the post-survey? 2) How did the program contribute to new ways to connect to community resources for participants? We received IRB approval for the study protocol, including community partner involvement, recruitment methods, consent process and verbal consent form, surveys, and training for any study personnel.

Inclusion Criteria

The PI consulted with the state unit on the aging team to determine the inclusion criteria for the pilot project. For the older adults in the pilot program, inclusion criteria were: 1) be age 50 years or older; 2) hold residence in the five selected communities; 3) lack and want a digital device &/or internet access; 4) be willing to receive 2-3 months of technology training through the URI eGen Cyber-Seniors program; and 5) be willing to complete intake forms, pre-or post-surveys, and take part in a phone interview about their experience.

Older Adult Recruitment and Data Collection

Older adults were recruited through the five community partners. Each partner was given a flier that they were able to modify to meet their specific site needs if necessary. If interested in the iPad pilot program, individuals called the centers and filled out an online registration form with staff. Once individuals were recruited, student researchers called each interested person to inform them of the details of participating in the study. Spanish-speaking student researchers completed the pre- and post-surveys with any Spanish-speaking participants. This often involved multiple calls, voice messages, and sometimes a consultation with senior center staff to reach potential participants. If the individual provided their verbal informed consent to participate in the research study and program, the student then asked them questions from the pre-survey over the phone. Students marked down responses to the pre-survey and entered the information into an electronic form. Participants understood they could keep their iPad if they completed all aspects of the study, and that the Hotspot would work for approximately one year.

After completion of the pre-survey, each person was assigned an iPad and a Hotspot (if needed). Toward the beginning of each semester the university team arranged a day/time to bring the iPads and Hotspots to the site or for site staff to pick them. The site identified a process for getting the iPads to each individual. After that, each older participant was assigned to a student mentor, and the student mentors called them to schedule days/times to meet with them. Student mentors were assigned to a number of older participants based on the number of hours they were able to commit to the program over the course of the semester. For example, if a student mentor had five hours each week to work with participants, they were assigned 8–10 people since they met with each person weekly or bi-weekly for about one hour. Student mentors and older participants mostly met via phone or Zoom for the lessons due to COVID-19 restrictions as well as transportation challenges. Furthermore, Spanish-speaking students were matched with older adults who primarily spoke Spanish to provide mentorship. We also worked to ensure our student mentor population was racially diverse to help with racial concordance with older participants who are people of color (Edwards, Monroe, & Mullins, 2020).

Once participants completed the learning goals on the checklist, student mentors let research staff know they had finished their meetings and that the person was ready for a post-survey. In cases where a person did not finish the checklists during the time the students had to meet with them, we re-assigned the older participant to the next semester. We would then complete a post-survey with them once they finished. To complete the post-surveys, one of the student researchers would call the older adult and ask them questions over the phone. Most of the questions were the same as the pre-survey. We did include a few program evaluation questions at the beginning of the post-survey. At the end of the post-survey, we introduced the interview portion to the participants. The interview portion included open-ended questions about the program and how it influenced people's lives. Student researchers offered to reschedule the interview at a different time or complete it right after the other questions. Nearly everyone chose to complete it that day.

To assess for digital competence on the pre- and post-survey, we asked participants how much they felt competent or able to: 1) search & find information about goods & services; 2) read or download a file; 3) obtain information from public authorities or public services; 4) seek health information; 5) send/receive emails; 6) use video calls, such as Skype; 7) participate in social networks; 8) post messages on social networks; 9) share talents or interests on social networks; 10) share interests and ideas with those they know; 11) use copy/paste tools; 12) have a telehealth appointment. These questions were derived from a report about digital competence available when we first began our program (European Commission, 2014). For each of these survey items, response choices included: 1) not at all; 2) a little; 3) somewhat; 4) very much. Using these questions/responses, we created two measures: a composite scale that averaged the responses across the 12 questions (range 1-4) and a count of the number of digital competencies in which respondents reported "very much" (range 0-12). The alpha for the pre-survey was 0.91.

To examine technology use, we asked respondents how frequently they use the following technological devices: 1) desktop computer; 2) laptop computer; 3) tablet (e.g., iPad, Kindle); 4) smartphone (e.g., iPhone, Android); 5) flip phone; 6) landline; 7) television; 8) Other. For each of these survey items, response choices were: 1) never; 2) monthly; 3) weekly; 4) daily; 5) multiple times a day. We examined "technology usage," which was an average across the eight questions for technology use (range 1-5). We also examined an index of how many different technological devices (computers, tablets, phones) they reported using at least weekly (range 0-5).

To examine purposes for using technology, we asked respondents if they use technological devices for: 1) e-mail; 2) social media (Facebook, Twitter); 3) watch videos (YouTube); 4) video conferencing (Skype, FaceTime, Google Meet, Zoom, WebEx); 5) Search the internet; 6) online banking or paying bills; 7) health appointments or health information; 8) shopping. Response choices were yes or no. Using these responses, we created an index, "purposes for technology," which counts the total number of purposes they use technology for (range 0-8). The alpha for the pre-survey measure was 0.77.

For the post-survey interviews, the student researchers informed the participants that we would be recording the interview, that their name would not be stated in any of our reports, and that the recording would be deleted once we no longer need it for analysis purposes. The audio recordings were uploaded to a secure file folder and shared with the PI, and the recordings were professionally transcribed. For any interviews conducted in Spanish, the recordings were transcribed in Spanish, and then translated into English using a translation service and verified by student researchers who spoke both English and Spanish. All transcripts were uploaded into NVivo qualitative software for analysis. Open-ended interview questions included the following: What was your favorite part of the program? What has it meant for you to be involved in the program? Has your iPad helped you connect with family and friends in different ways? What social groups or activities have you joined (or been able to do) since getting your iPad?

Analysis

To answer Research Question 1, we analyzed items and scales from the pre- and post-surveys. For each variable, we compared whether there was a change in the score from pre- to post-survey and if that change was statistically significant using Wilcoxon signed rank tests. This is the nonparametric equivalent of a paired samples t-test, which was suitable for our data which was not normally distributed. For each variable, we are testing the hypothesis that scores changed from the pre-survey (time 1) to the post-survey (time 2). All analyses were carried out using SPSS.

To answer Research Question 2, we analyzed responses from participants who answered questions from the post-survey interview using a narrative approach. This approach enables participants to tell their stories, and as researchers, we then sought to learn the meaning of the experiences of participants, including their environment and their lived experience (Josselson, 2011). A grant from the university to the PI allowed for the hiring of two students to help in completing this project. To analyze the interviews, the study team consisted of a graduate student researcher, an undergraduate student researcher, and the PI. To begin, we all reviewed the interview guide and three transcripts. Everyone was asked to write down key themes they identified from this initial review. We then held a meeting with the three of us in which we compared key themes and came up with a preliminary list of primary codes and subcodes. The student researchers went back to the transcripts to ensure this list could be used for coding. We met one more time where we made some modifications to the coding list. Once we agreed on the list of codes and subcodes, each student researcher coded five of the same transcripts and then compared the codes. In instances where there was disagreement, they met to discuss the differences and identify an agreed path forward for coding. Once agreements were made, they coded another five transcripts and reviewed agreement percentages until achieving at least 80% agreement, and after which, they continued with the remaining transcripts by dividing them up.

Results

Participation Data and Participant Demographics

Between January and December 2021, a total of 272 people from the five community partners showed interest in participating in the iPad pilot program. Of those, 184 completed the pre-survey (67.7% response rate) over the phone with URI student researchers and were assigned an iPad and if needed, a Hotspot. All 184 participants received their iPads, and of the 184 people, 89 received a Hotspot for internet connection (48.4%). Of the 184 people who received an iPad, 145 people completed a post-survey by May 2022, thus finalizing their program completion (78.8% completion rate). Ninety-eight people completed the post-survey interview (67.6% response rate). Only 14 iPads were returned by participants (15.2% return rate). See Table 1 for details on program information by community site.

Demographics

See Table 2 below for a listing of the demographic characteristics of participants in the pilot program. This includes everyone who completed a pre-survey, and the table also includes those who completed the post-survey interview. For the total sample, the participants ranged in age from 55–100 with a mean age of 72.4. The sample was predominantly female identifying and rather diverse regarding racial/ethnic group identification. Most primarily spoke English, but about one-fifth of the participants primarily spoke

Table 1. *Program Information by Community Site*

Started Program Between January 2021-December 2021	Site 1	Site 2	Site 3	Site 4	Site 5	Total	%
Registered by Partners	30	58	56	78	50	272	
Completed Pre-Survey (became research participants)	28	41	48	40	27	184	67.7% Response Rate
iPads Delivered	28	41	48	40	27	184	100% Served Rate
Hotspots Delivered	10	24	18	15	22	89	48.4% Hotspot Rate
Completed Post-Survey	14	37	42	27	25	145	78.8% Completion Rate
iPads Returned	3	3	3	4	2	14	15.2% Return Rate

Spanish. Relationship status also varied with many participants identifying as single and/or divorced; participants were allowed to choose more than one response. For current employment status, most were retired, though over 20% did identify as unemployed. Most lived alone. A majority of participants were lower income (meaning had less than $30,000 a year in income). About half of the participants had a high school education or below, and about an equal number of participants had some college or were college graduates. Self-reported health status was rather mixed. Finally, about half reported having internet access. The post-survey interview sample did not differ significantly from the pre-survey sample on any of the demographic variables.

Quantitative Results (Research Question 1)

Based on statistical analyses, the program participants showed statistically significant improvements in digital competence (average score) going from 2.06 (low competence) to 2.74 (moderate competence) (range 1-4, $p<.001$). The number of digital competencies in which respondents reported feeling "very much" able to do increased from 2.01 to 4.01 (range 0-12, $p<.001$).

Table 2. *Demographics of Participants (N=184)*

Characteristics	Total Sample Mean/% N=184	Interview Sample Mean/% N=98
Age (Range = 55 -100)	72.4	71.7
Female	77.7%	75.5%
Race/Ethnic Group		
White	56.5%	57.1%
Hispanic	21.7%	19.4%
Black	13.6%	17.3%
Native American / Alaska Native	4.9%	4.1%
Asian	1.1%	1.0%
–missing	2.2%	1.0%
Primary language		
English	77.7%	80.6%
Spanish	20.7%	17.3%
Other	1.6%	2.0%
Relationship status (allowed to choose more than 1)		
Single	34.8%	28.6%
Divorced	30.4%	32.7%
Widowed	22.3%	21.4%
Married/Partnered	17.4%	20.4%
Current employment status		
Retired	66.3%	64.3%
Unemployed	22.8%	23.5%
Employed	5.4%	5.1%
Disabled	2.2%	3.1%
Other	2.7%	4.1%
–missing	0.5%	0%
Lives alone	70.7%	69.4%
Income		
Less than $30,000 a year	81.0%	79.6%
Greater than $30,000 a year	17.4%	19.4%
–missing	1.6%	1.0%
Education		
HS or less	48.9%	44.9%

Some college	25.0%	27.6%
College or more	26.1%	27.6%
Self-reported health status		
Poor	9.2%	7.1%
Fair	20.7%	19.4%
Good	40.2%	40.8%
Very Good	20.7%	21.4%
Excellent	9.2%	11.2%
Internet access		
Yes	49.5%	48.0%
No	35.9	30.6%
–unsure/missing	14.7%	2.0%

In addition, participants' average technology use from pre- to post-survey increased from 1.99 (monthly) to 2.7 (close to weekly), and tablet use frequency went from 1.53 (less than monthly) to 4.08 (daily); both were statistically significant (*p*<.001). Furthermore, the number of technology devices used regularly went from 1.47 (pre) to 2.62 (post), and the number of purposes in which participants used technology went from 4.09 to 5.55; both were statistically significant (*p*<.001). See Table 3 for these details.

Table 3. *Pre/Post Results for Technology Measures*

	Pre-Survey Mean	Post-Survey Mean	N	p-value
Digital Competence (average, range 1–4)	2.06	2.74	145	p<.001
Number of digital competencies (range 0–12)	2.01	4.01	145	p<.001
Technology usage (average frequency, range 1–5)	1.99	2.7	145	p<.001
Tablet use frequency	1.53	4.08	145	p<.001
Number of different types of devices used regularly (range 0–5)	1.47	2.62	145	p<.001
Purposes for using technology (range 0–8)	4.09	5.55	145	p<.001

Note: Wilcoxon signed rank tests were used to compare pre and post measures.

When examining tablet use specifically (see Table 4 below), on the pre-survey a majority of respondents (76.6%) reported never using a tablet. On the post-survey, most respondents reported daily or higher tablet usage (76.6%). Only 2.8% of respondents in the post-survey reported monthly usage. No one reported "never" on the post-survey.

In examining the digital competence questions specifically, Table 5 below shows the pre/post differences across all the questions. As shown, all questions were statistically significant from pre- to post-survey. The questions that show the greatest increase from pre- to post-survey were using video calls, obtaining information from public authorities or public services, seeking health information, and being able to have a telehealth appointment.

We also ran our analysis separately for English (n=108) and Spanish (n=34) speakers. We found that both groups showed statistically significant improvement on all measures of digital competence, technology usage, and tablet use frequency between pre- and post-test (using Wilcoxon signed rank tests). However, the change in mean scores was larger for the Spanish-speaking group for all measures. Therefore, we also compared Spanish and English speakers on the pre-survey measures to see if groups were starting out at different levels of competence and experience (using Mann-Whitney U tests for non-parametric data). We found significant differences in pre-survey values between the two groups for number of digital competencies, technology usage, number of devices, and number of purposes for using technology. For all of these, English speakers were starting at a higher level. We did not find differences in mean digital competence or in tablet frequency usage.

Qualitative Results (Research Question 2)

Analyzing responses from the post-survey interview, we aimed to understand how the program has helped participants get new connections to community members and to community resources. Within this theme, we identified the following sub-themes: 1) feel more capable and confident; 2) now know where to find resources; 3) now join social groups/activities; 4) participate in faith-related groups; 5) meet with doctors and book health appointments; 6) provide long-lasting life changes. Table 6 below shows the number of comments identified that fit into that particular sub-theme. These numbers are provided to indicate how often each sub-theme was mentioned, but we do not suggest over-interpreting these numbers.

Offered New Connections to Community

A main issue for older adults as it pertains to technology is simply not knowing how to use the device. After participating in the program, many individuals reported that they felt **more capable and confident** performing tasks on their devices. By feeling more confident, individuals were able to ac-

Table 4. *Tablet Use Pre/Post Outcomes*

Frequency of Tablet Use (e.g., iPad)				
How often used?	**Pre-Survey**		**Post-Survey**	
	Frequency	Percent	Frequency	Percent
Never	111	76.6%	0	0%
Monthly	9	6.2%	4	2.8%
Weekly	9	6.2%	30	20.7%
Daily	14	9.7%	61	42.1%
Multiple times a day	2	1.4%	50	34.5%
Total	145	100%	145	100

Table 5. *Digital Competency Pre/Post Outcomes*

Digital Competency (1=not at all, 2=a little, 3=somewhat, 4=very much)	**Average (mean)**			
Participants feel confident or able to:	**Pre**	**Post**	**N**	**p value**
Search and find information about goods and services	2.60	3.21	145	p<.001
Read or download files	1.86	2.63	145	p<.001
Obtain information from public authorities or public services	2.10	2.94	144	p<.001
Seek health information	2.31	3.12	144	p<.001
Send/receive e-mails	2.58	3.26	144	p<.001
Use video calls, such as Skype	1.87	3.01	143	p<.001
Participate in social networks	2.14	2.54	143	p<.01
Post messages on social networks	1.86	2.32	145	p<.001
Share talents or interests on social networks.	1.74	2.16	144	p<.01
Share my interests and ideas with those I know	1.98	2.46	142	p<.01
Able to use copy / paste tools	1.70	2.41	144	p<.001
Able to have telehealth appointment	2.01	2.81	144	p<.001

Note: Wilcoxon signed rank tests were used to compare pre and post measures.

Table 6. *Themes Related to New Connections to the Community*

How Did the Program Offer New Connections to the Community?	
Themes	# of comments from participants
More capable and confident with their devices	63
Now know where to find resources	64
Now join social groups/activities	62
Participate in faith-related groups	6
Meet with doctors and book health appointments	8
Provide long-lasting life changes	32

cess new opportunities to connect with the community. For example, they now feel comfortable navigating through the process of searching for information using search engines, such as google, or joining a Zoom call.

> *It has made me a more capable and more determined person, that if the young people of today can, I can too. I feel more determined. I feel more confident to say, "I can or will try." If I see that I can't, I say, "I have to be able," and I try, and until I get it, I don't know, it's a very good satisfaction for me.* –Age 66, female, Hispanic, Spanish-speaking

> *At least now I know what I'm doing when I want to interact with my friends far away.* –Age 63, female, White, English-speaking

> *I feel more confident. Well, I still get a little fearful with pushing buttons on the computer because, I'm thinking that I won't be able to undo it. Mostly, I'm getting beyond that. It's okay to explore, and to really find things out.* – Age 71, female, White, English-speaking

Now that they are more confident in using technology, they communicated that they **now know where and how to find resources** that are available to them. Prior to joining the program, many participants were unaware of all the information and resources that were available online.

> *There's a lot of resources on it. There's a lot of activities on it. I just enjoyed realizing that there was so much there to do.* –Age 70, female, White, English-speaking

> *I think the thing that was most valuable was finding out all the resources that are available and ... also the sense of community for meeting regularly with other seniors.* –Age 66, female, White, English-speaking

> *Well, what I'm saying is when I start exploring online with the iPad, all the activities are available. Obviously, it's going to open*

up a lot of doors. That's something I'm looking forward to. –Age 75, male, White, English-speaking

By learning how to find the resources that are available to them, participants discussed that they had **now joined social groups or activities** that are of interest to them. This is important for individuals to stay active in the community and in the things they enjoy doing. This also opened up the possibilities of developing new hobbies, participating in civic engagement, and exploring new interests, particularly when they were not able to participate in their usual in-person activities.

Oh my God, I've been able to join podcasts, I've been able to join meditation classes, I'm a biggie for that. I also joined a group of live pastors. I've also joined the book club. I joined my walking club. Oh boy, what else? It seems I've joined so many things. –Age 64, female, Hispanic, English-speaking

I've learned a lot to knit. As there are programs there, to knit, to do many crafts, many things. –Age 78, female, Hispanic, Spanish-speaking

I've gone to some of the [Community] Library activities, that they opened up to the general public and I've been to some of the activities in the city of [Community] at [the] Park. My friends and I check out things like the farmer's markets and that. –Age 70, female, White, English-speaking

I haven't joined too many social groups, but I did join an online book club –Age 65, female, Black, English-speaking

I go on activities for creating and selling things and looking up styles and things that I can do in the community on a weekly basis. –Age 76, female, White, English-speaking

By learning new technology, participants were able to continue to **participate in faith-related groups.** Many of these group meetings were moved online due to the pandemic and have remained that way in some capacity since. This allowed for leaders of the groups to hold classes online or stream services for those unable to come in-person.

I have joined the activity only of the church, which as I see sometimes is the Mass, because sometimes many people go to church and I do not like to go because of COVID, that has helped me. I see the activities they have. –Age 75, female, Hispanic, Spanish-speaking

Well, I'm a minister, so I use it for Bible study. I use it for our services on Sunday morning so it helps me to be able to see some of the people in my church that I can't see right now so it's really great. Really great. –Age 71, female, Black, English-speaking

Older adults were also now able to **meet with their doctors, correspond with medical staff, and book their health appointments online**. This is important for those individuals who experience transportation issues, and as many people have learned, can be an excellent option for meeting with doctors for follow-up appointments, second opinions, or other appointments that do not require a physical examination. Most doctors' offices now have online portals to communicate with patients and share information, so participants were able to utilize these resources as well.

> *I make my doctors' appointments. I will also call him and communicate with the doctors.* –Age 75, female, Hispanic, Spanish-speaking

> *The fact that I'm able to do this technology. It's not as difficult as I had thought. It's just made it so much easier, especially with my doctors' appointments.* –Age 63, male, White, English-speaking

Overall, the majority of the participants repeatedly mentioned how the program contributed to **long lasting life changes** for them. Many felt more connected to the community and with their loved ones. Many appreciated being able to continue their normal life through technology, and they were eternally grateful for the opportunity to partake in the program.

> *It just makes me feel more energetic and more interested in my life because I feel like I have the support of somebody, and I enjoy having meetings, looking forward to seeing and hearing your smile and nice voice. It gives me a chance to see more of life.* –Age 83, female, White, English-speaking

Discussion

The goal of the pilot was to increase digital literacy and social and economic equity for older adults through structured programming. Participants engaged in intergenerational meetings with students in utilizing digital devices, resources, and optional weekly zoom meetings. Overall, the intergenerational program met its goal of enhancing digital inclusion for Rhode Island participants, mostly lower income older adults, and contributing to new ways for participants to connect to community resources. Our analysis shows that participants increased their technology use and digital competence from pre- to post-survey, thus showing the participants in the program now use their devices, especially their new iPads, a lot more and feel more confident and competent with their technology knowledge. Spanish-speaking older adults had similar pre/post results; however, their growth from pre- to post-survey was greater than it was for English-speaking older adults. The qualitative results showcased how the program contributed to long lasting life changes for the majority of participants who were grateful for the opportunity to engage in an intergenerational program. Participants revealed an increased sense of confidence in using their devices to access connection opportunities, find resources, and join social, faith-based, or healthcare-related activities. Because the qualitative results support the quantitative findings, we believe this strengthens the confidence of the findings from the pilot study.

Peek et al. (2016) conducted a study of older adults and identified a need for research that provides technology and training for older adults in such a way that large-scale rollouts are possible. To fill that gap, this study piloted a program that could be used in any country/state or community to provide iPads (a product available to the general public; Wu et al., 2015) and mentoring by college/university students that exposed them to working with the aging population and enhanced professional skills (e.g., problem-solving, time management, leadership). Future research is needed to examine if a larger scale roll-out beyond this pilot can produce similar outcomes and to identify best practices for implementing programs of this nature. This study also advances the literature by offering a much-needed pilot program targeted to older adults from disadvantaged communities, many of which have higher numbers of older adults from racial/ethnic minority groups, that assessed the frequency of technology use as well as technology proficiency (Drazich et al., 2019; Mitchell et al., 2019). As described by Drazich et al. (2023) in discussing the considerations for avoiding some of the potential negative impacts of older adult utilizing technology, "it is important to ensure that older adults do not feel further stress from being forced into using technology, and that they are provided the resources and education they need to feel prepared to use technology" (p. 161). This study advanced the literature by following these suggestions and identifying positive impacts from doing so.

One of the biggest take-aways from implementing this program is the need to consistently work to balance all four stakeholder groups' needs. This program offers mutual benefits for all stakeholders involved including community partners, older adults, faculty/staff, and students, and this has been critical for sustainability of the program. Community partners are seeing the need for technology support for older adults but often do not have the capacity themselves to meet the need. Older adults appreciate the program because it helps them gain technological knowledge and skills while getting to know the younger population, and they can participate in the program at their local senior center or over the phone and through virtual ways. The program benefits faculty/staff who want to offer unique, meaningful student experiential education opportunities for students and conduct research studies to advance scholarship related to intergenerational technology programs, service learning, ageism, and social connectedness. Students, eager for internship and service-learning opportunities, also benefit from this program because they can complete their hours and gain professional skills. Because there are mutual benefits for all involved, this program continues to flourish and (mostly) meet the needs of all engaged parties.

However, trying to keep everyone happy and balancing the needs of the four groups of stakeholders is most challenging. For example, it can be challenging to ensure students are getting all the hours they need, it can be difficult to ensure older adults are starting the program at the same time students are trained and ready to meet with them, and it can be time-consuming to make sure equipment is ready and delivered when it is needed. While we have consistently found ways to make it work, we are working to identify sustainable staffing with the addition of increased graduate students to aid with implementing the program state-wide and continue to balance all the stakeholder needs. At this time, meeting the interest and demand across the state within ideal timeframes is certainly posing a challenge because we have wait lists. However, while this is a programmatic challenge, we are working to add a delayed treatment group to our design, which will enhance the rigor of the research.

Senior/community center partnerships work well for recruiting and supporting older adults, and the program seems to be meeting the needs of the older adults it serves. From a recruitment standpoint, having community partners recruit participants through their regular channels (e.g., newsletters, emails, flyers) has proved quite effective, and we suggest other programs and studies consider a similar partnership. Furthermore, because many older adults have had success and appreciate the program offerings, word-of-mouth has become one of the biggest recruitment tools. This, however, does not mean that every person who has experienced the program fully understands how the program works. We intentionally created a program that can be individualized to meet the diverse needs and learning styles of the older adults included, but inevitably there are older adults who have higher expectations than we can meet, have greater challenges than what we can handle, or do not read the materials provided to them explaining the program. For others that develop similar programs, we recommend acknowledging these issues as potentially difficult and continuing to make modifications and communicate with partners to address these types of challenges.

Policy Implications

The COVID-19 pandemic amplified and heightened the need to address the digital divide for older adults. Programs to address the increased isolation facing older adults through virtual means were offered in many states by local senior centers. Research also documented that increased internet use contributed to positive outcomes in quality of life and mental health for older adults (Wallinhemo & Evans, 2021). Webinars to promote learning about best practices to engage older adults in digital competency were offered by engAGED, a national association funded by the federal Administration on Aging and administered by USAging (2023). The state unit on aging digiAGE initiative's goal was to bridge the digital divide for older adults and family caregivers through public/private partnerships and investments in smart devices, training to increase digital literacy, expanding connectivity for older adults and family caregivers, and promoting compelling online content. Initially small grants from corporate sponsors helped fund several small pilots, and Federal COVID Relief funds from the Administration for Community Living (ACL) awarded to the state unit on aging provided it the opportunity to move forward with digiAGE. In allocating these funds, the ACL specifically provided funds to be used for prevention and mitigation activities related to COVID–19. Funds needed to focus on addressing extended social isolation among older individuals, including activities for investments in technological equipment and solutions or other strategies aimed at alleviating negative health effects of social isolation due to long-term stay-at-home recommendations for older individuals for the duration of the COVID–19 public health emergency (ACL, 2021).

Because the URI eGen Cyber-Seniors Program had demonstrated previous experience in assisting older adults with digital technology through its past intergenerational technology programs, this URI team was well positioned to apply that experience to implement this targeted pilot. The state unit on aging worked with URI to modify their program to meet COVID-19 restrictions, engage local senior programs in recruiting older participants from more underserved communities, and include an evaluation component using surveys to collect basic demographic information and measure impact. These design features are attributed to the success of the pilot and have important implications for public policy.

The fact that over 80% of participants were lower income and almost half lacked internet access highlights the need to provide affordable broadband. This need was recognized by Congress when it passed the 2021 Consolidated Appropriations Act, which established the $3.2 billion Emergency Broadband Connectivity Fund to implement the Emergency Broadband Benefit program (EBB) to provide low-income households with a discount off the cost of broadband service and certain connected devices during the COVID-related public health emergency. The EBB program started in May of 2021 and ended at the end of December 2021 when it was replaced with the Affordable Connectivity Program (ACP), which was designed to be a permanent program. Data from the Federal Communications Commission (FCC) shows 24,623 people in our state subscribed to EBB during that time, and nationally, about 14 percent of the nine million EBB subscribers were age 65 and over (Universal Service Administrative Co., 2022). The ACP benefit changed from the $50/month provided under EBB to $30/month (households on tribal lands received and continue to receive $75/month). Persons enrolled in EBB were automatically enrolled in ACP and would continue to receive the $50 a month for 60 days during the transition. As of February 2023, there were just under 16 million ACP subscribers and 17 percent were age 65 and over (Universal Service Administrative Co.) Although this was an increase from the percent of older EBB participants, U.S. Census income data for older households shows a need to continue to promote awareness of the ACP to older adults to address the affordability issue (18% have income below 150% federal poverty level) (Universal Service Administrative Co., 2022). The iPad pilot demonstrated value in helping persons learn how to find information about benefits, programs, and services online. This is especially important for persons in underserved communities who often lack such knowledge and demonstrates that providing devices and connectivity is not sufficient and needs to be accompanied by technology training uniquely tailored for older adult learners as the iPad pilot program has done.

The lessons learned in the pilot program can serve as a model for and inform other state government-university collaborations working to promote digital equity for older adults and to stimulate government and foundation funders to support grant funding in this area. This is especially important as states develop plans and programs in response to the "Internet for All" federal initiative (National Telecommunication & Information Administration, 2023). Through this initiative states receive funds from the administration's (NTIA) Broadband Equity, Access & Deployment (BEAD) program and the Digital Equity Act (DEA) that provides Digital Equity Planning and Capacity Grants to plan for and implement digital equity and inclusion initiatives. In response to this new federal funding, the state Commerce Department launched a Broadband Initiative to close the state's digital divide. They estimated 164 households, and 410,000 individuals are eligible for the $30-per-month discounts from the ACP. However, as of February 1st, 2023, only 56,226 households had made ACP claims. With Census data showing 27 percent of the state's older households with income of $25,000 or less it is important for the State Unit on Aging and its community partners to continue outreach to make older adults aware of the ACP discounts so they can fully participate in the digital world. Many of the state's older adults reside in large, subsidized apartment complexes restricted to persons aged 62 and over and those with disabilities. To promote digital inclusion for these adults, BEAD funding can be used to install building-wide connectivity in these complexes to assist in meeting resident connectivity needs thus addressing cost as a barrier.

Providing devices and connectivity is not sufficient and must be accompanied by technology training uniquely tailored for older adult learners as demonstrated in the pilot program. To meet this need, advocates should push for continued funding through the Administration for Community Living for state grants that support digital literacy training programs for older adults. Additionally, as states work on Strategic Planning for using the significant federal funding available under the Digital Equity Act, older adults and entities that serve them must be involved in the planning to ensure the unique needs of older adults including those needing devices with accessibility features, those for whom English is not their primary language, and those living in rural areas are considered in the planning and implementation process. As our research found, targeting digital inclusion initiatives to non-English speaking populations, such as Spanish-speaking older adults as our research did, is suggested since these populations may start with lower digital competence but also have greater capacity for improvement.

Limitations and Future Research

We, of course, need to be cautious in interpreting the findings because we did not have a control group, and the pandemic itself (meaning people gradually increased or resumed their normal activities) may have contributed to the improvements in the measures analyzed in the study. However, we attempted to address this concern as well as social desirability bias by identifying objective technology-related measures. While the study has strengths with the sample size, geographic dispersion, and mixed methods design, we plan to address the methodological shortcomings in future research. For example, we are adding additional communities during more "normal" times related to the pandemic, which we will compare to the pilot sample, and we are also adding a waitlist control group. We also plan to examine how variation in the number of sessions held with student mentors influenced potential outcomes and examine the data using more advanced statistical analyses. Future research will further assess outcome differences across racial/ethnic groups as well as intersectional groups (e.g., older adults who are Black and low income compared to others).

We began rolling out the program state-wide in January of 2022, and we are continuing to gain momentum. Starting in January 2022, we began enrolling participants from additional sites, and by October 2022, we now have a total of 14 communities taking part and enrolling participants in the program and research project. We will be spending the next couple of semesters establishing processes that work with each partner and ensuring we find enough student mentors for each site. Future publications will detail these efforts and compare results to the findings from this article and others regarding pilot project outcomes. Future research will also examine implementation of similar programs within higher education institutions across the United States and Canada. This pilot study showed promising results for addressing digital inclusion among a sample of racially/ethnically diverse, mostly lower income older adults across one state. Community or state policy initiatives could benefit from offering similar programs, particularly to help increase digital inclusion among older adults and/or ensure access to community resources that increasingly involve digital means to learn about or access them.

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"Connect it down to the person": Perspectives on Technology Adoption from Older Angelenos

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Abstract

Older adults can face multiple barriers to digital device adoption. To better understand these barriers and other influential factors of digital device use, we conducted focus groups and interviews with adults ages 60+ in collaboration with a non-profit senior services organization in our large metropolitan area. The average age of participants (*n*=41) was 74.7 years (*SD*= 7.4 years). The sample included both Spanish-speaking (*n*=21) and English-speaking (*n*=20) participants. We used an immersion-crystallization framework for analysis, engaging in extensive iterative cycles to add, remove and amend codes to identify four major themes: 1) facilitators and 2) barriers of technology usage and digital device uptake,

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3) negative aspects of use, and 4) preferred learning methods for digital device training. We found that participants primarily used digital devices to connect with family and friends and cited this ability to connect as a key driver of both initial and continued use. Family members, prior work experience, and community resources were the main facilitators while lack of know-how was a major barrier. Participants cited substantial concerns about online scams and fraud with frequent device use. Participants preferred hands-on methods for digital device training and stressed the importance of patient instructors and repetition. To align with our findings, policies that support older adults in overcoming barriers to digital access should comprehensively address secondary barriers to digital adoption by providing ongoing individualized training and social support.

Keywords: Older adults, digital divide, technology acceptance, qualitative methods

"Conéctelo a la persona": Perspectivas sobre la adopción de tecnología por parte de los angelinos mayores

Resumen

Los adultos mayores pueden enfrentar múltiples barreras para la adopción de dispositivos digitales. Para comprender mejor estas barreras y otros factores influyentes del uso de dispositivos digitales, llevamos a cabo grupos de enfoque y entrevistas con adultos mayores de 60 años en colaboración con una organización de servicios para personas mayores sin fines de lucro en nuestra gran área metropolitana. La edad promedio de los participantes (n=41) fue de 74,7 años (DE= 7,4 años). La muestra incluyó participantes tanto de habla hispana (n=21) como de habla inglesa (n=20). Utilizamos un marco de cristalización de inmersión para el análisis, participando en extensos ciclos iterativos para agregar, eliminar y modificar códigos para identificar cuatro temas principales: 1) facilitadores y 2) barreras del uso de la tecnología y la adopción de dispositivos digitales, 3) aspectos negativos del uso y 4) métodos de aprendizaje preferidos para la capacitación en dispositivos digitales. Descubrimos que los participantes usaban principalmente dispositivos digitales para conectarse con familiares y amigos y mencionaron esta capacidad de conectarse como un factor clave tanto del uso inicial como continuo. Los miembros de la familia, la experiencia laboral previa y los recursos de la comunidad fueron los principales facilitadores, mientras que la falta de conocimientos prácticos fue una barrera importante. Los participantes mencionaron preocupaciones sustanciales sobre estafas y fraudes en línea con el uso frecuente de dispositivos. Los participantes prefirieron métodos prácticos para la capacitación en dispositivos digitales y destacaron la importancia de los instructores pacientes y la repetición. Para alinearse con nuestros hallazgos, las políticas que ayudan a los adultos mayores a superar las barreras al acceso digital deben abordar de manera integral las barreras secundarias a la adopción digital brindando capacitación individualizada y apoyo social continuos.

Palabras clave: Adultos mayores, brecha digital, aceptación de tecnología, método cualitativo

“将其与人联系起来”：洛杉矶老年人对技术采用的看法

摘要

老年人在采用数字设备方面可能面临多重障碍。为了更好地理解这些障碍与数字设备使用的其他影响因素，我们与洛杉矶大都市区的一家非营利性老年服务组织合作，对60岁以上的成年人进行了焦点小组访谈。参与者(n=41)的平均年龄为 74.7 岁(SD= 7.4)。样本包括说西班牙语(n=21)和说英语(n=20)的参与者。我们使用沉浸分析-具体化(immersion-crystallization)框架进行分析，通过广泛的迭代周期来添加、删除和修改代码，以确定四个主要主题：1)促进因素，2)技术使用和数字设备采用方面的障碍，3)技术使用的消极方面，4)数字设备培训的首选学习方法。我们发现，参与者主要使用数字设备与家人和朋友联系，并将这种联系能力视为初次使用和持续使用数字设备的关键驱动力。家庭成员、以前的工作经验、以及社区资源是主要的促进因素，而缺乏实际经验是主要的障碍。参与者对频繁使用设备而可能导致的网络诈骗和欺诈表示严重担忧。参与者更喜欢数字设备培训采用实践方法，并强调耐心的指导者和重复实践的重要性。根据我们的研究结果，支持老年人克服数字访问障碍的政策应通过提供持续的个性化培训和社会支持，以全面应对数字采纳的次要障碍。

关键词：老年人，数字鸿沟，技术接受，定性方法

As we strive for greater digital inclusion, policy interventions to facilitate digital adoption must address the challenges faced by older adults who remain disconnected. To improve our understanding of these barriers, our research team asked a diverse group of English- and Spanish-speaking, community-dwelling older adults in Los Angeles about how they use digital devices, what factors prevent initial digital uptake or contribute to eventual disuse, and what factors promote sustained digital device use.

Background

The Digital Divide

A *digital divide* separating those with access to technology from those without, was first recognized by the National Telecommunications and Information Administration (NTIA) in 1995 (National Telecommunications and Information Administration, 1995). The NTIA used the terms the "have nots" and the "information disadvantaged" to describe people who lacked access to essential communications technologies such as telephones, computers, and modems (NTIA, 1995). More than two decades later, the percentage of adults in the United States who use the internet has risen dramatically, from 50% in 2000 to 93% in 2021 (Pew Research Center, 2021). Supporting those who remain disconnected from the economic, social, and health benefits of digital access continues to be a central, albeit complex, policy goal.

Although the NTIA's 1995 report did not specifically use the term "digital divide," it outlined inequities in digital device access that persist almost three decades later, despite major technological advances and the increasingly essential role digital devices play in our daily lives (Sanders & Scanlon, 2021). Lower rates of internet adoption are still associated with older age, lower educational attainment, low income, and living in a rural community (Anderson, 2019) along with race/ethnicity and primary spoken language (California Public Utilities Commission, 2019). While living in a rural community is a disadvantage to having reliable high-speed internet (Vogels, 2021), urban dwellers also face challenges. For example, while 20% of households in California's rural Central Valley region have no broadband connection or only have connection via smartphone, 19% of city-dwelling Angelenos are similarly situated (Mackovich-Rodriguez, 2021).

COVID-19, Digital Access, and Aging Equity

The COVID-19 pandemic rapidly exacerbated digital inequities and functioned as a focusing event (Kingdon, 2010) that brought digital access policy into the spotlight. People of all ages who lacked internet access and digital devices (e.g., computers, tablets, smartphones) faced new challenges amidst COVID-19 orders to stay at home, whether it was children pursuing their education or older adults seeking telehealth services. Digital access became increasingly viewed as an essential utility to support Americans' safety, health, and quality-of-life (Coughlin, 2020), and the digital divide increasingly viewed as a human rights issue (Sanders & Scanlon, 2021).

The pandemic also spotlighted the close relationship between digital equity and aging equity in the United States, and the multiple ways that digital connectivity can positively impact older adults' lives (Coughlin, 2020). Benefits include reduced social isolation and loneliness, improved psychosocial well-being, increased health care access via telehealth services, and improved management of home-based long-term services and supports via technology-enhanced virtual care (Alibhai, 2017; Cox, 2020; Hoffman et al., 2020; Sims et al., 2017). The state of California took policy action to support digital connectivity among older adults in response to COVID-19, starting with an executive order to improve affordable and reliable broadband access statewide. As the order details, "Closing the digital divide by increasing access to the internet and digital devices will improve the ability of older adults and people with disabilities to connect to family and friends, health care providers, and to access additional support during the COVID-19 pandemic and beyond" (Exec. Order No. 73-20, 2020).

Challenges Facilitating Digital Adoption among Older Adults

While access itself is essential, studies have shown that even after older adults obtain broadband access and an internet-connected digital device, some are further challenged by secondary barriers, including lack of proficiency and training in the digital skills needed to do basic problem-solving, content creation, or communication in an online environment (Kebede et al., 2022). While secondary barriers can be mitigated by informal technical support from family and friends, family and friends often fall short of fully meeting older adults' digital access needs because they lack the time and digital know-how themselves (Geerts et al., 2023). Digital access interventions that address primary but not secondary barriers may improve initial digital device uptake but not sustained usage (Damodaran et al., 2014).

Researchers have examined older adults' relationship to the digital world by developing digital readiness and technology adoption models (Haufe et al., 2019; Peek et al., 2017). These models have improved our understanding of the digital divide and the role the digital skills gap plays by describing technology acquisition processes and outcomes among older adults. However, more information is needed on what strategies and approaches may best serve those who have not previously had access or who have been unwilling to use technology. More knowledge is also needed on older adults' preferred learning methods for formal technology instruction (Geerts et al., 2023).

Acknowledging these gaps in knowledge, the primary aim of our study was to build understanding of what factors influence general technology usage, initial digital device uptake, and sustained digital device usage among older Angelenos, including those who identify as having a low level of comfort using technology or as technology non-adopters. An additional aim of our study was to explore what pedagogical techniques older adults find most helpful when obtaining formal instruction on using digital devices.

Methods

Recruitment

We recruited participants in collaboration with a nonprofit senior services organization in Los Angeles that has several established technology training programs. Our shared goal was to gain a better understanding of older Angelenos' experiences navigating the digital divide, particularly but not exclusively within a pandemic context, to inform the organization's future technology training curricula. The organization recruited members from their community of racially and ethnically diverse, predominantly low-income, and urban-dwelling older adults to participate in interviews or focus groups by distributing English- and Spanish-language flyers with home-delivered meals from July to September 2021. Additional participants were recruited through word-of-mouth snowball sampling, referrals from case and site managers at the organization, newsletter announcements, and outreach at social events sponsored by the organization.

Participants

Participants had to be age 60 or older, live in a community setting within the Los Angeles metropolitan area, and be able to communicate in either English or Spanish. A designated staff member at our partner organization screened participants for eligibility and collected basic demographic information to provide in aggregate to the research team. The inclusion of Spanish-speaking older adults was critical to our study's aim since approximately one in three of our partner organization's clients are Hispanic or Latino and many clients' preferred language is Spanish. These characteristics reflect broader Los Angeles County demographics; in 2021, 49% of Los Angeles County residents identified as Hispanic and 38% of Los Angelenos spoke Spanish at home (U.S. Census Bureau, 2021).

Data Collection

The first four authors conducted focus groups and interviews via participants' preference of phone calls or Zoom in August and September 2021. Our semi-structured interview guide consisted of nine open-ended questions and covered the following topics: current and past digital device use; comfort level using digital devices; initial experiences learning how to use digital devices; past experiences taking technology classes; interests for future technology classes; advice to age peers who are uncomfortable using digital devices; and general attitudes about technology and digital inclusion.

We conducted four focus groups and three interviews in English, and six focus groups and four interviews in Spanish, speaking with a total of 41 participants (English n =20, Spanish n =21) over 17 sessions. Interviews ranged from 17 to 45 minutes (*mean* = 29 minutes, *SD* = 9.7) and focus groups ranged from 52 to 97 minutes (*mean* = 74.5 minutes, *SD* =14.62) depending on the length of participants' responses and the number of participants per focus group. Table 2 shows the breakdown of focus groups and interviews and the number of participants per session. All participants engaged independently and remotely from their own homes except for a few who took part from the home of another participant or with the help of a caregiver.

Table 2. Number of participants in Focus Groups and Interviews

#	Language	Focus Group or Interview	Phone Call or Zoom	# of Participants
1	ENG	FG	Zoom	6
2	SPAN	FG	Phone	3
3	SPAN	FG	Phone	2
4	ENG	FG	Phone	4
5	ENG	FG	Zoom	4
6	ENG	I	Phone	1
7	SPAN	FG	Phone	5
8	SPAN	FG	Phone	2
9	ENG	FG	Phone	3
10	SPAN	FG	Phone	3
11	SPAN	I	Phone	1
12	SPAN	I	Phone	1
13	ENG	I	Phone	1
14	SPAN	FG	Phone	2
15	ENG	I	Phone	1
16	SPAN	I	Phone	1
17	SPAN	I	Phone	1

Interviews and focus groups were conducted by one to three members of our research team with the assistance of a designated staff member at our partner organization. Participants provided verbal consent to be recorded during their session. Recognizing that the presence of academic researchers and of recording can impact participants' willingness to speak freely, facilitators made conscious efforts to create a nonjudgmental and inclusive environment. Efforts included dedicating ample time for introductions, reviewing confidentiality and group communication expectations before beginning, presenting opportunities for participants to ask the facilitators questions, and emphasizing the value of participants' experiential knowledge. Facilitators also emphasized that there were no wrong answers and treated similarities and differences in participants' perspectives on technology with curiosity by asking probing questions. Additionally, all research team members were committed to practicing reflexivity throughout the research process, critically reflecting on how our own personal backgrounds, experiences, and beliefs influenced our interactions with participants and interpretation of the data (Birks et al., 2014).

Each participant received a $25 gift card as a gesture of appreciation for participating in the study. The study was determined to be exempt from human subjects review by the Institutional Review Board at the University of Southern California.

Analysis

Focus group and interview content were captured by audio recording and preliminary time-stamped transcripts were created with Sonix AI, an online artificial intelligence software platform. We reviewed and corrected the transcripts manually, using intelligent verbatim transcription (IVT), sometimes called, "denaturalized" transcription (Bucholtz, 2000). IVT is commonly used in social science research conducted in partnership with nonprofit organizations (McMullin, 2021). Using IVT, utterances such as "um" or "ah" are removed along with stutters or stammers, and repeated words and non-standard language (e.g., "gonna" instead of "going to") are edited for clarity to produce documents that are easy to analyze (McMullin, 2021).

We developed an a priori codebook based on our literature review of older adults' use of technology, along with field notes taken by research team members during the data collection process. The first and fourth authors coded all English transcripts and the second and third authors coded all Spanish transcripts. We then used an immersion/crystallization framework for analysis, engaging in extensive and interactive group analysis to add, remove, and amend codes (Borkan, 1999). Multiple iterative cycles of intra- and inter-pair coding, discussion, and reconciliation required the coders to return again and again to the data. This repeated exposure to and probing of the data helped the team hone in on common topics and significant patterns across transcripts through which meaningful themes began to take shape.

As a supplementary analysis method to support theme identification, we also counted the number of times each code was used across all transcripts, using Microsoft Excel to assist with analysis. We then compared code frequencies to determine code prevalence and identify thematic differences between the English and Spanish groups. We used these insights to make collective decisions on combining complementary codes and eliminating sparsely used or minor codes and to ultimately reach a consensus on identified themes.

Table 3. Codebook: Themes & Descriptions

Codebook	
Theme	**Description**
Facilitators of Technology Usage and Digital Device Uptake	Participants describe what facilitates their use or adoption of digital technology.
Family, Friends, or Neighbors	Participants' family members or any person the older adult identifies who either introduced them to or supports them in their use of technology.
Community Resources	Participants cite a community resource or organization (e.g., senior center, library, etc.) that introduced them to and/or supports them in using technology. It may also include state and local government programs, as well as non-government organizations. Support may be technical, financial, or both.
Use of Technology in Employment	Participants who said they used technology, or acquired technological skills, in their working lives, which they were able to apply to current technology usage.
Barriers to Technology Usage and Digital Uptake	Things that get in the way or prohibit the use of technology or prohibit the acquisition or use of digital devices.
Lack of Know-How	Participants are hesitant to use applications or devices that they can't set up for themselves; for example, they may not know how to install or download apps, so another person does it for them, and they use it, but they wish they had their own "know-how;" lack of formal education may be a factor for some in this area.
Lack of Perceived Usefulness/ Low-Interest Level	Participants express that they don't have an interest in learning how to use a digital device; this can be because they don't have a need for it in their lives or work, or there is no urgency, critical need, or incentive to adopt technological devices or platforms.

Physical or Psychological Limitations	Participants express challenges arising from physical or mental limitations. This may or may not have to do with the natural aging process.
Fear	Participants express that they have fears about using technology; for example, they fear that they will fail to understand how to operate a smartphone or fear they won't understand how to navigate the internet.
Lack of Digital Literacy	"The ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills." *Digital literacy—Welcome to ALA's literacy Clearinghouse*. (n.d.)
Don't Want to Be a "Burden"	Participants express that they don't want to be a burden on others, especially family; or they don't want to "bother" or "annoy" others with repeated questions.
Lack of Time	Participants have other commitments going on in life that impede time for learning technology.
Financial	Participants express they lack the financial resources to afford a physical device or internet service for their home.
Lack of Device	Participants express challenges in learning or using technology due to lack of a device for practice or use.
Negative Aspects of Technology and Digital Device Use	Things participants dislike about technology in general or things they dislike about specific aspects of it (e.g., they find Facebook promotes negativity; they don't trust online banking).
Fraud and Privacy Issues	Fears, concerns, and challenges expressed about fraud, scams, hacking, phishing, identity theft, or any other nefarious things that can occur as a result of being online; participants express concerns about their overall privacy online.

Online Account Safety and Digital Hygiene	A person's sense of self-efficacy and capability to manage one's digital life; participant has concerns about how companies collect and/or use their personal information or is uncomfortable with online companies knowing a lot about their personal or private lives
Variability/Inconsistency Across Platforms & Devices	Participants express challenges posed by the variability or inconsistency across devices (e.g., iPhone vs. Android, Mac vs. Windows); variation in platforms and devices across time (e.g., OS updates).
Lack of Transparency	Participants have trouble discerning what is safe to click on and what is not, e.g., predatory advertisements, business tactics, and generally misleading practices employed online.
Preferred learning methods for digital device training	Suggestions from participants on best learning methods for older adults:
Patient Instructor	Having a patient instructor.
Instruction style	Instruction styles include: Hands-on Step-by-step "Cheat sheets" Writing things down Small groups One-on-one Repetition
Age, Cohort, and Group-Appropriate Content	Linguistic, culturally, and cohort appropriate instruction; organize technology instruction by learner proficiency.
Peer-to-Peer Engagement	Encouragement and advice from peers engendered a sense of companionship.

Research Team

All authors are gerontology researchers at a large academic institution and have training in qualitative methods and focus group/interview facilitation. We have diverse sub-disciplinary backgrounds in public health, public administration, social work, and theater. The second and third authors are Hispanic and bilingual in English and Spanish, while the first, fourth, and fifth authors are non-Hispanic and do not speak Spanish. We were intentionally collaborative during all research stages. All authors were involved in designing the study, determining the research questions, and interpreting the data. We believe the diversity of our team and commitment to non-hierarchical collaboration are methodological strengths of the study.

Results

Participants included English-Speaking focus groups and interviews (EFGs) (*n*=20) and Spanish-Speaking focus groups and interviews (SFGs) (*n*=21) of older adults ages 60 to 89 years old. As shown in Table 1, most participants were female (68%), Hispanic/Latino (54%), lived alone (54%), and had completed at least some college (51%). More than half of the participants had an annual income of less than $40,000, with at least a third reporting income within the 2021 income eligibility limits for California's Medicaid (Medi-Cal) and SNAP (CalFresh) programs. Most participants reported having difficulty seeing (73%), with fewer reporting difficulties with hearing (17%) and mobility (24%). The EFG and SFG samples were similarly distributed in age and gender but differed in educational attainment, annual income, and living arrangements. As displayed in Figure 1, a larger proportion of EFG participants than SFG participants had completed at least some college, had income above California's 2021 Medi-Cal and CalFresh income eligibility limits ($16,395 per year for a single individual), and lived alone.

Most participants used at least one internet-connected digital device, whether it was a smartphone, tablet, laptop, computer, or smart TV. Only one participant verbally indicated that his cell phone was not a smartphone. When asked about their comfort level using technology, just 22% of participants said they had a high level of comfort while the rest indicated either medium (39%) or low (34%) levels of comfort. Participants reported using their digital devices primarily to communicate with family and friends. After communication and social connection, participants most commonly used their devices for entertainment and information-seeking. Information-seeking activities included practical tasks such as reading or watching the news, googling a topic of interest, checking the weather, or using a mapping application to get directions. Social media participation was the next most discussed digital activity. The most popular social media platform was Facebook, but Instagram and Twitter were also mentioned.

Table 1: Sample Characteristics by Language

	English n (%)	Spanish n (%)	Total n (%)
n	20	21	41
Age			
60-69	4 (20)	4 (19)	8 (20)
70-79	9 (45)	11 (52)	20 (49)
80+	6 (30)	5 (24)	11 (27)
Gender			
Men	6 (30)	7 (33)	13 (32)
Women	14 (70)	14 (67)	28 (68)
Race or Ethnicity			
Non-Hispanic White	6 (30)	0 (0)	6 (15)
Hispanic/Latino	1 (5)	21 (100)	22 (54)
Black African-American	4 (20)	0 (0)	4 (10)
Asian	5 (25)	0 (0)	5 (12)
Other	2 (10)	0 (0)	2 (5)
Highest Education			
High School or Less	3 (15)	14 (67)	17 (41)
Some College	8 (40)	4 (19)	12 (29)
Post College	8 (40)	1 (5)	9 (22)
Annual Income			
$16,395 or Less	4 (20)	10 (48)	14 (34)
$16,396-$39,248	7 (35)	4 (19)	11 (27)
$39,249 or More	4 (20)	3 (14)	7 (17)
Living Situation			
House	6 (30)	1 (5)	7 (17)
Apartment	12 (60)	13 (62)	25 (61)
Other	2 (10)	7 (33)	9 (22)
Lives Alone	12 (60)	10 (48)	22 (54)
Reports Difficulty with:			
Vision	17 (85)	13 (62)	30 (73)
Hearing	3 (15)	4 (19)	7 (17)
Mobility	6 (30)	4 (19)	10 (24)
Uses Mobility Device	10 (50)	8 (38)	18 (44)
Tech Comfort			
Low	5 (25)	9 (43)	14 (34)
Medium	7 (35)	9 (43)	16 (39)
High	8 (40)	1 (5)	9 (22)

* All percentages are out of the listed n. Percentages will not add up to 100% if some participants have missing information.

We identified four major themes: 1) facilitators of technology usage and digital device uptake, 2) barriers to technology usage and digital device uptake, 3) negative aspects of technology and digital device use, and 4) preferred learning methods for digital device training. Facilitating factors were individual, for example, a participant enjoyed having a smartphone to communicate more regularly with children and grandchildren. Facilitators also included affordability, availability, and community and family assistance with

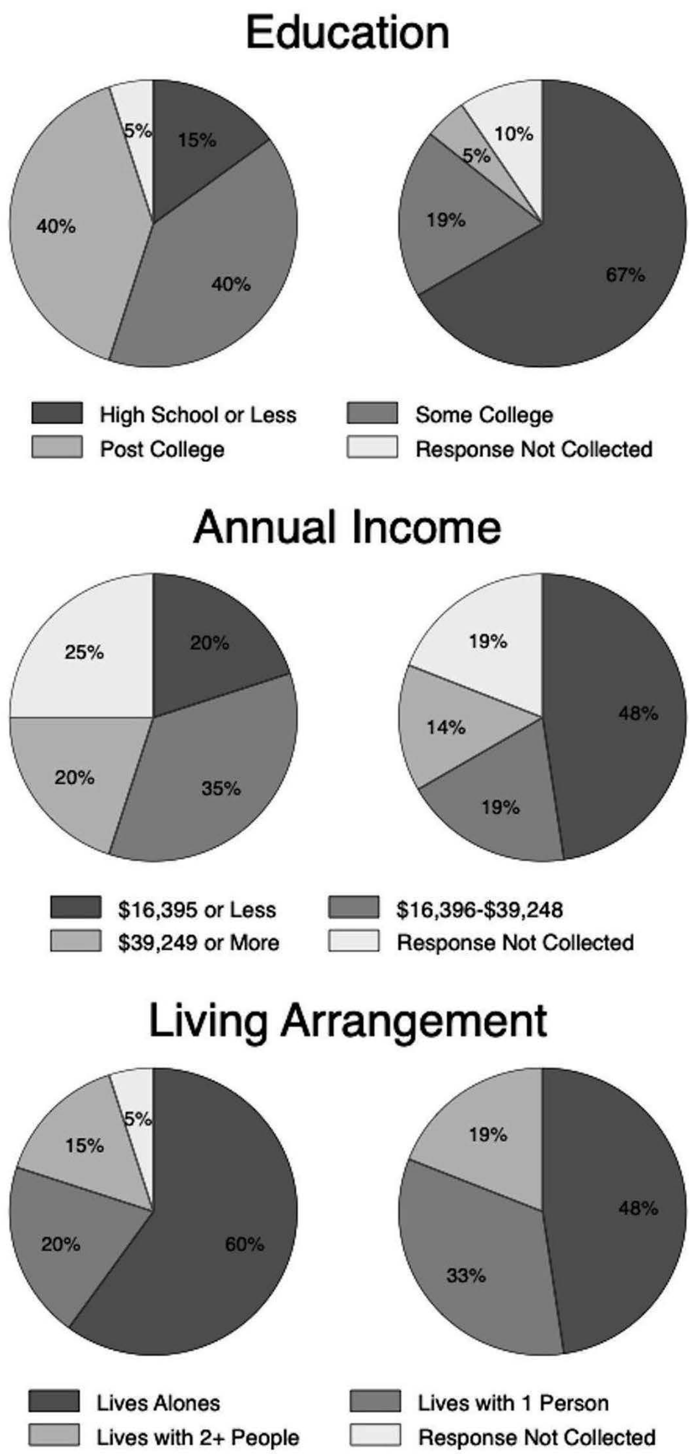

Figure 1. Key Sample Characteristic Differences by Focus Group Language, English (left) and Spanish (right)

onboarding and training. Factors that acted as barriers were also personal in nature, such as experiencing fear when using digital devices due to a "lack of know-how." Other barriers were socioeconomic, such as limited income to purchase a device or maintain a service plan. Although barriers presented challenges to uptake and continued device usage, they did not generally preclude participants from all digital device use. Instead, participants described making adjustments, asking for help, and avoiding certain digital tasks but continuing to use digital devices despite barriers.

While barriers were challenges to digital device use that participants worked to resolve, negative aspects were challenges with digital technologies that simply had to be endured. Negative aspects were often indicative of broader societal issues that extended beyond technology. For example, nearly every participant voiced uneasiness around online account safety or anxiety about being targeted for online scams. Similar to barriers, negative aspects did not necessarily prevent participants from uptake or continued usage. For instance, variability across devices made it difficult to learn technical tips from peers but did not keep most participants from asking friends and family for device advice.

Finally, the fourth theme stemmed from questions about technology training. We asked participants what advice they would have for someone who wants to put together a class for older adults to learn how to use digital devices. We also asked what topics a class should focus on and what concerns it should address for those who feel scared or skeptical. In response, participants identified factors that motivate digital skill building and expressed how they learn best. Preferred learning methods included learning-by-doing and other types of hands-on instruction, such as when a teacher guides a participant step-by-step through performing a task on their digital device. We present illustrative quotes and further descriptions of each theme below. SFG participant quotes have been translated by the second and third authors and are presented in English.

Theme 1: Facilitators of Technology Usage and Digital Device Uptake

Family, Friends, Neighbors

The number one facilitator for digital device uptake was having a family member, a close friend, or neighbor introduce, provide support, or, in some cases, facilitate access to devices. Except for two participants in the SFGs, individuals across all groups gave examples of how their family members not only taught them basic ways to use their phone but also advanced their knowledge of different available apps (e.g., podcasts, scanning features) and of more novel uses such as projecting their smartphone screen onto their television. One EFG participant credited his daughter with opening him up to a new platform saying, "I'm [now] interested in political podcasts … my daughter has turned me on to those. So, she kind of leads me into things that I wouldn't normally connect with."

For some participants, simply having someone available to troubleshoot issues or remind them how to do a task functioned as a facilitator for them, like this SFG participant who said, "Well, as far as technology is concerned, I have learned a lot because my children teach me how to use the smartphone and the computer." One EFG participant said having people they can count on to point them in the right direction keeps them from being discouraged:

> *I'm not really adept on … how to operate all those features on the cell phone. Sometimes I'm able to do it … sometimes I'm not. So, if … I'm not able to do it, I don't get frustrated. I can ask a lot of people. I have nephews and nieces or brothers that understand more about this technology than I do, so I always have someone to rely on to ask questions.*

Community Resources

Community resources were another facilitator of digital skill-building but not necessarily initial digital device uptake. An EFG participant discussed the plethora of free resources available at local libraries, including newspaper subscriptions, music, movies, and electronic books: "The library is a very good place to learn how to work a computer … there's a guy that goes around checking or answering questions for those who are using the computers, and computers at the library are free."

Prior to the COVID-19 pandemic, some participants also took advantage of desktop computers available for free use at libraries and senior centers. A few even found free support or troubleshooting assistance in unexpected locations, such as through staff members at health clinics.

In the SFGs, some participants said community-based organizations, such as our partner organization, provided computer classes with assistance from staff and volunteers. Other participants revealed that staff at their internet or cell phone service providers, such as T-Mobile and the Apple store, were common sources of free assistance. One SFG participant recounted:

> *Let's say suddenly, it's one thing or another, I know that if I have a hard time [with the phone], I go to the company where I pay for [it]. Well, I tell them to show me, "How can I do [this]? What can I do?"*

SFG participants relayed that they found service providers to be generous with their time, offering to do things such as help them learn how to download a phone app or create a user account.

Use of Technology in Employment

Prior use of technology at work also functioned as a facilitator of both initial uptake and sustained usage. Several participants reported that they had acquired technological skills through current or past jobs that they were able to apply when using digital devices. While the technology in their former working lives may have been less sophisticated predecessors to the technology they currently use, having prior knowledge about, for example, how email works or what an operating system is, provided an advantage in developing modern digital literacy. It should be noted that this facilitator was primarily and disproportionately discussed by participants in the EFGs. As one EFG participant said, "I did use computers in my work … I was an ESL teacher at a community adult school for about 20 years, but even prior to that, I was using computers." Another EFG participant offered this hypothesis:

> *I started with the computer back in 1983... [so] I have a comfort level of messing with it or learning about it, and that's what is often missing. I claim if you haven't been exposed [to it] in your work or in school … after 60, it is not so easy to start playing with the computer. That's what I think we're up against. People who have used it in their work, then it's no big deal.*

Other EFG participants agreed that early exposure to technology use at work gives older adults an advantage in today's digital world.

Theme 2: Barriers to Technology Usage and Digital Uptake

Lack of Know-how

With that in mind, the biggest barrier to technology use was self-reported lack of know-how, especially among SFG participants who expressed that sentiment nearly three times as often as EFG participants. Lack of formal education came up twice in the SFGs when discussing digital know-how, as participants said they felt their lack of education placed them at a disadvantage when learning how to use a phone or other device. Notably for SFG participants, lack of know-how was a barrier that precluded their usage of certain devices all together, limited their use of certain features on various devices, and limited their facility with performing tasks on the device itself or on the apps installed on them. Three SFG participants conveyed this with one saying, "Well, I have a simple phone, which I only use for making or receiving calls. That's basically how I use it. I don't use a smartphone because I don't know how," and another saying, "I think [smartphones] are more difficult. I am not familiar with the phone [so] I am not going to use it. Even turning it on and off is not easy for me," and a third saying, "I can also use WhatsApp. But [someone else] installed it, so I do not know how to [do that] but I would like to learn."

Overall, we observed that even when participants reportedly had acquired objectively average or above average skills using their digital devices and digital platforms, they often professed to be "not good at technology." For example, when asked about the ways she uses her phone, one participant in a SFG answered: "I have Instagram, I have Facebook, I have WhatsApp … I use Google." However, when asked how she would rate herself, she responded, "In general terms, I am at a basic level … where I have learned [only what's] necessary." Similarly, another SFG participant rated herself "between basic and middle," yet said she did the following digital activities: "I use Google Chrome, Excel, I watch movies on Netflix, I check my bank statements, [and] I read [text] messages."

Lack of Perceived Usefulness

Another salient barrier was "lack of perceived usefulness." We included lack of usefulness as an a priori code due to its long-standing history in the technology adoption literature. The concept originates from the "technology acceptance model" (Davis, 1989), which essentially posits that if a person is not interested in engaging with technology, it might be because they do not see how it would be useful to them. If they do not have a need for it in their lives or work, or there is no critical incentive to adopt technological devices or platforms, then that could explain, in part, why an older person is not engaging with it. Most of the participants in our study did not eschew digital technology overall, rather certain aspects of various platforms and applications. For example, the idea of perceived usefulness was exemplified by an EFG participant who said, "I don't know Excel, or stuff like that … I don't really have a need for those things, you know what I mean. I'm glad I don't need to ever even use it." Another EFG participant said:

> *I don't mind … I like to learn stuff, but … after 25 years of not having a computer, I don't see the logic in obtaining one because I already have my cell phone. I figured that's about as comfortable as I'm going to get, and I don't have to worry about getting bills or having somebody teach me.*

Participants in the SFGs expressed a lack of perceived usefulness more than five times as often as those in the EFGs. One SFG participant articulated how the lack of need has translated to a lack of perceived usefulness, saying simply "I don't really think I need [social media apps], so that's why I … haven't been that interested in [having] that technology." Another connected lack of perceived usefulness to employment to explain why she does not use the device:

> *I haven't found it necessary to use these devices … there is no interest, you could say. If I would have needed to, because that's what my job required me to do or something like that, yes, and maybe I would have started trying to learn.*

To a lesser extent, some SFG participants were not motivated to use technology because they had assistance from family members who performed digital tasks on their behalf (e.g., online bill paying), giving them little incentive to learn on their own.

Physical or Psychological Limitations

Some participants expressed physical limitations, such as vision problems, and cognitive limitations were a barrier to using devices like phones or computers. They described how cognitive limitations made tasks such as remembering how to use an application or remembering the password they used to set up a device or online account daunting, with one SFG participant saying, "Everything is useful. I am of no use because I have my memory [problems]; I forget everything."

Fear

Although participants used the word "fear," in the sense of "fear of the unknown," when talking about technology, what they often seemed to be describing was a lack of confidence in interacting with the unfamiliar. One EFG participant attributed this fear to formative experiences she had using technology as a child and younger adult:

> *So, I use technology, but I'm terrified of it. And when I grew up, it was like, if you don't know how to do it, don't touch it … it [is] still ingrained. If you don't know how to do something, don't touch it.*

SFG participants expressed this sentiment of fear nearly four times as often as EFG participants for a wide range of reasons, from the most basic problem of not knowing how to use digital devices to very specific fears of being "tracked" online, or fears that if they "pressed the wrong button" they could potentially cause their device to "break down." One SFG participant admitted to "a fear of not being able to do it [using her device]" while another one asserted her fear of the unknown, saying, "I'm afraid to get into where, I mean, what I don't know on the phone."

Lack of Digital Literacy

Struggles with digital literacy, which is defined by the American Library Association as, "the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills" ("Digital literacy—Welcome to ALA's literacy Clearinghouse," n.d.) was a topic that arose in various ways in the EFGs, but was almost non-existent in the SFGs. "Digital literacy" was not a term our participants used, but their expressions about it are captured in one exemplary quote in which a EFG participant illustrated a string of technical issues she struggled with:

> *Like … with different apps … knowing where to touch [the screen so that] you're not going to lose something, or how to find the right printer so you can print something, or if you've had to scan something, how to scan with your phone. I need to learn [how] to do a screen print. Some people can do the screen print on their phone and, it's like, I've done it by accident, but I never can repeat it again, so people will [say], 'take a screenshot,' and I don't know how to do that. The instructions don't come with the phone.*

Don't Want to be a "Burden"

Although less of a concern than some of the other areas, participants in both EFGs and SFGs indicated that they worried from time to time that their questions or need for repetition would "bother" or "annoy" family members to whom they turned for assistance or problem-solving on their digital devices. They expressed guilt about asking to repeat things they have already covered, especially if the task was relatively simple.

Lack of Time

Lack of time was a differentially salient barrier between the EFG and SFG groups. Participants in the SFGs mentioned lack of time as a barrier to use, explore, learn, or practice using their cell phones more than ten times as often as participants in the EFGs. Lack of time was typically due to work or household obligations and, in some cases, due to caregiving responsibilities. One SFG participant said, "I have to go to work and do things first, and I can't just be on the phone." Another expressed that it was important to expand her knowledge about how to use her cell phone but gave us examples of her daily obligations that keep her from setting time aside to learn:

> *I would like to learn because there are many things that are important. I don't want to be on the phone 24 hours … I have more things to do—I have to cook, I have to clean, I have to care for my mother. I have many things to do.*

Financial

Both groups expressed financial barriers to obtaining a digital device, either due to lack of funds to purchase a device or lack of a consistently adequate income to afford the monthly cost of service plans. In the SFGs, some participants had a device because they were provided free of cost by government-funded programs but were limited in how they could use the device due to restrictions on data usage. One participant mentioned that, at one time, she was not able to send texts because she had reached her data cap. One SFG participant admitted, "I don't have a computer, and I don't have internet … because I can't pay for it. I can't say I'm going to pay for internet because it's a luxury I can't afford."

Lack of Device

Another barrier was lacking a digital device, often but not always due to financial reasons. All but one of the EFG participants had at least one device, and most preferred to use smartphones or tablets. However, one interviewee was staunchly against using digital technology and lacked a device by choice, primarily due to concerns about privacy and security. Additionally, some EFG participants did not own a desktop or laptop, while some said that, even though they had desktops, they mostly used their smart devices. Reasons reported for lacking these devices were financial barriers and convenience.

Similarly, participants in three of the SFGs said they did not have the funds to purchase a device. One participant put it simply: "How could I learn to use a smartphone if I didn't have one?" Although they expressed interest in learning how to use the device, they found it pointless to attend a class or learn to use a device if they were not going to have the ability to practice at home. One member of the SFGs, mentioned the importance of owning a device to learn to use it and practice outside of class:

> *As we see today [referring to the focus groups] there are some of us who don't have this tablet or a smartphone … There are people who still use the flip phone … We don't have the opportunity to learn on that [smart device].*

Theme 3: Negative Aspects of Technology and Digital Device Use

Fraud and Privacy Issues

Topics of fraud, scams, "hacking," "phishing," identity theft, and privacy concerns were raised among all the English-speaking participants. One stated:

> *Let me just give you a simple example, yesterday, I got a call on my phone saying that your order for $799 of dog food is ready to be processed at Amazon. Now, this is the problem. I don't have a dog, I don't have an Amazon account, and I would never be able to afford $799 of dog food … So, this is just an example of why technology is not good for me.*

These concerns seemed to focus on online privacy, but many participants in both the EFGs and the SFGs also had experiences with receiving scam calls, many of which purported to be messages about their Social Security benefits, but the nature of scam calls was wide-ranging. One SFG participant said, "At first, hackers called me. They called me saying it was the Social Security office." Some of the EFG participants discussed receiving phishing e-mails as well and said that it was often challenging to tell the difference between which emails were legitimate and which were nefarious.

Online Account Safety and Digital Hygiene

Related to fraud and privacy, online account safety (e.g., identity protection, how to spot scams, and ward off fraud attempts), and a topic we have defined as "digital hygiene," were a big concern for the EFGs though not as much for the SFGs. Digital hygiene refers to a person's sense of self-efficacy and capability in managing one's digital life. Accessing and managing data and storage on devices generated substantial negativity and was a source of frustration because it stymied participants' desire to interact with their devices and share content.

For example, a participant may know how to take photos, but does not know how to retrieve them to share with family members in a text message. One EFG participant talked about her struggles, saying:

> *Yeah, there is other stuff on the phone that I don't really know how to do. Like now, I have a big*

> *gigabyte [storage] on my phone, and it's saying it's almost [used up] because there's stuff that I'm [saving multiple times], that is filling up my [memory]. I've got so much stuff ... like pictures ... I try to save them and [then I realize I've] already saved it before. I don't know where to put them where I can have easy access to them. I lost a lot of my pictures because [I] didn't know how to see them in one file.*

Nearly all participants were aware of and, in some cases, had big concerns about online account safety, and most participants were aware that older adults were targets of being taken advantage of online. One participant shared why she would appreciate ongoing assistance with online safety:

> *I know you all are talking about safety, that would be one good thing because my congressman, every now and then, would have something … and it was about senior citizens being careful when you use the computer. And so that could be, like you said, [online] safety … that would be a good class to have somebody who can help … check your accounts or something like that, or how to make sure everything is safe.*

Another participant, who was an avowed opponent of adopting technology, summed up a lot of the fears reflected across all FGs:

> *I don't think that I'd be wanting to do any kind of online banking or shopping because … you're giving out your financial information on the air, into the cloud. You don't know who's going to get it or how they're gonna use it. You might go and do some banking and then next time you go into banking, they say your balance is zero.*

From a public awareness perspective, it appears that messaging on the topic, regardless of how it broke through on the individual level, has been very effective in reaching older adults.

Variability/Inconsistency Across Platforms & Devices

After privacy, fraud-related concerns, and data management challenges, variability and inconsistency across platforms and devices was noted as a negative, although SFG participants mentioned it about half as often as EFG participants. One way inconsistency was expressed, for example, was if the participant had an Android phone and the son or daughter who tried to help them was an iPhone user. The platforms might be different enough between the devices that the assistance does not translate from one device to another. As these three EFG participants explained:

Participant A:

> *My problem with technology is especially when you have to change phones from regular to 5G. I'm not able to log in to a lot of my*

> *apps that I had before because it doesn't recognize my passwords. So that's frustrating.*

Participant B:

> *That's the thing. The big problem is the technology keeps advancing so quickly that everybody's in a different range of … I don't text [but] my daughter texts … and there's all these different [apps], like TikTok, and all these different places, and it separates the generations. You know, the young people are doing one thing and … I still have the VCR, I still watch videotapes, so … there's a big generational gap in technology and media.*

Participant C:

> *There is a problem because each company has different phones ... I manage my Apple phone, but I cannot help the person who has a Samsung.*

Lack of Transparency

To a much lesser extent, lack of transparency online was also considered to be a negative aspect of digital participation. Lack of transparency in our sample referred to the participant simply having trouble discerning what content was safe to click on and what was not. Similar to fears about fraud and scams, the English-speaking groups mentioned this more often than the Spanish-speaking groups but spoke of it in more general terms. One SFG participant described it vividly, saying: "Humans have always used lying as a weapon. It is like smoke." An EFG participant's reflection on lack of transparency was quite detailed and specific:

> *I forget which is which, but when you're looking at the websites and it says … either 'http' or 'https'... one of them is wrong … I forget, which was the one that you don't want to use, [but] it's not secure, actually. I think the other thing too, is that a lot of times on emails, you … get offers for free gift cards … associated with AT&T or whatever. Just forget those. If something sounds too good, it certainly is too good … I think you have to be very careful about that and don't even open up certain e-mails. If it looks suspicious, just … delete it.*

Lack of transparency could be categorized as the participant being unsure when they were being misled online, or expressing they had trouble distinguishing between real advertisements and predatory business tactics.

Theme 4: Preferred Learning Methods for Digital Device Training

Patient Instructors

The number one thing for everyone was the importance of having a patient instructor. One EFG participant put it like this:

> *But I learned very well from him. You know, learning from him was*

> *like taking candy from a baby. It was real easy, but it was fun. And when you learn something with fun and relaxation, it comes to you much easier.*

Participants said teachers who are patient, who can speak in a language they are comfortable with, and who can break down the "techy talk" into ordinary words people can understand is critical for them to absorb, process, and feel successful with digital uptake.

Instruction style: Hands-on, Step-by-Step, Cheat-Sheets, Hand Holding, and Repeat, Repeat, Repeat!

Other factors that were of relatively equal importance to all participants were that the instruction should be "hands-on," "step-by-step," contain a lot of repetition, and have participants of similar skill levels grouped together. One EFG participant illustrated how people in his age group needed instruction "step by step, like as if we were kindergarten." Another elaborated on this idea, saying:

> *You know … here's this short-term memory loss … especially for seniors. There's this thing about, if you're learning something new, and the next two or three days [go by], you're going to forget that from what you learn, unless you keep [repeating] it, maybe every other day. But if you learn something today, and you don't [reinforce it], you're just going to lose that again because it's just part of growing old. That's [why] you need the hands-on thing.*

It was also mentioned peripherally that, if possible, it helps to have people in the same class also using the same devices because it makes the class more efficient if, for example, those using an Android don't have to wait while those using an iPhone get different instructions unique to their device, and vice versa. This was not a deal-breaker, but it was noted as a "nice to have." Having "cheat sheets" made available seemed to be more important to participants of the SFGs, although EFG participants noted that writing things down for themselves was one thing they did to help them remember how to do things:

> *Yeah, sometimes I want to find certain things on the computer and … I can't. It makes me upset. So, I had to call my daughter to help me Google it. And then once I know it already, then it's easy for me to … follow the instructions. Most of the time I tell her to write down the instructions, so I will not be asking so many times, you know? So that's what I do.*

Another notable difference was that, while SFG participants preferred classes consisting of small groups with some time dedicated to each student, EFG participants preferred one-on-one instruction, including many who said they needed "hand holding," not so much to learn, but to remember how to do things:

> *I think it has to be all eclectic the way we were going to be taught. And the main one is one-on-one. But the lectures help it overall, and even little groups help. But sometimes you need a real one-on-one. You know, the young people can grab this stuff real quick and understand how to do it. This is much harder, and I find that I have to have it over and over.*

The need for repetition, especially if a participant was more of a beginner, was something participants felt was a key factor in managing their digital lives, but they also expressed some guilt around having to ask someone to go over something multiple times. This pertained more to family members than instructors they had taken classes with, but there was the sense in some participants that not remembering how to do things made them feel like they might be an annoyance.

Age, Cohort, and Group-Appropriate Content

Another important factor was that the content and approach were appropriate for an older adult cohort. For example, an older adult in one of the EFGs told us about a class at a community college where the instructor focused on things like Microsoft Excel and PowerPoint. She felt out of place because she had no background using those programs in her daily life and because she felt the instructor took basic knowledge of her skill level for granted, saying:

> *This particular instructor, he wanted to take it like it was a college level and, when you're learning something, it's like learning a new language if you don't know the foundation of it or the basics. It's like all Greek to you, and I felt that not only that, he didn't make me feel welcome in the class, he made me feel as if I was an alien from another country, another planet.*

Being grouped in classes where everyone is at the same level was equally important to both EFGs and SFGs. One EFG participant put it like this:

> *There's different levels of expertise, even among people like us who would like to have a class to learn a little more. And so, you know, maybe divide it into [similar skill levels] because you're going to get bored. If you have to sit through somebody who's starting at 'point zero,' and you're already relatively proficient.*

Notably, people with fewer skills and lower levels of comfort with a device didn't like the idea of being in a class where everyone was more advanced than they were, and where they might feel lost or feel like they cannot keep up. On the other hand, people with higher skill levels said they would get impatient if the class was too basic or did not move fast enough, or covered skills with which they were already facile, as the participant above put it.

Peer-to-Peer Engagement

For participants of the SFGs, the opportunity for peer-to-peer engagement was over three times more important than it was for EFG participants. Encouragement and advice from peers engendered a sense of companionship. Similarly, if their peers recommended a class in which they had a positive experience, they were more inclined to join. They also liked the idea of joining a class with a friend or companion to have the "sense of not being alone." Classes involving peer-to-peer engagement were far less important for EFG participants but not insignificant compared to other factors.

Discussion

This study examined both primary and secondary facilitators and barriers to digital adoption among a diverse group of English- and Spanish-speaking older adults in Los Angeles. While the literature demonstrates that lower rates of adoption are associated with older age, we would argue that most participants in our urban-dwelling sample were exceptions to the norm. Access to the internet and to digital devices, which challenges 23% of older Californians (Mackovich-Rodriguez, 2021), was moderated by family members, friends, neighbors, and availability of community resources. Across both the EFG and SFGs, communication and social connection with family and friends were, without exception, the key drivers for technology use. Family and friends not only motivated initial uptake of digital technology but also facilitated sustained use through their proxy roles of "tech support" for many participants. These informal trouble-shooters functioned as buffers, preventing lack of know-how, technical difficulties, or other secondary barriers from discouraging participants from using digital devices.

Another element that contributed to lower "tech anxiety" and narrowing the digital skills gap was prior experience using technology at current or former jobs; even in cases where that technology would now be considered "outdated," work experience served as a mechanism to embrace current technology use. Although adopting new technology was not necessarily easier for those with prior experience, it seemed to reduce fear and increase confidence. It should be noted that EFG participants were disproportionately advantaged in this sense, as they were four times more likely to have used technology in their jobs and were more likely to have had at least some college education compared to SFG participants.

Despite being touched on in all focus groups, primary factors, such as lack of money, time, and interest in technology were not the biggest barriers to uptake among these participants. Similarly, the differences in opportunity, resources, and digital literacy, even among participants who expressed an extreme lack of confidence, or who admitted technology "terrified" them, most were undeterred by these secondary factors.

While it was true that informal support among all participants was both motivating and substantive, there was also a considerable amount of guilt around being an annoyance or a burden to family members when asking for help, especially about things they had gone over in the past. Because of these feelings of guilt when it comes to informal, or "warm" support, our inquiry about formal or "cold" training was enlightening, not because the preferred learning methods were unconventional, but because the nature of these methods (e.g., intensive hand holding, constant repetition, directed task mastering) engenders a sense of guilt when it comes to warm support. Conversely, our participants did not have a sense of guilt when talking about how they would want a teacher in a formal setting to provide instruction. Some participants likened learning new technology to learning a new language, noting that repetition is not only a normal way of teaching, but also expected in order for the learner to progress and gain a sense of mastery.

Policy and Practice Implications

Our findings have several policy implications for state and municipal governments in California and across the United States. First, they indicate that subsidizing access to affordable internet and digital devices for older adults remains a top priority for older Californians. COVID-19 opened a policy window around digital access, spurring multi-level government initiatives to improve disparities in digital access among older adults. Federal legislation in response to COVID-19 such as the Coronavirus Aid, Relief, and Economic Security Act and the American Rescue Plan Act of 2021 created new sources of technology funding (Advancing States Aging and Disabilities Technology Workgroup, 2020; Colello & Napili, 2023; Phillips, 2021; Shea & Tripp, 2021). This new funding, in addition to temporary pandemic-related Older Americans Act funding flexibilities, has enabled aging service providers to innovate and expand digital access services since 2020 (Colello & Napili, 2023; Gallo & Wilber, 2021).

More recently, the Biden-Harris Administration announced the allocation of $42.45 billion dollars in funding, "to deploy affordable, reliable high-speed Internet service to everyone in America" (The White House, Office of the Press Secretary, 2023). This initiative is part of the Broadband Equity, Access, and Deployment (BEAD) program under the new infrastructure law passed in 2021, and clearly states that once connectivity goals are met, "any remaining funding can be used to pursue eligible access-, adoption-, and equity-related uses" ("Broadband equity, access, and deployment (BEAD) program," n.d.). Key stakeholders, including State Units on Aging (SUAs), Area Agencies on Aging (AAAs), community organizations that serve older adults, businesses that provide digital devices and services, and older adults themselves can leverage this directive within the BEAD program to fund meaningful digital access initiatives in California and nationally.

Second, our findings illustrate the important role of local community-based aging service organizations in implementing federal digital access initiatives such as BEAD. These organizations are uniquely equipped to assist clients in navigating both primary barriers to initial digital device uptake and secondary barriers impeding continued usage. Community organizations are also uniquely well-positioned to build relationships at the local level with businesses and academic institutions to design creative programs that can assist their clients in bridging the digital divide (Mullins, 2022). These organizations can engage not just older adults but community stakeholders of all ages to inform the design and implementation of programs and services that address barriers to digital inclusion from a life course perspective. Accordingly, government agencies should allocate federal funding for digital device training and technical support locally to give AAAs and their contracted community organizations the ability to offer the individualized and sustained technology support programs and services that older adults need to thrive in an increasingly digital world.

Finally, our findings suggest that messaging to older adults, their families, and others whom older adults rely on for technical assistance should work to dispel the myth that older adults and digital devices are like oil and water, and also emphasize how digital devices facilitate intergenerational social connections. Several participants reported consistent and varied digital device use yet described themselves and others in their age group as lacking the ability to be tech-savvy. Messaging that challenges negative stereotypes about older adults and technology may help to change internalized perceptions that limit digital self-efficacy. Messaging that promotes the role of digital device adoption in fostering reciprocally supportive intergenerational relationships between older adults and younger family and community members may also appeal to older adults and caregivers. Simply the process of receiving digital device instruction from others, regardless of adoption outcome, can act as a catalyst for strengthening social ties (Francis et al., 2018; Tsai et al., 2017). Considering the often-detrimental health effects of social isolation and loneliness, digital access services that dually function as social support programming are multiply valuable.

Limitations

Due to COVID-19 safety measures, the research team had to conduct all interviews and focus groups remotely. This was a shift from preliminary plans for hybrid in-person and remote data collection. To accommodate participants' technological restrictions and communication preferences, we conducted several one-on-one phone calls and audio-only conference calls. While using the phone allowed us to research our desired sample, it required researchers to take a more active role as facilitators to maintain focus without visual cues. It also posed challenges to rapport building and precluded us from observing body language to assist in data interpretation. Additionally, it prevented us from speaking with older adults who used neither digital devices nor analog telephones. Although these format restrictions were imperfect, we aimed to meet the challenge, similarly to our participants, with adaptation and persistence.

Conclusion

Our goal in this study was to gain insight from older adults on how to support older adults who are hard-to-reach for economic, educational, or personal reasons in crossing the digital divide. Given that the greatest facilitator of digital device adoption was family and friends, people who live alone, or people who do not have easily accessible immediate or extended family, may be among the hardest to reach.

Older people are frequently stereotyped as being resistant to learning new things, especially when it comes to digital technologies. Our findings suggest however, that this is not an accurate appraisal. Most of our participants demonstrated a tenacious commitment to overcoming obstacles in order to achieve full digital participation and inclusion. However, their perspectives on digital device use and the barriers they faced in using digital devices were heterogeneous, with distinct differences in sub-themes between SFG and EFG participants. For example, lack of formal education, wasting time, and language barriers only came up in the SFGs, not in the EFGs, which indicates that future studies should explore how cultural and language factors influence in digital device adoption.

Our findings indicate that effective digital device instruction for older adults first crossing the digital divide is often, to a large extent, a bespoke endeavor. To promote sustained digital adoption, aging service providers should offer comprehensive training that is adaptive to individual levels of experience and expertise and is paced to the learner's abilities. As one EFG participant epitomized with this advice:

> *[A class] has to feel like, 'Okay, I've got all this information, now what do I do with it? Can I go into more individualized instruction?' If [someone] gets a little overwhelmed … how do you start to make it personal? It's [about] connecting it down to the person.*

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Digital Health Games for Older Adults: Development, Implementation, and Programmatic Implications of Health Game Use in Senior Centers

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Abstract

By 2030, an estimated 21.6% of the U.S. population will exceed 65 years old. Within this demographic, ongoing broad efforts are needed to address modifiable factors related to common chronic conditions of aging. Digital, or "serious," health games offer one innovative approach to reach and engage older adults, with documented positive impacts on physical, mental/cognitive, and social health. Informed by healthy aging theory and community-engaged, user-centered design methods, our multidisciplinary team has developed a prototype multicomponent educational exergame designed to educate about and promote healthy lifestyle behaviors (i.e., healthy eating, physical activity), stimulate cognitive functioning, engage movement, and promote social connection. Additionally, we included functional near infrared spectroscopy (fNIRS) in our pilot work to measure real time brain activation during gameplay. Our objectives are to: 1) describe the formative development and testing process of an example multi-component educational exergame, including multidisciplinary team science collaboration, application of aging theory, and use of community-engaged and user-centered approaches; and 2) present a pilot study examining implementation and multiple aspects of an innovative educational exergame, including usability, acceptability, preliminary impact, and cognitive function measurement using brain imaging technology (fNIRS) to measure changes in cognitive load during gameplay. The results provide initial support for acceptability, usability, and positive perceived impact, as well as the preliminary encouraging pre to post improvements in behavioral intention, content knowledge, and relative neural efficiency. This paper also explores the potential of implementing serious health games in senior centers as part of their regular programming.

***Keywords*:** exergame, health promotion, older adults, behavior, cognition

Juegos digitales de salud para adultos mayores: desarrollo, implementación e implicaciones programáticas del uso de juegos de salud en centros para personas mayores

Resumen

Para 2030, se estima que el 21,6 % de la población de EE. UU. superará los 65 años. Dentro de este grupo demográfico, se necesitan amplios esfuerzos continuos para abordar los factores modificables relacionados con las condiciones crónicas comunes del envejecimiento. Los juegos de salud digitales o "serios" ofrecen un enfoque innovador para llegar e involucrar a los adultos mayores, con impactos positivos documentados en la salud física, mental/cognitiva y social. Informado por la teoría del envejecimiento saludable y métodos de diseño centrados en el usuario y comprometidos con la comunidad, nuestro equipo multidisciplinario ha desarrollado un prototipo de juego educativo multicomponente diseñado para educar y promover comportamientos de estilo de vida saludable (es decir, alimentación saludable, actividad física), estimular el funcionamiento cognitivo, involucrar el movimiento y promover la conexión social. Además, incluimos espectroscopía de infrarrojo cercano funcional (fNIRS) en nuestro trabajo piloto para medir la activación cerebral en tiempo real durante el juego. Nuestros objetivos son: 1) describir el desarrollo formativo y el proceso de prueba de un ejemplo de exergame educativo de múltiples componentes, incluida la colaboración científica de equipos multidisciplinarios, la aplicación de la teoría del envejecimiento y el uso de enfoques centrados en el usuario y comprometidos con la comunidad; y 2) presentar un estudio piloto que examina la implementación y múltiples aspectos de un exergame educativo innovador, incluida la usabilidad, la aceptabilidad, el impacto preliminar y la medición de la función cognitiva utilizando tecnología de imágenes cerebrales (fNIRS) para medir los cambios en la carga cognitiva durante el juego. Los resultados brindan un apoyo inicial para la aceptabilidad, la usabilidad y el impacto positivo percibido, así como las mejoras preliminares alentadoras previas y posteriores en la intención de comportamiento, el conocimiento del contenido y la eficiencia neuronal relativa. Este documento también explora el potencial de implementar juegos de salud serios en centros para personas mayores como parte de su programación regular.

Palabras clave: exergame, promoción de la salud, adultos mayores, conducta, cognición

老年人数字健康游戏：老年中心的健康游戏开发、实施以及计划启示

摘要

到2030年，预计21.6%的美国人口将超过65岁。在这一人群中，需要持续的广泛举措来应对一系列与常见慢性衰老疾病相关的可改变因素。数字（或“重要的”）健康游戏提供了一种接触老年人并使其参与的创新方法，这种方法对身体、心理/认知以及社会健康产生了可证实的积极影响。基于健康老龄化理论和一系列关于社区参与、以用户为中心的设计方法，我们的多学科团队开发了一款原型多组件教育运动游戏，旨在教育和促进健康生活方式行为（即健康饮食、体育活动）、刺激认知功能、参与运动、以及促进社会联系。此外，我们还在试点研究中使用了功能性近红外光谱学(fNIRS)，以衡量游戏过程中的实时大脑激活情况。我们的目标是：1)描述示例多组件教育运动游戏的形成开发与测试过程，包括多学科团队的科学协作、老龄化理论的应用、以及关于社区参与和以用户为中心的方法的使用；2)提出一项试点研究，分析创新教育运动游戏的实施和多个方面，包括可用性、可接受性、初步影响、以及认知功能测量——使用大脑成像技术(fNIRS)测量游戏过程中认知负荷的变化。研究结果为可接受性、可用性以及积极的感知影响提供了初步支持，并为行为意图、内容知识和相对神经效率的前后改进提供了初步鼓励。本文还探究了一种可能性，即在老年中心实施重要的健康游戏，以作为其常规计划的一部分。

关键词：运动游戏，健康促进，老年人，行为，认知

Background

Recent estimates indicate that by 2050, 22% of the total global population—including the United States—will be people 60 years or older (World Health Organization [WHO], 2017; Administration on Aging [AOA], 2020). Many older adults manage one or more chronic conditions such as diabetes and cardiovascular disease, emphasizing the need for healthy lifestyle promotion (Kochanek et al., 2017). There are many evidence-based health promotion interventions in older adults targeting multiple behaviors, such as healthy eating and physical activity. National groups, such as the National Council on Aging (NCOA) and the Centers for Disease Control and Prevention (CDC), have recognized the importance of using evidence-based interventions to address multiple areas of healthy aging.

To that end, "serious health games" may offer an innovative tool to support healthy aging. Serious health games are defined as digital games that focus on impacting health (Adams, 2010), and have been used in a variety of ways to affect health, such as educating about health topics, promoting lifestyle change, supporting self-management of chronic diseases, and rehabilitation. Mounting evidence supports a positive impact across diverse populations (Li, Theng, & Foo, 2014; Sanchez et al., 2019; Staiano & Flynn, 2014; Zhang et al., 2022). In addition to potential health-related benefits, serious health games may have benefits based on their focus on fun, engagement, and social interaction (Li et al., 2018). Exergames, a specific type of health game, are designed to incorporate movement into gameplay. Exergames have been widely studied and research has shown the promising impacts of exergames in many health areas with diverse populations (Calafiore et al., 2021; Cugusi, Prosperini, & Mura; 2021; Street, Lacey, & Langdon, 2017; Wu et al., 2022). Exploring the use of serious health games in general and specifically exergames as a health promotion approach may pave the way for their consideration among evidence-based interventions incorporated into programs and policies that support healthy aging in older adults.

Serious Health Games in Older Adults

Multiple systematic reviews of serious health games and exergames have been published summarizing outcomes in older adults. Since the focus of our research is on independently living older adults, we will summarize relevant work on their impact with this population overall rather than in specific health issues or clinical populations. In general, research supports the efficacy of serious health games on different aspects of health. One early systematic review (Hall et al., 2012) (N = 13 studies) of use of digital video games in older adults concluded that such games showed positive impacts in physical (e.g., balance, mobility), mental (e.g., working memory, depression), and social outcomes. A recent systematic review (Xu et al., 2020) examined the use of video game interventions in older adults (N= 23 studies) and found a positive impact of such games on mental (e.g., executive functions, processing speed) and physical (e.g., balance, mobility, walking performance/gait parameters) health of older adults. The authors recommended the use of exergames, especially those with a cognitive component, to simultaneously affect physical and cognitive health. For example, one systematic review (N=18 RCTs) examined the impact of exergames on physical performance measures and found a positive impact of exergames on mobility and balance (Taylor et al., 2018). A recent meta-analysis (N=48 studies) examined the specific effect of exergame training on various aspects of physical functioning in healthy older adults (Hai et al., 2022). This meta-analysis found that exergame training demonstrated a small effect on overall physical functioning with differential impacts in specific areas (moderate benefits specifically in balance, lower body strength, aerobic endurance; small benefit in gait; negligible effects on upper body flexibility and lower body flexibility). Another recent meta-analysis focused on the use of the Nintendo Wii-Fit exergame (N= 10 studies) found positive improvement in functional, static, and dynamic balance in older adults but no significant impact on lower limb muscle strength (Liu et al., 2022). In sum, the research to date highlights the promising impact of serious health games, especially exergames, for older adults.

Cognition in Older Adults and Impact of Health Games

One area of health of particular concern in older adults is cognition. Cognition is the ability to coordinate thoughts and actions for completing a goal (Lennox-Smith et al., 2018). As individuals age, cognitive decline (trouble remembering, recalling, learning new things, concentrating, or making decisions) becomes more prevalent (CDC, 2019; Hegde & Ellajosyula, 2016) and often begins to worsen between the ages of 50 and 70 years (Xu et al., 2020). Due to the projected increase in the older adult population, there is high demand for programs and interventions aimed at decreasing the progression of cognitive decline. While memory can worsen with age, its severity can be offset by behavioral interventions targeting cognitive stimulation (Martin et al., 2011). Programs aimed at slowing cognitive decline among older adults have been previously implemented and have included components such as education, socialization, and physical activity in a variety of settings (Causse et al., 2017; Eggenberger et al., 2016; Fishburn et al., 2014). Exergames that incorporate these components and are used in combination with other approaches may add one innovative approach to our toolbox to help minimize cognitive decline.

Researchers performing systematic reviews have found that exergames provide improvement in cognitive and dual task function (Ogawa et al., 2016) in older adults and training with video games improved several cognitive functions (Toril et al., 2014). For example, Howes concluded that active computer games can significantly affect balance and cognition in older adults (Howes et al., 2017). In another study, Moreira et al. (2021) found that exergaming improved cognitive status in older adults similar to the effects associated with traditional exercise training. A recent review of cognition and exergames (Stojan & Voelcker-Rehage, 2019) found executive functions were most examined in these studies. However, only four studies included physiological measures of cortical activity such as using modalities such as EEG or functional near infrared spectroscopy to assess executive function levels. The extant literature also suggests exergames may improve cognitive functioning in older adults (LeRouge & Wickramasinghe, 2013; Stojan & Voelcker-Rehage, 2019), although the underlying neural mechanisms that may give rise to potential cognitive and motor benefits of exergames are not well understood (Yeung & Chan, 2021). Therefore, more research is needed to examine changes in neural activity that may demonstrate the impact of exergame use in older adults.

One emerging technology holds promise when studying physiological measures of cognitive function during movement activities. fNIRS is a non-invasive way to examine the allocation of cognitive resources and intervention efficacy by providing measures of brain oxygenation and hemodynamic change (a proxy for neural activity) occurring within the prefrontal cortex (Shewokis et al., 2015, Vassena et al., 2019). fNIRS can provide information about cognitive load changes, such as improvements in working memory, neural efficiency, and involvement (Mellecker et al., 2013). A benefit of fNIRS use is that it is relatively motion tolerant and can provide information about cognitive load changes (i.e., improvements in working memory and neural efficiency) when combined with behavioral performance data, such as game play scores (Shewokis et al., 2015; Stojan & Voelcker-Rehage, 2019). Previous research (Causse et al., 2017, Fishburn et al., 2014; Vassena et al., 2019) has shown strong agreement between executive function and average oxygenation measure changes.

Aging has been linked with higher reliance on cognitive resources (Mirelman et al., 2017), thereby further supporting the value of fNIRS measurement in our game research. Moreover, aging has been linked with a gradual increase in the activity of prefrontal cortex; and a comparison between age groups has shown that this compensatory mechanism may reach a resource ceiling effect beginning at 70-years-old, resulting in reduced executive function efficiency and subsequent motor impairments (Nóbrega-Sousa et al., 2020). Therefore, we believe including oxygenation measures from fNIRS, in combination with behavioral measures from game play, in our research paradigm will provide an innovative way to document changes in executive function. In addition, this current research may garner preliminary support to include in consideration of policy and procedures for implementation of exergaming protocols with independently living older adults.

In summary, the literature to date supports the positive impact of serious health game interventions and, specifically exergames, on important dimensions of healthy aging, especially including physical and mental/cognitive health. These serious health games, particularly exergames, show promise in impacting independently living older adults as a form of training for both physical health and cognitive function. Furthermore, there are few studies that examine the impact that serious health games and exergames may have on social health or social engagement. Inclusion of exergames to supplement health-related programs in sites where large numbers of independently living older adults (e.g., senior centers, community centers) congregate may offer one approach to support the overall effort to enhance healthy aging.

Objectives of Paper

As described in the background section, research indicates that positive outcomes of serious health games exist in multiple health areas important to successful aging (Hall et al., 2012, Kovisto & Malik, 2020). At the same time, Hall and colleagues (2012) have noted some limitations in game development for older adults. Furthermore, few studies of exergames have investigated theory-guided outcome domains, described specific development/tailoring for older adults, or included older adults in the development process (Koivisto & Malik, 2020, Lee et al., 2021). Finally, limited research has used fNIRS to measure prefrontal cortex changes that result from exergaming in older adults. We hope to address these knowledge gaps with our work. Therefore, the two aims of this paper are to: 1) describe the formative development and testing process of an example multi-component educational exergame, including multidisciplinary team science collaboration (Bennett & Gadlin, 2012), application of aging theory, and use of community-engaged and user-centered approaches (Brox et al., 2017; LeRouge & Wickramasinghe, 2013); and 2) present a pilot study examining implementation and evaluation of multiple aspects of an innovative educational exergame, including usability, acceptability, preliminary impact, and cognitive function measurement using brain imaging technology (fNIRS) to measure changes in cognitive load during gameplay; and conclude by discussing the programmatic and policy implications of the use of exergames in older adults attending senior centers.

Aim 1: Version Formative Development and Testing Process

Given the prior literature highlighting the emerging interest and potential impact of health games in older adults, our team's prior work developing, tailoring, and/or examining the impact of exergames or gamification in youth and older adults (Orsega-Smith et al., 2012; Orsega-Smith et al., 2020; Ruggiero et al., 2014; Ruggiero et al., 2020; Ruggiero, et al., 2023), we sought to expand this work in a variety of ways. Building on our prior work, we organized a multidisciplinary team, guided by Successful Aging theory (Rowe & Kahn, 1997) and user-centered approaches (Lee et al., 2021), and employed community-engaged methods (Brox et al., 2017; CDC, 2011) to develop and examine a new multi-component educational exergame.

Multidisciplinary Development and Research Team

Our team uses a multidisciplinary team science approach (Bennett and Gadlin, 2012) with collaborators from computer science, psychology/behavioral science, and kinesiology, along with specific expertise in aging and motor learning. The team also brings experience in the development and implementation of tailored technology-based health promotion interventions; community-engaged mixed-methods research; and embodied interactive games. The development work expanded upon team members' prior work with health game development (Ruggiero et al., 2020; Ruggiero et al., 2023), research in senior centers using commercial exergames (Orsega-Smith et al., 2012; Orsega-Smith et al., 2020), use of fNIRS in adults participating in cognitively stimulating computer-based tasks (Bakhshipour et al., 2020; Koiler et al., 2022; Liang et al., 2016; Milla et al., 2019), and designing embodied interactive systems and games using Microsoft Kinect for healthcare education and rehabilitation (Barmaki & Hughes, 2018a; Barmaki & Hughes, 2018b; Barmaki et al., 2019; Bork et al., 2017; Yu et al., 2018).

The game development phase leveraged our team member's prior experience with health games (Barmaki & Hughes, 2018; Barmaki et al., 2019; Orsega-Smith et al., 2012; Orsega-Smith et al., 2020; Ruggiero et al., 2020; Ruggiero et al., 2023; Yu et al., 2018) to develop an educational exergame targeting multiple areas emphasized in aging theory (see next section). Our prior game development/tailoring work with older adults was based on a review of limited literature at the time on game design for older adults (e.g., Gerling et al., 2012) that influenced the specific game design elements such as quiz-like game, points, and features such as font size, game pace, audio, team play option, easy instructions; simple game interface. Multidisciplinary researchers, students, and programmers worked together to iteratively design the game, develop the content, and conduct the formative examination of the game. The team regularly interacted with a programmer to discuss initial and ongoing design ideas and share feedback for ongoing iterative adaptation of the game.

Informed by Aging Theory

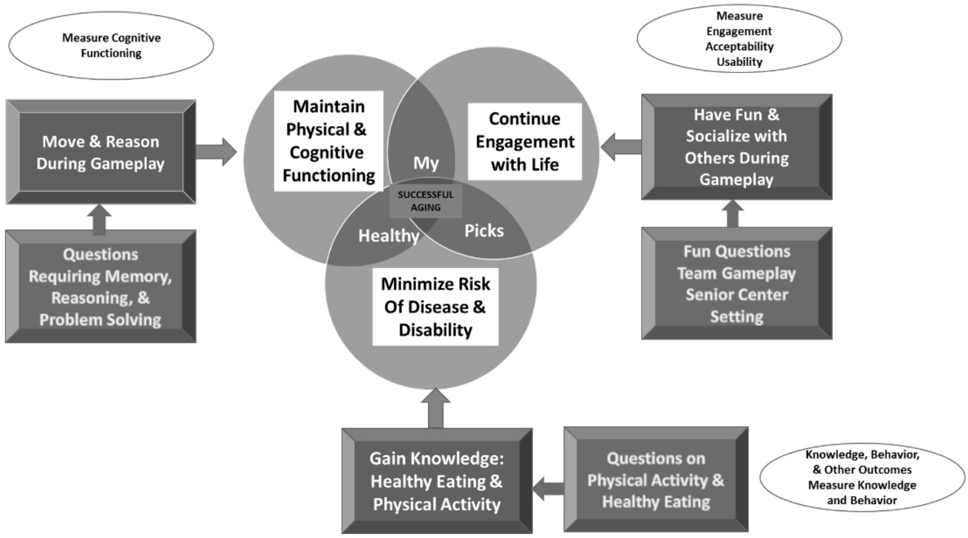

Figure 1. Successful aging theory informs game development, implementation and measurement.

Note: The circles represent the theory components, boxes represent game goals and game question types, and ovals describe measurement areas (Rowe and Kahn, 1997).

Our work is informed by Rowe and Kahn's (1997) mode of successful aging (see Figure 1) which posits that successful aging occurs at the intersection of engagement with life, avoidance of disease, and maintenance of cognitive and physical functioning. In the development of MHP, the overall goals for these three areas during gameplay were to encourage movement and stimulate cognitive reasoning; have fun and socialize; and gain knowledge to promote healthy lifestyles. In a paper highlighting Rowe and Kahn's framework, they mention that engagement with life includes being part of a social group or engaging in leisure activities with friends and family (Liffiton et al., 2012). In turn, this theoretical/conceptual framework informed the specific content, game features, and gameplay implementation approach, including physical activity and healthy eating educational content; cognitively challenging items; and questions with tailored difficulty levels, minigames, and other strategies for example team gameplay and scores designed to be fun/engaging. Our development work focused on using content and strategies to address each of these areas (See Table 1). For example, minimizing risk of disease and disability was addressed by including educational questions, educational messages, and mini-games related to healthy eating and physical activity. Maintaining physical and cognitive functioning was addressed by including cognitive challenge or educational questions, educational messages, mini-games, and through movement during gameplay. Continued engagement with life was addressed through inclusion of trivia questions and competition to make it fun and team gameplay to promote social engagement with others (Liffiton et al., 2012).

Table 1: Healthy Aging Goals/Topics, Game Methods, and Samples Used Across the Game

Healthy Aging Goal/Area	Method	Sample Items
Minimize Risk of Disease and Disability – Educate about lifestyle change		
Healthy eating	Educational questions	1)Vegetables are a good source of: (a) fiber, (b) vitamins, (c) minerals, (d) all of these choices 2)You should try to avoid food and drink containing too many: (a) minerals, (b) nutrients, (c) added sugars, (d) electrolytes
Healthy eating	Educational messages	MyPlate recommends that half the plate be made up of fruits and vegetables.
Healthy eating	Mini game	Virtually catch dropping fruits and vegetables while avoiding catching less healthy items
Physical activity	Educational questions	1)Physical activity can lower the risk of: (a) type 2 diabetes, (b) depression, (c) cancer, (d) all of these choices 2) What regular activity can help bone strength? (a) walking around the room several times, (b) reading a book while on a stationary bike, (c) lifting soup cans while watching television, (d) all of these choices
Physical activity	Educational messages	Getting at least 150 minutes a week of moderate-level activity, such as brisk walking, is recommended for older adults.
Physical activity	Mini game	Complete the swimming breaststroke with arms while virtually swimming
Maintain physical and cognitive functioning – Educate about and activate cognitive functioning		
Cognitive functioning	Cognitive challenge questions	1)Which does not belong? (a) team, (b) sport, (c) cat, (d) goal 2)A soccer game has 45-minute halves, how long is the full game? (a) 12 minutes, (b) 45 minutes, (c) 90 minutes, (d) 100 minutes

Cognitive functioning	Educational messages	Finding a new hobby, like learning a new instrument or language can keep your mind active!
Cognitive functioning	Mini games	Virtually move shapes that appear in the center of a circle to their matching shapes around the circle (See Figure 2 for picture)
Physical functioning	Movement during question responding gameplay	Stretching arms to virtually answer questions
Physical functioning	Movement during mini games	Stretching arms or incorporating other movements to complete mini-game activities
Maintain engagement with life – Promote fun, engagement, socialization		
Social connection	Team gameplay	Game implementation involved forming and playing in teams with encouragement to cheer on and support team members their gameplay
Engagement/fun	Competition	Scores for correct answers are provided for each round of gameplay. Game implementation involved tracking team scores across gameplays and teams were encouraged to compete for the highest score.
Fun	Trivia questions	1) Which famous band released the album "Abbey Road"? (a) the Beatles, (b) Aerosmith, (c) Oasis, (d) the Rolling Stones 2) Which city is known as the "City of Love"? (a) Paris, (b) Chicago, (c) Hong Kong, (d) Los Angeles

Note: This table is separated into the three components of the "Successful Aging Theory" (gray shading used for section headings).

Community-Engaged User-Centered Game Adaptation

User-centered design (UCD) principles, including literature review, surveys on user preferences for game questions/preferences; observing gameplay, focus groups, guided the development of the game prototype with feedback loops between design and implementation (Brox et al., 2017; LeRouge & Wickramasinghe, 2013). We used UCD for iteratively adapting the game (Lee et al., 2021) for independently living older adults and senior center implementation. End users' (older adults) needs, wants (for instance, movement/content difficulty levels), and suggested modifications were considered at each stage of the adaptation process (Baranowski et al., 2014). This method incorporated multiple prototype demonstrations with gameplay iterations. Our integrated community-engaged approach (CDC/ATSDR, 2011 involved gathering input from both senior center staff/leadership and its members. Overall, we obtained the following from our community members over the course of our formative work: input for game development/tailoring (e.g., instructions, question/movement difficulty levels; educational content) (Koivisto & Malik, 2020); general feedback on our overall research approach, especially including recruitment planning (e.g., strategies; anticipated barriers/solutions); and input on senior center implementation approach to support feasibility and enhance engagement/fun (e.g., gameplay approach: timing, frequency, team approach). These user-centered approaches will be more specifically described in the descriptions of the adaptation and examination of each game version.

"MyHealthy Picks" (MHP) Version 1 Description

MHP Version 1 used a Unity game engine (Unity Technologies, San Francisco, CA) and Kinect One sensor (Microsoft Corporation, Seattle, WA) allowing for a robust physical activity component. In this embodied interactive game, users' body movements and gestures are tracked by the Kinect sensor to control the game interface. Users' images are captured by the computer camera and projected, so users see themselves along with questions and response choices, on a large monitor in front of them. The game is played by virtually selecting question responses by stretching and hovering their hands over their answer choice (See photos in Figure 2) or engaging in various movements during the mini-game activities. Version 1 focused on the areas of avoidance of disease and disability and maintaining physical functioning

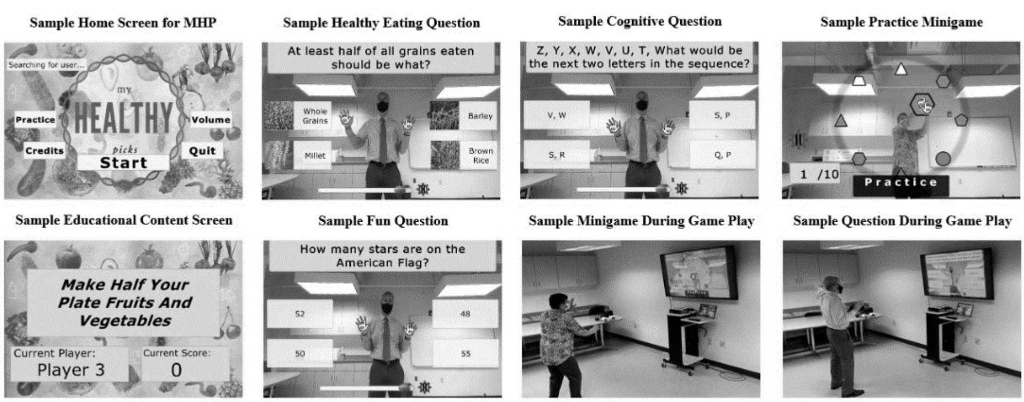

Figure 2. Version 2 game, including home screen, sample questions, educational message screen, cognitive mini-game, and gameplay.

based on healthy aging theory. Specifically, content included questions and educational messages in the areas of healthy eating and physical activity and activities were developed to promote movement (See Table 1 overview).

Version 1 Formative Testing

This pilot was designed to get preliminary feedback on acceptability and usability of the game from older adults. A convenience sample of older adults (N=14) was recruited from a senior center using flyers and word of mouth recruitment approaches. Interested individuals observed a game demonstration and played MyHealthy Picks Version 1 at a senior center. After gameplay, the 14 participants (13 females, 1 male) completed an anonymous survey that assessed aspects of acceptability and usability of the game. Participants ranged in age from 65–81 years (mean age = 73.07 years) and ten identified as white and four as African American/Black. All 14 participants also took part in a semi-structured focus group to gather qualitative feedback on the game. The structured focus group questions focused on the general game appearance and experience, what they liked about the game, background graphics, text size and color, and feedback on types of game questions (healthy eating, physical activity), planned (cognitive), or considered (trivia questions). In addition, recommendations were obtained for specific types of trivia questions to add, audio, feedback on educational messages, and general recommendations for how to make the game most appealing to older adults (e.g., Gerling et al., 2012).

The results generally indicated favorable feedback on the game with greater than 90% of participants agreeing or strongly agreeing that it had clear instructions (93%), appealing audio (92%), readable text (93%), was comfortable and enjoyable to play (93%), and they would play it again if asked to do so (93%). More than 80% of participants agreed or strongly agreed that the sound quality is appropriate (84.6%), they got excited to get the answers correct (86%), and the game increased their enthusiasm for learning more about healthy eating (84%). In addition, about 78.6% agreed or strongly agreed (21.4% neutral) that feedback related to their correct/incorrect responses was motivating, and 62% agreed or strongly agreed (15% neutral; 23% disagree/strongly disagree) that they were paying attention to their score. These survey results support the acceptability and usability of Version 1 of the game.

The focus group input was transcribed and then reviewed by two investigators to identify the main themes regarding game aspects participants liked or felt needed improvement. When asked about their overall game experience, there was a balance of positive (e.g., "it was fun"), negative (e.g., "hand tracking wasn't precise"), and neutral (e.g., "it wasn't too hard") comments. Participants provided positive feedback on multiple features, such as getting feedback on answers (e.g., "I liked when you got a correct answer and the confetti on the screen"), getting a score (e.g., "Getting a score was kind of neat"), and types of questions (e.g., "good variety"). The participants provided constructive feedback for further adaptation of instructions (e.g., more clear), adding more trivia question types (e.g., history, movies, sports), adding levels of content (e.g., easy, medium, hard), adding options for movement, improving the graphics and colors, and improving the hand tracker sensitivity.

Version 2 Game Adaptation

Based on the participant feedback and observations by our team, the following adaptations were made to create MyHealthy Picks Version 2: 1) improved color contrast and graphics overall; 2) added new categories of questions (i.e., cognitive stimulation activities, trivia) and developed additional questions in the areas of physical activity and healthy eating to create different levels of difficulty 3) refined the hand tracking for gameplay (i.e., Kinect sensor sensitivity); and 4) developed minigames to add other opportunities for movement. Cognitively stimulating questions to target areas of attention, perception, comprehension, executive control, and calculation were developed by our multidisciplinary team. It has been suggested that gamification of these types of cognitive training questions may be enjoyable for older adults (Lumsden et al., 2016). A variety of trivia questions, such as history, movies, and music, were added to the game based on senior center member input to make the game more fun and engaging. Content was expanded for physical activity and healthy eating and, in general, content was obtained from reliable information sources, such as USDA MyPlate.gov, National Institute on Aging, Dietary Guidelines for Americans, U.S. Department of Health and Human Services Physical Activity Guidelines for Americans, and the Centers for Disease Control and Prevention (CDC). Various levels of questions (easy and moderate) and use of a team gameplay implementation approach was added to encourage social engagement. This adaptation process also included regular meetings with the programmer to exchange ideas for adapting the game based on user input and researcher observations to work towards developing the next version.

Version 2 Formative Testing

Following initial development, the new educational, trivia, and cognitive questions were reviewed by a convenience sample of six older adults who were in the target age range of 65–85 years of age including senior center members and general population. Participants were given the new and expanded list of questions to review and were asked to provide feedback on perceived difficulty level, interest, and perceived relevance of the trivia questions. Based on the user feedback, the questions were refined and categorized by level of difficulty. This process led to the final set of questions incorporated into Version 2 to be tested in the formative pilot on this game version.

A new MyHealthy Picks Version 2 was demonstrated to and/or played by a small sample of members from a local senior center (N = 4; 3 females, 1 male). Over a 30-minute demonstration period, participants either directly played the game or observed others play the game. The gameplay was followed by a focus group (N = 4) in which additional feedback was garnered on overall impression of game, aspects liked, areas for improvement, anticipated use, and feedback on specific game features (for example, questions, mini-games, sensor use, movement). Two investigators independently reviewed the transcript for overall themes and suggested areas for game refinement. Most comments (about 20%) on overall impression of the game (i.e., "what did you think of MyHealthy Picks?"; "How would you describe the game in a few words?") were positive, such as "engaging," "encouraging," "fun," "informative," "colorful," and "fun and different…way of learning." Examples of aspects of the game they liked included "learning," "move your body," and "exercising your brain." General suggestions offered for enhancing the game focused on adding levels or more instructions/practice before gameplay, and using rewards. Feedback for improving specific game features focused on improvement in mini-game functioning. Responses to the questions of "would you play the game again?" and "would you recommend it to a friend?" were all positive.

Version 3 Game Adaptation

Based on feedback using game Version 2, the following adaptations were made to the game to develop MyHealthy Picks Version 3: 1) adding a practice round for participants; 2) providing instructions (text and audio) within the game to explain how to play; and 3) improving the functioning of the three minigames. For piloting purposes, this game version focused on inclusion of 20 easy questions in each of four categories: healthy eating, physical activity, cognition, and trivia; and three mini-games focused on the three healthy aging areas (See Table 1).

Aim 2: Implementation Pilot (Version 3) Participant Eligibility, Criteria, Recruitment, and Incentives

Participants were recruited from a senior center via distribution of study information in fliers, social media, informational sessions, and word of mouth. Interested senior center members signed up during an informational session at the local senior center. Inclusion criteria were age 65–95 years, community dwelling and independently living, and a member of our partner senior center. Participants were excluded if they had health conditions that precluded participation in physical activity and were non-English speaking. Prior to participation and guided by the consent form, interested/eligible individuals were fully informed of the study purpose, procedures, risks, and benefits, and given the opportunity to have their questions addressed; if interested, they completed the consent form for participation. Upon completion of participation, each participant received a ten-dollar gift certificate as an incentive. All procedures were approved by the University of Delaware's Institutional Review Board.

Procedure

Participants completed an informed consent process, completed a pre-questionnaire, had the fNIR sensor placed on their foreheads, played the game for 15 minutes as a pretest, and subsequently were assigned to a team. The team gameplay occurred in four sessions over a two-week period. Participants worked together in teams of two to three members to answer knowledge, trivia, and cognitive challenge questions and competed for the highest score across the teams. Following the four sessions of team game play, individuals completed a post-questionnaire and had a post session of individual gameplay for 15 minutes with the fNIRS measures being taken.

Questionnaires were conducted electronically on an IPAD using Qualtrics or on paper, as preferred by the participant. The pre-questionnaire collected demographics, health status, and stages of change/intention to change. The post-questionnaire included stages of change/intention to change, acceptability (e.g., satisfaction), and usability (e.g., perceived ease of use, usefulness of game).

Measures

Demographics

Questions assessed the following: gender, race, age, education, marital status, employment status, annual salary, living situation, and health conditions.

Behavioral stages of change

Adapted from Nigg and colleagues (1999) five stages of change questions, participant's intentions or engagement in a health behavior were assessed. Questions were used for the following behaviors: eating five or more fruits and vegetables per day, eating whole grains, avoiding high fat proteins, avoiding high fat dairy, avoiding sugary drinks, and engaging in 30 minutes of physical activity per day. Participants were asked to select one of the following statements related to intention or engagement in each behavior: No, and I do not intend to start in the next six months (i.e., precontemplation stage); No, but I intend to start sometime in the next six months (i.e., contemplation stage); No, but I intend to start in the next month (i.e., preparation stage); Yes, I have been but for less than 6 months (i.e., action stage); and Yes, I have been for 6 months or more (i.e., maintenance stage).

Usability

The System Usability Scale (SUS; Brooke, 1996) was adapted to focus specifically on health games. Example items include "I think that I would need technical support to be able to use this game," "I found the various features in this game were well integrated," and "I thought there was too much inconsistency/repetition in this game." The standard scoring approach was used to create the final usability score [range = 0-100; Brooke, 1996] and a benchmark of 68 was used for comparison (Hyzy et al., 2022).

Acceptability, Perceived Impact, and Anticipated Use

The researchers developed a survey to gather information on acceptability (content, game features, mini-games, team play), perceived impact, anticipated frequency of use, and recommendation to others (See Table 3 for survey items). In addition, one survey item addressed recommending the game to other adults. These questions used a four item Likert scale with response choices of "strongly disagree," "disagree," "agree," or "strongly agree." One additional item asked: "How often would you play the game if you could play it at home?" with response choices of "never," "less than once a week," "once a week," and "more than once a week."

Cognition

The Saint Louis University Mental Status Exam (SLUMS) was used to screen for detecting mild cognitive impairment (Tariq et al., 2006). It uses small cognition tasks such as recalling simple words, reciting numbers backwards, and answering verbatim questions after a small passage.

Pre and Post-test Content Knowledge

Ten questions each on healthy living, physical activity, and cognitive challenge assessed each of these areas. These questions were items included in the game during 15 minutes of gameplay as part of the pre and post-test during fNIRS data collection. Sample game questions included: "What are the benefits of physical activity?" and "What should half of your plate include?" This measure was scored by summing correct answers across the 30 items (range = 0-30) and creating a percentage correct (0-100%).

Brain Oxygenation and Relative Neural Efficiency

fNIRS was used to measure prefrontal neural correlates of cognitive aspects of the exergame. Our fNIRS system (fNIR Devices, Model 200s) requires participants to wear a headband-like sensor pad on the forehead and provides images of the surface of the brain (Figure 3). Placement of the fNIRS sensor band aligns the center of both the horizontal and vertical axes of the head with those of the band. This fNIRS system involves a series of four light sources and 10 light detectors. The light sources introduce near-infrared light introduced to the scalp, and the light detectors collect the light that travels through the brain and back to the surface. Part of the light will be absorbed by hemoglobin in the blood stream when it travels through the tissue. Based on the amount of absorbed light (the difference between emission and detection), the concentration of oxygen can then be calculated (oxyhemoglobin or Δ HbO). The greater the concentration of Δ HbO, the

Figure 3. In the top picture, the fNIRS sensor pad includes light sources (in orange) and detectors (in red). Infrared light is absorbed by hemoglobin in the blood screen. Oxygenation is calculated from the difference between emitted and detected light. The bottom picture shows a participant with the sensor pad placed on the forehead, where it will capture oxygenation of the prefrontal cortex.

more neural activity is occurring in that section of the brain. To examine changes in cognitive load that occur as a result of exergame practice, we calculated an estimate of relative neural efficiency (RNE), which is a measure that places brain oxygenation measures within the context of participant performance as a means to quantify the relationship between these two measures. In our case, a high scoring SLUMS performance coupled with low oxygenation values indicates high relative neural efficiency, whereas a low SLUMS performance with high oxygenation values indicates low relative neural efficiency (Koiler et al., 2022; Paas et al., 2003; Paas et al., 2005). This allows us to interpret changes in brain oxygenation within the context of changes in exergame performance following the principles of Cognitive Load Theory (Sweller, 1988).

Results

Participant Descriptives

The participants in this study were independently living members of a local community center. There were thirteen total participants, all females and white with a mean age of 78.3 years of age (range 67–94 years). All participants were retired and had a high school education or greater with a majority living alone (69%). The three most common health conditions reported were arthritis, hypertension, and thyroid disorder.

Acceptability, Perceived Impact and Anticipated Use

Greater than 90% of participants responded either "agree" or "strongly agree" to all but one acceptability and perceived impact question. For one content acceptability item (i.e., educational content was easy to understand), 85% of participants responded with either "agree" or "strongly agree." All participants (100%) agreed or strongly agreed that they would recommend the game to other adults. Regarding anticipated frequency of use of the game at home, the majority (92%) indicated they would play the game again. These results indicate overall favorable acceptability and strong perceived impact of the game.

Table 3: Version 3 Pilot Survey Results

Content Area Question	Strongly Disagree		Disagree		Agree		Strongly Agree	
	n	%	*N*	%	*n*	%	*N*	%
Content Acceptability								
It was easy for me to understand the educational content.	2	15.38	0	0.00	7	53.87	4	30.77
I was satisfied with the healthy eating and physical activity educational questions.	1	7.69	0	0.00	9	69.23	3	23.08
I was satisfied with the trivia questions.	1	7.69	0	0.00	8	61.54	4	30.77
I was satisfied with the brain teaser and puzzle questions.	1	7.69	0	0.00	8	61.54	4	30.77
Game Features Acceptability								
It was easy for me to understand the instructions.	1	7.69	0	0.00	8	61.54	4	30.77
I was satisfied with the game audio.	1	7.69	0	0.00	6	46.15	6	46.15
I was satisfied with the graphics.	1	7.69	0	0.00	6	46.15	6	46.15
I was satisfied with the music.	0	0.00	0	0.00	9	69.23	4	30.77
I was satisfied with the pace of the game.	0	0.00	0	0.00	9	69.23	4	30.77

Mini-Game Acceptability								
I was satisfied with the shape matching activity.	0	0.00	0	0.00	9	75.00	3	25.00
I was satisfied with the activity where you catch fruits and vegetables.	0	0.00	0	0.00	7	77.78	2	22.22
I was satisfied with the swimming activity.	0	0.00	0	0.00	7	87.50	1	12.50
The shape matching activity was fun.	0	0.00	0	0.00	10	83.33	2	16.67
The activity where you catch fruits and vegetables was fun.	0	0.00	1	10.00	6	60.00	3	30.00
The swimming activity was fun.	0	0.00	0	0.00	6	66.67	3	33.33
Acceptability with Social Aspects of Game								
Playing the game with a team was fun.	0	0.00	0	0.00	5	38.46	8	61.54
I found it enjoyable playing the game	1	7.69	0	0.00	9	69.23	3	23.08
I enjoyed the social part of the playing the game.	1	7.69	0	0.00	7	53.85	5	38.46
Perceived Impact of Game								
The game was helpful in improving my physical activity knowledge.	0	0.00	0	0.00	11	84.62	3	15.38
The game was helpful in increasing my motivation to do physical activity.	0	0.00	1	7.69	9	69.23	3	23.08
The game was helpful in improving my knowledge of a healthy diet.	0	0.00	0	0.00	11	84.62	2	15.38
The game was helpful in increasing my motivation to eat a healthy diet.	0	0.00	0	0.00	11	84.62	2	15.38
Recommend Game								
I would recommend this game to other adults.	0	0.00	0	0.00	8	61.54	5	38.46
Frequency of Gameplay								
If you could play this game at home, how often would you play it?	1	7.69	3	23.08	4	30.77	5	38.46

System Usability Survey

The average SUS score was 77.5 (out of 100; sample range = 45-100; SD = 15.94). Since the benchmark for satisfactory usability is 68 (Hyzy et al., 2022), this suggests usability of this health game with older adults is promising.

Stage of Behavior Change

There was little or no change in stage of change for grain intake, fruit and vegetable consumption, and avoiding sugar sweetened beverages. For avoiding high fat protein intake at baseline, five individuals were in pre-contemplation/contemplation stages and after two weeks of gameplay, three of those individuals moved into the action stage. Similarly, for avoiding high fat dairy intake there were six individuals in pre-contemplation/contemplation stages at baseline and after two weeks of gameplay, four of those individuals moved into the action stage. Additionally, there was no reported movement in intention to get 30 minutes of physical activity per day.

Knowledge

Following two weeks of MyHealthy Picks game play, individual participant overall knowledge scores significantly changed from pre to post-test ($t=2.8$, $p= .008$; $n= 13$). The overall number of correct answers was converted to a percentage correct (i.e., 27/30 is 90%). At pre-test individuals on average scored 81.6 (SD=15.4) and post-test was 91.8 (SD=6.9). Looking at the individual scores, 85% of participants had increases in their knowledge scores, one (8%) stayed at the same level (at 100%) and one (8%) participant's score slightly decreased. In terms of specific components, examination of pre-post physical activity knowledge approached significance ($t=1.6$, $p= 0.07$). Examination of healthy eating questions revealed a significant difference ($t=2.67$, $p=.013$) in knowledge of healthy eating between pre-test (67.04, SD=31.99) and post-test (88.89, SD=10.99). In summary, participants showed improvements in their knowledge of healthy eating and physical activity from pre-test to post-test.

Relative Neural Efficiency

We were able to collect fNIRS data from all participants during pre- and post-tests; because data reduction and analysis are complex, time consuming, and ongoing, we are reporting the results from the first participant for whom we were able to process both tests (Figure 4). The results suggest improvement in estimated RNE from pre-test to post-test for one participant. During the pretest, the participant expended a significant amount of cognitive effort during the exergame while performing relatively poorly (i.e., obtaining a low score) when answering the MHP questions during exergaming. After two weeks of practice (4 gameplays), this participant improved in RNE; that is, the participant answered more questions correctly using fewer neural resources. The participant moves from the low efficiency quadrant (high effort/low score) to the high efficiency quadrant (low effort, high score) after 2 weeks of practice (4 sessions). This pattern of change from low to high RNE is often associated with learning (Shewokis et al., 2015; Shewokis et al., 2017). While the results only represent one participant, they do indicate that, for at least this participant, the two-week educational exergame training appeared to enhance learning on the performance task. These results show promise that practice with the exergame may help to reduce cognitive load over time and underscore the importance of further research incorporating fNIRS measurement in health game research with older adults.

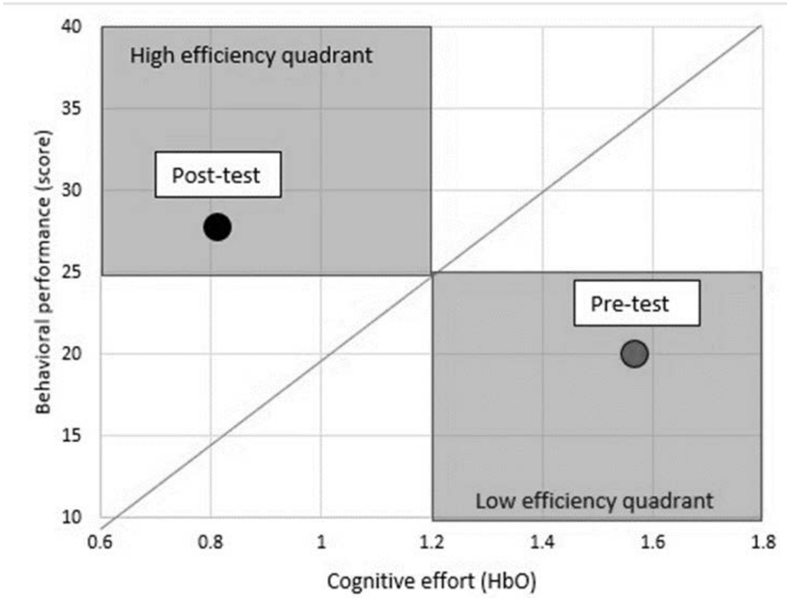

Figure 4. Changes from pre-test to post-test in an estimate of relative neural efficiency for one participant.

Discussion

This paper described the development process of an example multicomponent educational exergame, including multidisciplinary team science collaboration, application of aging theory, and use of community-engaged and user-centered approaches. Additionally, we presented our ongoing formative pilot work examining implementation and multiple aspects of an innovative educational exergame, including usability, acceptability, preliminary impact; and measurement of cognitive function. In this discussion section, we will discuss the programmatic implications of the use of this example exergame and health games in general within health promotion programs/activities for older adults attending senior centers.

Summary of Game Development Process

We highlighted our multidisciplinary team science approach and iterative user-centered, community engaged approach in the development of a multicomponent educational exergame for older adults. The development of the game was informed by focus groups and iterative input from older adults in senior centers, along with senior center staff. Game development and implementation was conducted in the context of regular interactions with our multidisciplinary research and development team (including programmers) to share ideas and determine needed or desired adaptations. The game iterations evolved to include additional features to promote enhanced engagement, support cognitive functioning, and facilitate socialization among participants. The development of the game benefitted from the diverse perspectives and experiences of the team and the formative input from the older adults attending senior centers.

Summary of Formative Research

Iterative formative pilot studies were described focusing on different versions of the game. The results of the formative implementation pilot studies suggest that participants found the innovative educational exergame, MyHealthy Picks, to be acceptable on multiple levels, including the content, game features, mini-games, and social aspects of gameplay. The qualitative input helped to confirm the game aspects that were liked by participants, such as physical activity and healthy eating content; and areas that needed continued adaptation and refinement, such as instructions for gameplay. Following the 2-week implementation of the pilot game, senior center members indicated that they felt the game would have an impact on their knowledge and motivation related to healthy eating and physical activity. Participants also demonstrated pre-post improvements in their knowledge related to healthy eating and physical activity and with performance in cognitive challenges. Preliminary behavioral data suggested positive movement in their stages of change for avoidance of high-fat protein and avoidance of high-fat dairy intake. Further, the cognitive load results, while limited to a single case example, suggests that practice with the exergame may improve relative neural efficiency and reduce cognitive load in as little as two weeks (four gameplay sessions). The findings of our formative work on MyHealthy Picks are promising and align with the overall literature demonstrating the positive impact of health games along multiple dimensions of healthy aging in older adults. This exergame, and other such serious health games for older adults, should continue to be examined in large-scale studies to investigate effectiveness in diverse populations and settings. Future studies are also needed to further explore fNIRS assessment within game implementation. Larger scale implementation studies are planned and, if effective, this game may provide another in innovative tool to incorporate into senior center programming to be used in combination with other evidence-based health promotion programming to support healthy aging.

Program and Policy Implications

The literature on the positive impact of health games in various populations, specifically with older adults, supports their potential value. The accumulating literature, including reviews and meta-analyses suggests that such games should be taken seriously as a potential tool to support healthy aging (Hai et al., 2022; Stojan & Voelcker-Rehage, 2019; Xu et al., 2020).

Serious health games have multiple benefits as potential strategies to complement and combine with other health promotion programing. For example, they can be easily implemented in a variety of settings for independently living older adults, including in their homes and community centers where groups gather.

Senior centers represent one community setting that is generally accessible to a large portion of older adults and are influenced by policy and programmatic approaches to provide educational, nutritional, and food services for assisting older adults independent living (Schneider et al., 2014). The literature supports the notion that social engagement is a common reason for attending a senior center (Chang-Gusko et al.,2022; Pardasani & Thompson, 2012; Taylor-Harris & Zhan, 2011) as is participating in health and wellness related classes, such as health education, exercise classes, cognitive strengthening-related classes (Pardasani, 2019). A recent review of senior centers in Canada and in the United States (Kadowaki & Mahmood, 2018) note that a key focus on programming is health and wellness, with the most common reported programs related to nutrition, exercise, and blood pressure monitoring. Incorporating educational exergames in senior centers in combination with other evidence- based health promotion programs have the potential to enhance engagement and impact multiple aspects of healthy aging. Furthermore, these games may also promote social interaction while participating in fun, educational activities. Our findings provide preliminary support for acceptability, feasibility, and usability of MyHealthy Picks for potential use in a senior center setting.

As evidence is accumulated for the potential positive impact of health games, in general, on older adults, these games could be considered by organizations that evaluate and promote evidence-based senior center programs/ interventions as an additional potential approach that may support healthy aging. The establishment of a substantial body of evidence on the positive impact could help inform policy relating to the use of exergames as part of the calculations used to determine state funding for senior centers. In the state of Delaware, exergames may fall under one of the program areas (physical fitness) used to assess service levels among the state's Grant- in-Aid eligible senior centers. Service and participation level information, in addition to demographic and geographic analyses, is used to determine public funding appropriations for these centers (https://www.bidenschool.udel.edu/ipa/content-sub-site/

Pages/Senior-Center-Grant-in-Aid-Funding-Formula-Program.aspx). This idea of federal funding and policies for health promoting activities may be further explored under the Title III-B Older American Act Funding (National Council on Aging, 2022b). This policy suggests that senior centers may be funded based on programs that promote aging in place which includes health promotion type programs.

Some senior centers already utilize some form of exergame, such as Nintendo Wii bowling, as a form of regular activity programming. Agencies that oversee senior centers could consider a policy to set aside time/space at centers to allow members to participate in exergames. For example, in the state of Delaware, there are over 100 senior centers with members who independently play Wii bowling on teams. They have established a league where senior center members compete against each other virtually and weekly submit their scores. This then serves as a way for individuals to interact socially as a team, be physically active, and have some fun competition on a regular basis. This is one specific example of how a region has successfully incorporated the use of an exergame in a population of older adults attending senior or community centers. The regular use of these exergames has continued and been sustained for ten years in this region and suggests that this type of exergame use can be easily implemented and sustained in community /senior centers.

Lessons learned through our pilot work on MyHealthy Picks provides guidance for programmatic senior center health game implementation. Senior center member interviews and focus group, and staff feedback suggest it is important to consider participant comfort (e.g., sitting/standing; difficulty level) in gameplay, involve a trained facilitator to provide a brief demonstration and instructions prior to game play, encourage social interaction through team play, and incorporate incentives for participating in the game play. Additionally, participants suggested that this game could incorporate opportunities for intergenerational game play by encouraging interaction between grandparents and grandchildren. Intergenerational exergame play may promote social engagement and education about health promotion, while being physically active.

Conclusion

Implementation of exergames, in general, and MyHealthy Picks as an example, may represent an innovative approach to engage, educate, facilitate socialization, and impact healthy aging in older adults attending senior centers or community centers. Accumulating evidence found in systematic reviews and meta-analyses, as well as our preliminary findings, support the impact of health games and underscore the importance of considering such evidence-based approaches, especially in combination with other health-promotion programs, for use in senior centers. Furthermore, the initial fNIRS research suggests that playing these types of exergames with an educational component may enhance learning on a performance task as indicated with brain activation. These initial results suggest the need for future studies of health game implementation incorporating fNIRS assessment to further understand the mechanisms by which cognitive load may be reduced. Larger scale implementation studies are planned and if effective, this game may be added as another innovative complementary educational option to healthy aging programming to consider for older adults at senior or community centers.

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Negotiating Technological Engagement: Use and Non-Use Among Older Adults in Assisted Living

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Abstract

Recent research on digital inequalities has shown that some individuals, including older adults, display careful consideration when deciding to use or not use technology. The purpose of this study is to explore the relationship between aging and technology use by examining not only the types of technologies used by older adults, but also how they make decisions about that use. Using semi-structured interviews and observations of staff members, residents, and family members of residents at a privately owned, for-profit assisted living facility in the northeast U.S., this research offers essential insights into the relationship between older adults and technology, along with the implications of that relationship on policy recommendations surrounding technology use. First, consistent with recent trends in research, the findings of this study reveal how technology use among older adults involves a complex decision-making process. Specifically, they navigate use and non-use by considering their skills and needs, while also managing their limitations and fears of technology. They also employ advanced mechanisms to compensate for the missed opportunities of non-use. Treating use as a negotiated process urges policymakers and practitioners to prioritize older adults' agency when considering the implementation of technological policy and intervention. Second, I propose an Interaction Approach of Technology Use as a more nuanced way to understand older adults' technology use as it relates to the degree of independence or dependence that occurs during that use. An interactive approach allows researchers and policymakers to consider a wider range of use when examining the relationship between older adults and technology.

Keywords: digital inequalities, aging, narrative gerontology, Interaction Approach

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Negociar compromiso tecnológico: uso y no uso entre adultos mayores en vida asistida

Resumen

Investigaciones recientes sobre las desigualdades digitales han demostrado que algunas personas, incluidos los adultos mayores, muestran una consideración cuidadosa cuando deciden usar o no la tecnología. El propósito de este estudio es explorar la relación entre el envejecimiento y el uso de la tecnología al examinar no solo los tipos de tecnologías que usan los adultos mayores, sino también cómo toman decisiones sobre ese uso. Mediante el uso de entrevistas semiestructuradas y observaciones de miembros del personal, residentes y familiares de residentes en un centro de vivienda asistida de propiedad privada con fines de lucro en el noreste de los EE. UU., esta investigación ofrece información esencial sobre la relación entre los adultos mayores y la tecnología, junto con las implicaciones de esa relación en las recomendaciones de políticas relacionadas con el uso de la tecnología. Primero, de acuerdo con las tendencias recientes en la investigación, los hallazgos de este estudio revelan cómo el uso de la tecnología entre los adultos mayores implica un proceso complejo de toma de decisiones. Específicamente, navegan por el uso y el no uso al considerar sus habilidades y necesidades, al mismo tiempo que manejan sus limitaciones y temores de la tecnología. También emplean mecanismos avanzados para compensar las oportunidades perdidas por la falta de uso. Tratar el uso como un proceso negociado insta a los encargados de formular políticas y a los profesionales a priorizar la agencia de los adultos mayores al considerar la implementación de políticas e intervenciones tecnológicas. En segundo lugar, propongo un enfoque de interacción del uso de la tecnología como una forma más matizada de comprender el uso de la tecnología por parte de los adultos mayores en relación con el grado de independencia o dependencia que se produce durante ese uso. Un enfoque interactivo permite a los investigadores y legisladores considerar una gama más amplia de usos al examinar la relación entre los adultos mayores y la tecnología.

Palabras clave: desigualdades digitales, envejecimiento, gerontología narrativa, Enfoque de Interacción

技术参与协商：老年人对辅助生活技术的使用和不使用

摘要

关于数字不平等的近期研究表明，包括老年人在内的一些人在决定使用或不使用技术时表现出谨慎的考虑。通过分析老年人使用的技术类型以及他们如何作出技术使用的决定，本研究旨在探究老龄化与技术使用之间的关系。本研究通过对美国东北部一家私营营利性辅助生活设施的工作人员、居民、以及居民家庭成员进行半结构化访谈和观察，提供了关于老年人与技术之间的关系的重要见解，以及这种关系对有关技术使用的政策建议的启示。首先，与近期研究趋势一致的是，本研究的结果揭示了老年人的技术使用如何涉及复杂的决策过程。具体而言，老年人通过考虑自己的技能和需求来决定使用和不使用技术，同时还会管理自己对技术的限制和恐惧。他们还采用高级的机制来弥补因不使用技术而错失的机会。将技术使用视为一个协商过程，能敦促决策者和从业者在考虑实施技术政策和干预时将重点聚焦于老年人的能力。其次，我提出一种技术使用互动方法，以更细微地理解老年人的技术使用，因为这与技术使用过程中出现的独立程度或依赖程度有关。交互式方法使研究人员和决策者在研究老年人与技术之间的关系时能考虑更广泛的技术使用。

关键词：数字不平等，老龄化，叙事老年学，互动方法

In our current information society, having access to and making use of digital resources is frequently used as an indicator of one's place in that society. Those who have been "left behind" in the digital age, particularly older adults, are seen as missing out and in need of intervention. However, this well-intentioned approach to understanding technology use by older adults often ignores how engagement in the technological landscape of modern society involves *choice*. Using or not using certain technologies, applications, hardware, software, etc., requires all types of users to undergo a complex decision-making process—one that is based on a variety of motivating factors as well as the social context in which those decisions are made. The purpose of this paper is to explore the relationship between aging and technology by (a) examining how older adults in assisted living navigate that decision-making process, and (b) utilizing an Interaction Approach to better understand the impact of social interaction on technology use.

Digital Inequalities and Narrative Gerontology

As the modern world entered the Information Technology Revolution in the second half of the twentieth century, the social inequalities experienced in industrial society not only permeated post-industrial, information society, but were also amplified by it (Castells, 1997; Quan-Haase, 2016). This new form of inequality, dubbed the Digital Divide, highlighted the gap between the *haves* and the *have nots* of digital technology. While the earliest conceptions of the Digital Divide focused on rates of access to technology, specifically, penetration rates for cable TV and then eventually high-speed Internet access, more recent research has focused on the usage that occurs after access has been gained. This distinction is crucial because it has shown that there is also a discrepancy between those that have access to digital technology and those who are actually using it (DiMaggio et al., 2004). Additionally, technology use is highly dependent on users' possession of the skills necessary to efficiently utilize the technology available to them (Quan-Haase, 2016).

Of primary concern to the research in this paper is the relationship between aging and technological engagement. Prensky (2001) coined the terms *Digital Natives* and *Digital Immigrants* to distinguish the technological experiences between those that were born into and grew up in a digital society (Natives) and those that were required to assimilate into the digital culture later in life (Immigrants). While the terms were originally intended to address the growing gap between educators and their students who spoke a different "language" of learning, digital inequality researchers quickly identified their usefulness for better understanding the complex relationship between age and digital engagement.

Exploring the experiences of older adults as technology users requires not only an appreciation of the digital inequalities that they face, but also a deeper understanding of the unique methods through which they come to view themselves as technology users. To accomplish this, I utilize a framework of narrative gerontology, an interdisciplinary field of study centered on the idea that human beings are inherently storytellers and listeners (Kenyon & Randall, 1999) and that this storytelling is a life-long endeavor (Blix et al., 2015). Thus, researchers can make use of the personal narratives of older adults to investigate how they experience their own technology use, including the ways that they go about making decisions regarding that use and the impact those decisions have on their position within a digital society.

Defining Use and Non-Use

In digital inequalities research and policy, it is essential that we carefully conceptualize the terms *use* and *non-use* when discussing the factors and consequences of technological engagement. Traditionally, *non-use* has implied limited access to technology, and consequently, unintended and unwanted exclusion from digital society. Prior research has shown that digital exclusion can have damaging consequences, including increased social exclusion (Castells, 1996; Ragnedda & Muschert, 2013) and reduced access to health care, wealth, education, and community and political engagement (Bimber, 2001; DiMaggio et al., 2001). However, non-use does not always mean exclusion. Digital disengagement, especially among older adults, can also be an indicator of digital *choice* (Selwyn, 2006). From a framework of agency in individual choice, it is crucial that we examine the language that we use to describe digital disengagement.

Approaching use and non-use as a *choice* rather than a consequence requires that we expand our conceptions of what *use* and *non-use* can mean in research and policy. Prior usage of these concepts has been quick to draw a distinct line signifying where use ends and non-use begins; however, these lines tend to be rather arbitrary. I propose instead that we think of use and non-use as existing on a continuum and as highly dependent on a situational context. For example, an older adult may choose to own a cell phone one day, and the very next day, they may decide that their cell phone no longer has any use for them. Likewise, the next week they may then find themselves using a family member's smartphone to video chat with their grandchild across the country. Their use and non-use can fluctuate across moments, devices, and applications. Thus, in order to better understand use and non-use in older adults, it is more advantageous to approach *use* and *non-use* as decisions that individuals continuously make about the role that technology plays in their everyday lives.

Likewise, because technology use and non-use should be treated as situational and continuous, we must also move away from the practice of labeling older adults as *users* or *non-users* of technology, even when referring to specific devices or applications. Adhering to such a strict binary ignores any nuance in our understanding of how decisions are made about use and non-use, along with what those decisions reveal about an individual's relationship to technology. Even attempts to expand the user typology, such as Reisdorf and Groselj's (2017) examination of broad users, regular users, low users, non-users, and ex-users, is limiting because it does not fully consider how use can differ within an individual user over time. Thus, further research and policy will benefit from letting older adults not only define, but also explore, their own use and non-use.

Research on digital inequalities and technology use frequently focuses on information and communication technologies (ICTs). While there is no uniform definition for ICTs, it is typically understood as any and all technology that facilitates connection within a networked society. For this study, I use the term *ICTs* to refer to individual personal devices (computers, tablets, smartphones, etc.) and access to high-speed Internet, as well as *technology* as an all-encompassing term that includes ICTs, the software and applications that are run on those devices, and any additional electronic devices that are present in everyday life. Because *technology* is such a broad concept, each interview resulted in its own definition of the term, one that was largely driven by the participants themselves.

Background

Technology Use and Non-Use as Choice

While much of the early Digital Divides literature focused on examining the types of use and non-use, including benefits and consequence of use, more recent literature has shifted toward better understanding how and why all individuals, including older adults, make decisions about their technology use.

Some of the most commonly cited technology uses by older adults include interaction/communication purpose (Morris et al., 2007; Wagner et al., 2010), information seeking (Quan-Haase et al., 2016), and leisure/entertainment (Wagner et al., 2010). These stated uses demonstrate a clear pattern: for older adults to adopt new technologies, they must deem them worthwhile. Specifically, new technology needs to be both highly useful and usable to older adults for them to want to learn how to use it (Seals et al., 2008). *Usefulness* of technology may be determined by its ability to: help older adults "keep up with modern times" (Selwyn, 2004; Sourbati, 2009); support the services that they are already using (Seals et al., 2004); and, specific to older adults in non-independent living situations, overcome the spatial barriers that are inherent in assisted living facilities (Winstead et al., 2013).

Likewise, Fernández-Ardèvol et al. (2022) found that older adults make decisions about technology use based on the negotiation of different media ideologies, such as using technology in their own way, implying that the legitimacy of use is defined by the user themselves.

Similarly, technology non-use can also result from careful decision making. Commonly stated reasons for non-use include concerns over "wasting time" on technology and online safety issues (Richardson et al., 2005), and its tendency to interrupt other activities in the home and at work (Mitzner et al., 2010).

Even among those considered *users*, computers are beneficial to a point or for some purposes (such as maintaining social connections with family), but they are not universally useful (Weaver et al., 2010), especially when they do not enhance systems already in place (Sourbati, 2009). While research has shown measurable barriers for older adults who are interested in adopting new technology, studying non-use as a decision-making process requires a clear delineation between *barriers* and *choices*.

A significant level of older adult non-use stems from individual *choice,* specifically, a lack of interest (Morris et al., 2007; Selwyn et al., 2003; Wagner et al., 2010), and it is crucial that this approach drives any further research and policy on older adults' use and non-use of technology. As Quan-Haase et al. (2016) explain:

> [A]gency is central to our understanding of digital seniors' use of ICTs, they critically consider various technological options, and make choices around personal preferences, convenience, and affordability. For digital seniors, ICT use is not a binary, they want to have the flexibility to choose for themselves how to engage with ICTs. (pp. 701–2)

Technology Use as Interaction

While previous literature has shown that technology use and non-use do contain an element of choice, accessing and using technological devices and applications is still an interactive process, especially for older adults. Specifically, family members, friends, and healthcare workers play an important role in helping older adults gain access to and learn about various technologies.

Selwyn (2004) found that older adults most frequently acquire computers through informal methods (such as getting one from a family member) rather than through independent purchases. Researchers have also noted that ICT adoption by older adults is not always done willingly, which may include pressure from family members to "become digital" (Quan-Haase et al., 2016).

Beyond family and friends, community support workers have also been found to encourage ICT interest and use in older adults, specifically regarding accessing public and welfare services (Sourbati, 2009).

Additionally, once ICTs are adopted, older adults may also feel a reliance on family members to help them with further education and any technical support issues (Quan-Haase et al., 2016; Selwyn, 2004; Selwyn et al., 2003). While this support typically comes from more technologically savvy family members, such as children and grandchildren (Francis et al., 2018), digital assistance can also come from in-home partner support (Marler & Hargittai, 2022). Hänninen et al. (2021) found that older adults often benefit from having access to *warm experts* who can be "involved in the digital everyday life of older adults, ranging from small acts of motivation and giving practical advice to actual co-use and proxy use of ICTs" (p. 1596). Likewise, recent research from Bartol et al. (2022) has shown that older adults frequently engage in a practice of *use-by-proxy*, whereby others assist with or perform technological tasks for them. Alternatively, additional research has revealed that some older adults, specifically those in nursing homes or senior community centers, express interest in and benefit from more institutional (rather than social) sources of technological support (Tirado-Morueta et al., 2021).

Despite moving toward an understanding of choice and agency in use and non-use, interaction with technology cannot always be avoided. Individuals living in a technology society, including older adults, have very little control over everyday interactions with the technology use of others. Wagenknecht (2017) refers to this as *affected bystanding*, or "the condition of individuals who involuntarily experience the impact of others' use of technological systems while not relating to these systems as users themselves" (p. 2241). For older adults, especially those living in non-independent living situations, this can come in the form of electronic assistive technology (Davies et al., 2017), as well as surveillance technology (Mortenson et al., 2016).

From previous literature, we know that the relationship between aging and technology is more nuanced than a basic binary distinction between use and non-use. Specifically, older adults have the ability to make active choices about their technology use and non-use; however, we do not yet have a full understanding of how older adults make those decisions or how the decisions are embedded in a situational context. Additionally, there is limited research available on the technology use of older adults in non-independent living situations.

This paper challenges the notion that those who do not use certain technologies do so because they are excluded from accessing or using them. Instead, use and non-use exist within an intentional and complex decision-making process. Having a better understanding of the needs and choices of a certain population is a necessary precursor to implementing more targeted and useful interventions surrounding technology use and access.

Through semi-structured interviews and observations of residents, their family members, and the staff of an assisted living facility, this study explores two primary research questions:

1. How do older adults negotiate their technology use (i.e., how do they make decisions about use and non-use of devices and applications)?
2. How can researchers and policymakers reconceptualize the way that we understand and talk about use and non-use, specifically among older adults?

Methods

The data for this study were collected at a for-profit, non-independent assisted living facility in the northeast United States that offers assisted living and multiple levels of memory care. The study site (the "facility") is managed by a parent company, which owns numerous assisted living facilities throughout the U.S. Assisted living facilities are unique locations that, as research sites, offer multiple benefits to data collection and analysis. Conducting research within a single facility allowed me to examine the role that institutional constraints and opportunities play in the process of making decisions about technology use and non-use. By only sampling participants from one facility, I ensured that the data reflect a shared institutional context. All the resident participants had equal access to high-speed Internet, technology within the facility, community life activities, and interaction with facility associates.

The participants for this study were sampled through a purposive sampling technique, which utilized the expertise and knowledge of a primary contact person at the facility, in order to carefully select individuals that could provide the most information-rich interviews. My contact, an executive associate employed by the facility who works in Community Life, had specific insight into which residents were cognitively able to participate in a lengthy interview about their lives and technology use. She also helped me identify associates at the facility that would be best to interview, and she assisted with scheduling times for each of them to meet with me. Associates were selected to produce a diverse sample regarding duties and roles within the assisted living facility, with a particular focus on those that had significant levels of interaction with the residents.

Finally, family members of the residents were also recruited through my contact at the facility. I provided her with a recruitment script that she sent to the primary contact of each of the residents I interviewed. Family members were asked to contact me if they wished to participate in the study. My sampling for family members was limited to one family member per resident interviewed.

The final sample of this study is made up of 14 residents, 13 associates, and four family members of residents. The sample of residents consists of nine women and five men, ranging in age from 60 to 97 years old; however, most are in their 80s and 90s. All the residents in the sample are white, which closely aligns with the overall racial makeup of the residents at the facility. The sample of the 13 associates consists of ten women and three men and represents a variety of age and racial groups; however, the demographic characteristics of the associates were not thoroughly discussed in the interviews nor explored in the analysis of the data. The family member sample consists of three women and one man; however, the ages and races of the family members is mostly unknown as those factors were not discussed in their interviews. Three of the family members were children of the residents and one was a resident's niece.

This study was approved by the Research Office at the University of Delaware (IRB # 1144412-2).

Data Collection

Data for this study were collected primarily through interviews with residents, family members, and associates in the assisted living facility. When possible, the findings from the interviews were supplemented by observations of these groups interacting with various technologies.

All the interviews were semi-structured and open-ended, and they were audio recorded with the permission of the participant. I also took handwritten notes during the interview to record observations of the participant and to mark important moments and themes in the interview.

The interviews with residents ranged from 18 minutes to 1 hour and 28 minutes, with an average of 45 minutes (*SD* = 24). They consisted of two main categories: (a) a life narrative, and (b) direct questions about technology use. The interviews began with the residents giving an overview of their lives; I initiated every resident interview with the same question: *Tell me about your life* (de Medeiros, 2014). During this stage of the interview, I occasionally asked follow-up questions for more details about a certain event or to prompt the resident to continue their narrative, but overall, it was an opportunity for residents to tell their own story in the way that wanted to (de Medeiros, 2014).

After they finished telling their life narrative, we engaged in a more direct question and answer style interview, in which we discussed the various types of technologies that they currently use or do not use (including how they use or do not use them). Often, these questions would lead to follow up questions regarding past use of technology, current relationships with friends and family, and general reflections about their lives.

The interviews with the associates ranged from 21 minutes to 1 hour and 39 minutes, with an average of 36 minutes (*SD* = 19). These interviews followed a slightly more consistent pattern than the resident interviews. All the associate interviews began with a narrative about their duties at the facility and their employment history. As with the resident interviews, this portion of the interview was largely guided by the participant and contained very few interruptions. The narratives were then followed by direct questions about the associates' use of technology at work and, finally, their observations about the residents' use of technology.

The family member interviews lasted between 20 minutes and 1 hour, with an average of 43 minutes (*SD* = 27), and they mainly covered topics related to the family member's perceptions of the resident's technology use.

In addition to the interviews, I also conducted four separate observations of community activities with the residents. Each activity session lasted 30 minutes, and they allowed me to observe residents interacting with associates while they used or discussed technology. Two of the sessions consisted of an associate using a computer system specifically designed to engage older adults in computer use. The other two sessions were informational sessions where associates led discussions about technological advancements and usages.

Data Analysis

The audio recordings of the interviews from all three groups of participants were initially transcribed word-for-word, and then they underwent a second round of transcription that involved returning to the audio recording and adding additional codes and structure—such as utterances, pauses, and overlapping speech—to the original transcription. This re-transcription allowed me to capture certain aspects of the interviews that were not available in the word-for-word transcriptions, including notes about non-verbal behaviors that I took during the interview.

In addition to providing a framework for conducting narrative-based interviews, narrative gerontology also offers a framework for analyzing narrative data from both a structural approach, which involves thematic analyses of what and why things are said during interviews, and a performance-based approach, which focuses on how stories are told during the interview, i.e., the narrative practice (Bamberg, 2012).

Each interview underwent a primary thematic analysis, which identified top level themes across cases within a set of interviews, and a secondary thematic analysis, which identified subthemes within the data. In a narrative thematic approach, which is distinctly different from a thematic analysis conducted in a grounded theory approach, "narrative scholars keep a story 'intact' by theorizing from the case rather than from component themes (categories) across cases" (Reissman, 2008, p. 53). While grounded theory is useful for developing generalizable theory across many cases, pulling discrete pieces out of the larger narrative is less useful for understanding how the themes fit into the context of the larger story. Unlike grounded theory, which relies on thematic saturation during analysis, narrative thematic analysis is more concerned with capturing the full stories of every participant. Particularly with a narrative case study design, the depth of a narrative thematic analysis is limited to the available participants at the data collection site. Thus, the analytical themes that emerge in a narrative analysis are not meant to be generalizable across all cases (as is with grounded theory), but rather they are an in-depth examination of one case study (Reissman, 2008).

Results

The interviews with the residents, their family members, and the associates at the facility in this study revealed not only *what* technologies older adults do and do not use, but also *why* they do and do not use them, along with *how* they go about making those decisions. When considering technological engagement, older adults employ a complex decision-making process that includes reasons for use and non-use, as well as mechanisms for compensating for any perceived consequences of that non-use.

Additionally, when examined holistically, patterns of use and non-use in older adults reveal a nuanced way of conceptualizing technological engagement: an Interactive Approach of Technology Use, which considers the degree of independence or dependence that occurs during that use. This approach considers a specific social aspect of technology use: use, especially among older adults, is not always self-guided. Instead, older adults engage in various types of use that are often assisted or mediated by family members, friends, and healthcare staff.

Complex Decision Making

The older adults in this study reported a wide array of technology use, both in devices, including TVs, radios/music players, telephones (landlines, cell phones, and smartphones), and computers (desktops, laptops, and tablets), as well as applications. While technological devices are unique to each resident, there were stated reasons for using and not using certain technology that spanned across devices. These findings mirror previous literature on use and non-use among older adults.

The primary stated use of communication devices, such as phones and computers, was to stay in contact with family members. Participants also revealed why this communication is so important to them: for many older adults, members of their families, including children and grandchildren, live a great distance away from them, which can result in infrequent face-to-face interaction. Mediated communication devices such as phones and computers (via e-mail) can compensate for this distance and keep older adults connected to their families.

In addition to maintaining communication with family members, residents also frequently referred to the everyday usefulness of some technological devices. Residents expressed the importance of keeping up with the news/world events, whether through radio, TV, or computer. Additionally, the residents cited the usefulness of TV, radio, and tablets for accessing entertainment in the form of music, television shows, and movies. Consistent with previous research, for the older adults in this study, their decision to use a particular device most often came down to a simple question: is it useful to me?

Finally, when discussing the potential for learning about new technologies, a few of the residents took the approach that there is "no reason why I can't learn." Essentially, the use of new technology was framed as an opportunity to stay up to date with technological advancements and to continue to expand their cognitive capacities. While many residents took an opposing stance (i.e., if they have not learned the technology by now then there is no point in doing so), others expressed the idea that their potential use of a device may not necessarily serve an immediate purpose, but it would be interesting to use it.

A few themes also emerged when residents were explaining their reasons for non-use. With some of the more modern devices and uses (such as computers and email), residents stated that they just did not have the capability to learn or use new technology due to mental or physical limitations. While this is often cited in the literature as a reason that older adults avoid technology, only a few of my respondents explicitly discussed this as a reason.

A more common explanation for non-use, specifically non-use of computers, was simply that learning about new technology had not been a priority for them. One resident, 85-year-old Helen, framed the situation as such: "No. I never took the time to do that. I never had the time, frankly, and at this point in my life, I'm not going to worry about a computer." For many of the residents, learning to use a new technology, such as a computer or a smartphone, did not seem like a worthwhile use of their time. In that same vein, learning a new technology was occasionally framed as pointless at this stage of their lives: it served no real purpose. In fact, some residents viewed other activities as a more important use of their time.

Mechanisms of Compensation

While the previous section provides an overview of the stated reasons of use and non-use in older adults, it does not take into account the complexities of how older adults negotiate which technologies to use or not-use *in relation to other technology*. Technology use does not occur in a vacuum. Rather, the decision to use or not use a particular device or application may be highly dependent on decisions to use or not use additional technologies. The findings below highlight the role that such a relationship plays in making decisions about use and non-use.

The first method through which older adults negotiate technology use is by expressing suitable alternatives to devices that they do not use. For example, one resident, 87-year-old Albert, does occasionally watch TV, but he prefers the radio. When I asked him how often he watches TV, he responded, "Oh, not very often? Not very often. I like my radio. There's two radio stations here, and if I don't listen to one, I'm listening to the other." His low use of TV is not because of a dislike of TV, per se, but rather a preference for listening to the radio. However, another resident, 90-year-old Betty, prefers reading over listening to the radio. In response to a question about using a radio, she stated, "Not really. I ... even in the car I don't because I don't want to be distracted and the radio distracts me. And as you get older it doesn't take much to distract you, so I really don't listen to it. Usually I read instead." Additionally, some residents choose non-digital means of communication when available. Irene (85 years old) provided a suitable alternative to e-mail: handwritten letters, which she prefers; and Helen (85 years old) explained that she rarely uses her phone to communicate with her family because they often send her cards in the mail. On the other hand, Harold (98 years old) stated that his family never pressured him to use a computer for communication (via e-mail) because "They talk to me on the phone. I use the phone a lot. Yeah, the phone, it comes in handy for me."

When discussing their families, including grandkids and great grandkids, I asked the residents where those family members lived and how often they were able to see them. I would then probe whether they had ever received photos of family members through e-mail or text. Two of the residents, Helen (85 years old) and Phyllis (94 years old), expressed that having a way to receive digital photos was unnecessary because they were able to view photos of far-away family on the phones of those family members who did come to visit. For another two residents, Irene (85 years old) and Doris (96 years old), digital photos of family members were not needed because their family took the time to send them printed photos. In fact, one resident Irene (85 years old) had been gifted yearly calendars (made by another family member) that contained a collage of family photos from the year. She kept a collection of past calendars in the top drawer of her dresser.

While each resident had their own unique combination of uses and non-uses, this theme of *suitable alternatives* was a commonly employed mechanism of compensating for the non-use of certain technologies. This finding illustrates how residents constructed non-use not as a shortcoming but rather a natural result of the process of negotiating use and non-use. Some technologies simply do not warrant use when suitable, and often preferred, alternatives are available.

The relationship between one specific set of technologies, telephones, offers a unique illustration of the complexity of this negotiation process. All fourteen of the residents in my sample own and use some form of a telephone. However, they varied in the style of phone (landline, cell phone, or smartphone) and the extent of its use. During all the interviews, based on a resident's initial answer about phone usage, I was able to walk them through discussing the negotiation process. In our discussion, Betty (90 years old) wove a narrative of her relationship with all three types of telephones. She explained that she originally had a landline, but she bought a cell phone after she moved out of the house and into assisted living. When she moved in, she was offered a landline through the facility; however, she decided that she did not need one because she already had a cell phone. When I asked Betty about her cell phone use, she clarified that she only uses it to call and does not text, because calling is "just as easy": "No, I should learn how to do that [texting], but I never did. In fact, my son said, 'I'll show you. Call me and I'll tell you how to do it,' but I figure it's just as easy to call and just say what you have to say." And finally, Betty argued that she does not need a smartphone because she already has a computer that does what she would want to do on a smartphone: "No, it's just to make calls. I don't want to deal with the smartphone. Enough technology." While this is just one set of technologies with one resident, my conversation with Betty clearly shows a careful negotiation process over which communication technologies do and do not have a place in her everyday life.

Interaction Approach of Technology Use

In order to more fully understand how technology use manifests in everyday life, I propose an Interaction Approach of Technology Use (Table 1) as a new

Table 1. Interaction Approach of Technology Use

	Use	**Concept**	**Example**
(Independent)	Individualistic	Use is self-directed; no assistance or guidance is needed to use; devices are owned and maintained by the primary user	A resident owns a cell phone, which he uses to make phone calls to his children and grandchildren
	Assisted	Use is still self-directed, but is contingent on occasional or regular assistance or guidance; devices can be owned by the primary user or by a secondary user (such as an individual or an institution)	A resident owns a TV, but she sometimes requires assistance from her family to turn it on A resident uses the computers in the community computer lab in the assisted living facilities where he lives
	Mediated	Use is guided and directed by a secondary user; the primary user engages in a hands-off way as an observer in a one-on-one interaction	A resident asks an associate at the assisted living facility to look up a piece of information on the associate's personal cell phone
	Communal	Use is guided and directed by a secondary user; use is conducted in a community setting with the secondary user engaging with the technology on behalf of multiple primary users	An associate at an assisted living facility uses computer software and a monitor to lead residents in a game of trivia
(Dependent)	Embedded	Taken-for-granted use; technology is embedded in the institution; primary users have little choice in whether or not they become users	A resident has a special device on his wheelchair that alerts associates of the assisted living facility whenever he approaches one of the buildings external doors

way to conceptualize use as it relates to the degree of independence or dependence that occurs during that use. This approach is not a typology of users nor is it a way of classifying technological devices or the activities done on or with those devices. Rather, the Interaction Approach is a continuum that can be used to situate singular moments of technology use based on how interactive that use is from the viewpoint of the original user.

On one end of the scale lies *individualistic* use, the most independent of the uses. Individualistic use of technology exists when the user owns and regularly operates a device (or conducts an activity on a device) without needing assistance. This type of use is traditionally what comes to mind when we talk about technology use.

Most older adults are now presumed to have some degree of individualistic technology use. However, the complexity of the Interaction Approach is that in one moment, use of a device can be highly individualistic, and in the next moment, that use can slide along the scale to a more dependent form of use.

Moving away from an entirely independent form of technology use toward more dependent use results in a situation where the user is still primarily in control of the use, but they require regular guidance or assistance. This type of *assisted* use can take two forms depending on the owner of the device: (a) the primary user (here: an older adult/resident) owns the device, but they need assistance to use it, or (b) The institution where the primary user resides (here: an assisted living facility) owns and maintains the device, but the resident is still the primary user.

This first form of *assisted* use, where the primary user owns the device but still requires assistance, is a commonly occurring type of use at the facility. All the devices that can be used in an individualistic way, such as TVs, phones, radios, and computers, can just as quickly require assistance. In the interviews with the associates at the facility, this was frequently discussed as "informal tech support." In addition to the associates, residents also reach out to their own family members for help with some devices, and family members may also try to encourage certain types of use.

In addition to acting as "tech support" for their family members, both the resident interviews and the family interviews revealed that older adults frequently acquire their technology because their adult children buy it for them. While this gifting of technology can result in a more independent use, there is an aspect of *assisted* use as well. As adult children are giving new devices to their parents, they are also typically setting up those devices and teaching them how to use the technology.

The second form of *assisted* use occurs when the device is not owned or maintained by the primary user. At the facility in this study, this form of *assisted* use occurs most frequently with the call bell/button, which is a pendant that is worn (as a necklace or as a bracelet) by every resident in the assisted living side of the building. The device is provided by the facility, but residents can press the button to request assistance from an associate. Another set of devices that function under this form of *assisted* use are the computers in the community computer lab. Although they are provided and maintained by the facility, these computers can be used by the residents with or without additional assistance.

Moving even further along the scale to a more dependent use, older adults can also engage in *mediated* use, or use that depends solely on the technology use of another person. In this type of use, older adults do not own or maintain the devices, and they are not the primary operators. Rather, they are, in simplest terms, observing technology being operated by someone else. However, this does not discount them as users of that technology when the operation of the technology is being done for their benefit.

Take for example the use of phones by the associates at the facility. During the workday, they are asked to not use their personal phones around the residents, *unless that use is for the benefit of the resident*. Associates reported that they frequently use their smartphones to connect with the residents by looking up information, playing music, and showing them photos of their own families. In this scenario, the associates remain the operators of the devices while the residents take a hands-off, observational role. However, both the associate and the resident are actively engaged with the smartphone and the content on the screen. In those moments, while the associates are engaging in *individualistic* use (albeit with an audience), residents are engaging in *mediated* use.

In addition to the associates using their own personal devices, they also reported seeing residents' family members bringing in devices to share with the residents. As opposed to *assisted* use, where family members are encouraging and helping residents to use technology, with *mediated* use, family members are using their own smartphones or tablets to share information with the residents. This type of use was most apparent during my observations of residents and in my interviews with the associates. However, because many of the residents in my interview sample had their own devices, such as cell phones and computers, which encouraged more *individualistic* and *assisted* use, they did not often discuss this type of *mediated* use.

According to the associates, residents typically seemed satisfied with just observing someone else using a smartphone rather than trying to use the device themselves. This behavior falls squarely within *mediated* use; however, if the residents were to attempt to use the device that is being shown to them, that use would slide toward a more independent use such as *assisted* use.

The type of interaction inherent in *mediated* use was also reinforced during my interviews with the residents' family members. When I asked 85-year-old resident Helen if her family ever brought their devices to show her things, she confirmed that they did. When I then interviewed Helen's daughter Gail, she reconfirmed that both *mediated* and *assisted* use were common within their interactions. Specifically, because her mother was losing her hearing, it made it difficult for her to talk on the phone. Thus, Gail's frequent in-person visits often resulted in her facilitating communication between her mother and her siblings through assisting and mediating her mother's phone use.

Gail and Helen's situation perfectly illustrates the fluidity of technology use. By placing use on a scale, we allow a behavior, such as an older adult trying (but not necessarily succeeding) to physically interact with someone else's phone, to oscillate between *assisted* use and *mediated* use. If Helen had been able to successfully navigate her daughter's smartphone when it was handed to her, that would reflect a more assisted style of use. However, because Helen was ultimately not interested in holding and operating the device herself, the use needed to be mediated.

This type of *mediated* use is similar to the *use-by-proxy* concept that is discussed by Bartol et al. (2022) and a form of *proxy use* that Hänninen at al. (2021) call *digital piggybacking*, whereby use is conducted in proximity to, but separate from, an older adult.

While *mediated* use more accurately describes spontaneous, one-on-one use, *communal* use refers to a form of dependent use that is planned out, regularly occurring, and conducted in larger groups. In assisted living facilities, this type of use typically occurs during community activities and is moderated by an associate or other volunteer activity leader.

At the facility in this study, communal forms of technology use are scheduled into everyday social activities. Specifically, residents are given the opportunity to engage in *communal* use in a group setting with a specially designed computer system that combines software geared toward older adults with a large touchscreen monitor that can be wheeled around the facility. In addition to pre-programmed applications, such as trivia, bingo, puzzles, games, and touch-to-paint programs, the system also allows users to access an Internet browser and a music player. While the system is designed so that anyone can interact with the touchscreen, for the most part, the residents seemed uninterested in doing so. Instead, they preferred to observe the associates as they navigated the system.

However, despite this general lack of interest in directly interacting with the system, I observed residents regularly engaging mentally and verbally with the activities happening on the screen. For the associates conducting these community activities, this system was an essential tool for engaging the residents in new types of technology.

It is essential to note that the degree to which *communal* use is engaged in and/or is beneficial to the users is strongly dependent on the makeup of the community. The presence of opportunities for *communal* use does not guarantee that all members of the community will engage in it, or that they are even interested in doing so. Thus, *communal* use may take on a different format for each of the subgroups within a larger community.

Finally, on the most dependent end of the scale lies *embedded* use, a type of use that reflects a complete lack of independence. *Embedded* use is a form of technology use that is so deeply integrated into the technological institution that it often goes unnoticed or is taken for granted. Some assistive technologies and most surveillance technologies fall into this category. The lack of independence is a result of *embedded* use requiring the control of another person beyond the primary user, but it also typically occurs without the primary user's consent (and sometimes knowledge). The primary user rarely has the choice to engage or not engage with *embedded* use; however, they are still heavily influenced by the embedded technology.

One example of *embedded* use at the facility is the Wander Guard system, a small tag that can be affixed to a resident or their wheelchair or walker that prevents the wearer from leaving through the external doors of the facility. Because Wander Guards are used for residents who pose an elopement risk, none of the residents I interviewed were required to wear them; however, through my observations and interviews with the associates, I was able to better understand how the devices embody *embedded* use in a technological institution.

Much of the previous discussion in this paper has regarded technology use and non-use, especially among older adults, as a complex decision-making process. While this is typically true, we must acknowledge the role that the technological institution, along with all social contexts, plays in that process. Embedded technologies are unique in that the primary user (here, the resident) loses the ability to make decisions about use and non-use.

Overall, the interviews and observations conducted for this study reveal an essential finding on how older adults engage with technology: navigating use and non-use involves a complex decision-making process. However, that process can only be fully understood by expanding our conceptions of *use* to consider the various ways that technology is incorporated into everyday interactions.

Discussion

The current study examines not only the stated reasons why older adults use and do not use certain technologies, but also how those decisions are made. Using frameworks from digital inequalities and narrative gerontology, the findings in this paper present a clearer picture of how older adults engage (and disengage) with technology by *choice.* Specifically, older adults utilize a complex decision-making process that negotiates their own communication needs, the usefulness of technology, and the availability of suitable alternatives to compensate for the perceived consequences of non-use. The findings of this study are consistent with prior research on the technology use of older adults, including Hagberg's (2012) conclusion that older adults are fully capable of making informed decisions about their technology use. Additionally, the finding on *suitable alternatives* is consistent with research from Mitzner et al. (2010), which found that older adults weigh the time it would take to learn a new technology against the potential benefits, and sometimes learning a new technology is just not worth their time.

Also crucial from these findings is the understanding that technology *use* and *non-use* are not permanent statuses, but rather a continuum of situational activities that are heavily dependent on social interaction. This Interaction Approach explores how independent or dependent a primary technology user is on others during their use. In all but one type (*embedded* use) the primary user is able to make an informed choice about their use. However, with *embedded* use, the primary user is heavily impacted by the technology, often without their knowledge or consent. This finding is consistent with Wagenknecht's (2017) research on the *affected bystander*, as well discussions on the use of surveillance technology in elder care (Mortenson et al., 2016).

Implications and Conclusions

The concept of *choice* in technology use has important implications for researchers, practitioners, and policymakers. Digital choice, or the ability to decide for oneself whether to use or not use certain technologies, is a reflection of personal agency. For older adults, especially those living in non-independent living situations, personal agency may be diminished. This study contributes to a growing body of literature in the last decade that emphasizes how older adults occupy a unique life-stage that allows for a complex and agentic decision-making process regarding their technology use.

In addition to maintaining agency, the concept of digital choice also has important policy implications, particularly those that are focused on technological interventions. Older adults have demonstrated that use and non-use are carefully negotiated. Thus, increasing digital literacy or usage is not as simple as providing more access to devices or educational information. For example: for an older adult that has no interest in conducting online banking on an application on their smartphone, a computer might prove to be a better option. However, continuing to bank in person or over the phone may still be a suitable alternative to that technology use. Technological interventions cannot be approached linearly.

In their research on attitudes toward technology during technological interventions, Berkowsky et al. (2013) found that older adults in assisted and independent living communities had more favorable opinions of technology when they received specialized instruction that was designed for older adults in their living situation. Thus, when planning and implementing technological interventions for older adults, policymakers and practitioners would benefit from engaging older adults in that process. In addition to developing more specialized and welcomed interventions, this practice may also benefit older adults in non-independent living situations who may be struggling with a sudden or sustained loss of personal agency.

Respecting digital choice, and an older adult's decisions to use or not use certain technologies, still hinges on the widespread availability of technology. Consistent with prior research, the findings in this study still support advocating for policy that increases technology access and education for older adults. Essentially, technology must first be made available before older adults (and all individuals) can choose to use or not use it. Similarly, Hakkarainen (2012) argues:

> Therefore, for promoting digital inclusion, the elderly should be provided with internet-related information, training, and support that would address their social representations and images of the internet. At the same time, however, for promoting citizens' equality in communication rights, older people should also be provided with the opportunities for ageing actively without using the computer. The contribution that this study makes to policy-making is that digital inclusion policies should also encompass a choice for internet non-use. (p. 1213)

Additionally, Tirado-Morueta et al. (2021) found that older adults are more likely to use the Internet if their access to it is coupled with training and support. Ultimately, successful technological interventions will engage older adults as complex decision-makers that are capable of making informed decisions about their technology use. Current efforts to improve access should continue; however, implementing new technological interventions will have a higher success rate if the concept of choice is carefully considered.

Finally, the findings in this study challenge the current notions of *use* and *non-use* by expanding technology use to a continuum based on how dependent the use is on another person. Traditional notions of technology use have focused on a limiting set of criteria: *use* is reserved for moments when a single individual is in control of a technological device or application. The Interaction Approach of Technology Use encourages researchers, practitioners, and policymakers to look beyond this definition and consider the profoundly social nature of technology use.

A non-linear, continuous approach to technology use is currently being explored in other research, most recently, in Hänninen et al.'s (2021) examination of the role that *warm experts* play in older adults' engagement with digital technology. Similar to the Interaction Approach, their typology examines use that ranges from active, independent use to more limiting forms of use.

Where the two approaches differ is in the data from which they were developed. The study in this paper was conducted on older adults in the United States, while Hänninen et al.'s (2021) research was conducted in Finland. Additionally, Hänninen et al. (2021) primarily tell the story of technology use from the perspective of the individuals, or *warm experts*, that are providing technological assistance to their older adult family members. Contrarily, the Interaction Approach frames the various usages from the perspective of the primary user, the older adult. Regardless, in both studies, data is collected from both the older adults and the individuals that they interact with in their everyday lives. Future research and policymaking will benefit from considering the contributions of both Hänninen et al. (2021) and the present study.

One immediate implication of such an approach for practitioners and policymakers concerns the implementation of new technological initiatives or interventions for older adults. During data collection for this study, the facility was in the process of purchasing new computers for the community computer lab. Conversations with the associates revealed that, even before purchasing the devices, they were already considering how the new computer lab would need to be introduced to the residents so that it could be utilized to its full capabilities. Taking a nuanced approach to technology use, one that considers varying levels of dependence and independence, can help inform that process. Using findings from the Interaction Approach, when introducing new technological devices to older adults (for example: purchasing computers for an assisted living facility), successful implementation will depend on how well the implementing agency considers the users' preferences for *individualistic* and *assisted* use, along with more *mediated* forms of computer use.

In addition to inserting new devices in a community, this approach can also inform the implementation of technology education interventions for older adults. While older adults may elect to receive technological skills training in order to engage in *individualistic* use, *assisted*, *mediated*, and *communal* use require unique skill sets as well. One such skill is the ability to know which devices can accomplish which tasks, as well as knowing someone in their everyday lives who can assist with the desired use. For example: when an older adult resident asks an associate to "look up" something for them, they are displaying a specific technological skill of knowing that a smartphone is capable of "looking up" information, even if they cannot or are not interested in holding the device in their hands and looking it up themselves.

While the Interaction Approach was developed from research on older adults in one assisted living facility, this continuum of use may be applicable to a wide variety of populations. Further research is necessary to test this conceptual approach in other assisted living facilities and with other groups of older adults in order to better understand how each of the forms of use outlined in this study may manifest in unique ways among different populations of people. Ultimately, approaching technology use as a continuum based on the level of required interaction in that use will continue to illustrate the deeply social nature of all technology use in society.

While the Interaction Approach of Technology Use provides new language for discussing use and non-use, it is only the beginning of a much deeper and more nuanced conversation in the fields of technology and aging.

Limitations

Despite its considerable contributions, there are two limitations within this study that need to be addressed. First, because this research was conducted at a single assisted living facility, the available sampling pool for residents, family members, and associates was heavily limited. Thus, the final sample for each of the interview groups was smaller than preferred. Additionally, the participants in this study were recruited using a non-random, purposive technique, which undoubtedly introduced a significant sampling bias. Thus, the generalizability of the findings should be approached with caution. Future research will benefit from sampling from a larger, more diverse pool of older adults, both within and outside of assisted living facilities.

Second, this study would have benefited from additional observational sessions of the residents interacting with family members and associates, as well as engaging directly and indirectly with various technologies, particularly *after* the Interaction Approach of Technology Use began to develop. The Interaction Approach emerged during data analysis as a new way to conceptualize how residents in assisted living facilities use technology in interactive ways. Given that the present research was largely exploratory, additional research will strengthen the validity of the Interaction Approach by asking questions that are specifically related to the various types of uses outlined in the findings of this paper.

Author Note

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