



SMART HOMES FOR SENIORS

Intelligent Home Solutions for
Independent Living

Final research evaluation report

February 2021

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Final research evaluation report

SMART HOMES FOR SENIORS

Intelligent Home Solutions for Independent Living

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We appreciate the time and contribution of all the householders who participated in this research, who welcomed us into their homes and shared their valuable insights and data.

Acknowledgement of Country

We wish to acknowledge the people of the Kulin Nations, on whose land the Monash and Deakin university teams work; and the people of the Jukumbal, Kamilaroi/Gomeroi Nations, on whose land the McLean Care team work and on whose land this project was undertaken. We pay our respects to their Elders, past, present, and emerging.

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Product disclosure statement

This project was carried out completely independently of the manufacturers, distributors and retailers of the smart home devices selected as part of this trial. No one on the project team received any incentives, reimbursements or other financial incentives from the brands and companies discussed in this report.

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FOREWORD

For many Australians across all generations, our 'new normal' means increasing interaction with technology in our everyday lives. However, research consistently highlights the disparity of outcomes for older people living in rural and remote locations – who don't have the same level of access to health care or technology services that their urban counterparts do.

As a specialist not-for-profit rural and remote aged care provider operating for almost 70 years, McLean Care recognises the importance of making sure that older people living in our service heartland are not left behind in the rapidly evolving field of smart home technologies. Consistent with our values, we are committed to making sure older people are able to derive equal benefit from them – not only as passive end-users, but sharing their voices as active participants in the growing field of research in this sector.

In 2019, we were successful in applying for a CHSP Innovation Grant from the Department of Health to conduct a unique trial of a broad range of off-the-shelf technologies with older people living in the rural communities of Inverell, Tamworth and Gunnedah. From the outset, the project was aimed at not only exploring the role of technology in supporting wellness, but also in capturing the unique views and experiences of older people themselves in terms of the functionality and accessibility of different devices.

We have moved well beyond the concept that older people don't engage with technology. This project has demonstrated that in these changing times, with our global population rapidly ageing, and with exponential growth in the types of technologies available, it is a natural progression for older people to become involved in their use. In this project, participants not only trialled the technology and provided useful feedback, but in many cases, they have successfully integrated it into their everyday lives.

The Smart Homes for Seniors project is a testament to how an effective industry-research partnership can work to shed light on areas of emerging opportunity at the intersection of truly person-centred care, and the field of assistive technologies. It has been a pleasure to work with the teams from Monash University's Emerging Technologies Research Lab and Deakin University's CADET Virtual Reality Training and Simulation Research Lab. The unique combination of ethnographic and technical research offered through this innovative collaboration sets this project apart from many others – not only nationally, but also internationally. Their thoughtful, professional and respectful fieldwork with older people living in our communities has been second-to-none.

I would also like to pay particular tribute to the participants themselves. In many cases, they stepped outside their 'comfort zones', welcomed the research teams into their homes, and shared their stories including their joys and frustrations about integrating smart devices into their everyday lives. This project

is so much richer for their input, and certainly could not have happened without them. We are confident the findings will be relevant not only for the aged care sector, but also for policy makers, researchers, ethnographers and technology developers alike. Importantly, the project outcomes will also be relevant to older people considering the use of smart devices. We trust you will find deep and relevant insights on the following pages – affirming that technology does have a place in supporting wellness and independence for older people living in the community. On behalf of all of the collaborative partners, thank you for interest in this project.



Sue Thomson
Chief Executive Officer, McLean Care

A stylized, handwritten signature of Sue Thomson in black ink.



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EXECUTIVE SUMMARY

PROJECT OVERVIEW

With an increasing ageing population globally, there is growing interest in 'smart home' technologies that can assist older adults to continue living at home. Contemporary research confirms that technology can support positive ageing and create increased opportunities to age in place without loss of independence. This is particularly important for older people living in rural, regional and remote areas, who have lower levels of access to services and poorer outcomes against a range of health and wellbeing indicators.

This report details the findings from the Smart Homes for Seniors project, which was designed to address the research and knowledge gaps relating to older people's use of smart home technologies, and evaluate their potential for supporting wellbeing and independence in regional and rural communities.

In 2019, McLean Care – a specialist not-for-profit regional, rural and remote aged care provider – received a Commonwealth Home Support Programme (CHSP) innovation grant from the Australian government's Department of Health. As part of the grant, McLean Care partnered with specialist researchers from Monash University's Emerging Technologies Research Lab and Deakin University's CADET Virtual Reality Training and Simulation Research Lab to trial smart home technologies in older people's homes with the aims of:

- Understanding how smart home devices can support older people in improving wellness outcomes and living independently in the home;
- Evaluating the benefits, opportunities and challenges of incorporating smart home devices into older people's homes and lives; and
- Understanding the usability challenges, expectations, hopes and anxieties older people have of smart home devices in assisting them to live more independently and to improve their wellness and wellbeing.

Older people have typically been a marginalised or undervalued group in the design of smart home devices, and have therefore been insufficiently accounted for in many user studies. Data revealed in the 2019 Australian Digital Inclusion Index (ADII) shows substantial differences in the rates of digital inclusion between Australians living in rural and urban areas, and Australians who are aged 65 or older. Research confirms that older Australians are increasingly concerned about being 'left behind' in the digital age, and highlights the concomitant need for proactive policy and research initiatives to help close this gap.

The project was unique in its interdisciplinary research methodology, which combined ethnographic insights, electronic data from the devices showing participants' usage patterns, user reviews and a short end-of-trial survey.



THE TRIAL INVOLVED FIVE KEY COMPONENTS:

1.

McLean Care recruited 23 households from their existing CHSP client base in the regional NSW communities of Inverell, Tamworth and Gunnedah, and provided them with a wide range of commercially available smart home devices from different vendors with diverse functionalities. Each household was able to select a combination of devices suited to their unique interests, household needs, and physical layout of the home.

2.

Deakin University collected electronic data from the different devices to analyse what was used and how.

3.

Monash University undertook ethnographic research (interviews, home visits, video tours and technology demonstrations, observations, follow-up phone calls and in-depth video calls) to document and understand participants' experiences with the technologies.

4.

McLean Care collected user reviews from the participants on the devices that were trialled and published them on a website.

5.

McLean Care administered a short end-of-trial survey to capture participants' interest in keeping the devices, paying for them in the future and overall feedback on the project.



SMART DEVICE OVERVIEW

Google Home digital voice assistant

81 Google Home devices were installed in all 23 homes. The Google Home suite of technologies installed included Google Home, Google Home Mini and the Google Nest Hub Max tablet installed with the Google Duo application (in 12 homes).

These devices provided:

- Voice-activated control of other smart home devices;
- Access to music, news, weather and other information; and
- A touch screen and voice-activated tablet for video calls (mediated with Google Duo app) and screensavers (via Nest Hub Max).



Aeotec smart lights

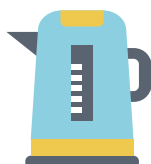
58 Aeotec smart lights were installed in 22 homes. The smart lights consisted of:

- Smart light bulbs (installed in existing lamps) to light up rooms and pathways at night, controlled by voice activation (on Google Home), push buttons (placed near beds and chairs), sensors, fobs and/or tablets; and
- Sensor-activated coloured lights to remind participants of other everyday activities (taking medication, opening garage doors).



Kogan smart kettle

13 Kogan smart kettles were installed in 13 homes. The smart kettle provided hands-free, voice-activated control of the kettle.



Roomba robotic vacuum cleaner

15 Roomba robotic vacuum cleaners were placed in 15 homes. The robotic vacuum provided a hands-free automated alternative to manual vacuuming and cleaning services provided by McLean Care. The Roomba vacuum was connected to Google Home, and activated by voice commands.



Other devices

A number of other devices were provided to some or all participants as part of the trial. These included:

- A standard network cabinet '**black box**' installed in all participants' homes;
- An **Apple iPad** tablet trialled by all participants and pre-installed with several applications relevant to that household (including Fibaro, Automation Bridge, Roomba, Sonos and Google Home);
- **Sonos music speakers** trialled in three homes (controlled by voice activation);
- **Netamo weather stations** trialled in two households providing location-specific weather information accessible via tablet or voice requests;
- **Easy Read digital clocks** trialled in four households providing the day of the week, date and time;
- **Aeotec smart switches** trialled in ten households and connected to existing appliances (e.g. pedestal fans) that could be controlled by smart buttons, voice activation, sensors and/or tablet;
- **Fibaro flood sensors** trialled in one household, located in the kitchen;
- **Fibaro smart buttons** installed in 23 homes to control smart lights and switches (e.g. pedestal fans);
- **Fibaro key fob** installed in ten homes as an additional control for the smart devices;
- **Aeotec motion sensor** installed at the front door of one home and connected to a smart light; and
- **Remotec air-conditioner Infrared (IR) controller** installed at five homes to connect air conditioners to Google Home.

OVERVIEW OF DEVICE USAGE INSIGHTS AND TRENDS

- Preference for particular smart homes devices remained constant over the trial with Google Home being the most commonly used device;
- Usage of devices varied widely between households and was difficult to predict;
- Usage of smart lights and switches varied widely between households and participants preferred different methods of control;
- Google Home was used daily by participants and usage remained consistent over time with a slight shift to making more varied requests towards the end of the trial;
- Google Home was a 'gateway' device, that enabled control of other smart devices and access to a variety of information and services;
- Google Home was commonly used to access music, news and other content;
- Participants used Google Home to make a wide variety of different voice requests; and
- Both the number of voice requests that couldn't be understood by Google and those where Google Home wasn't able to assist remained consistent throughout the trial.

POSITIVE IMPACTS OF DEVICES ON HEALTH, INDEPENDENCE AND WELLBEING

Overall impacts on wellbeing

Participants experienced small but significant comforts and conveniences from the trial technologies. These included:

- Having a smart light-enabled daily reminder for medications;
- Being able to vacuum areas of the home with physical ease;
- Enjoying a range of functional and entertainment options from the Google Home (e.g. music, news, or controlling other devices with voice commands);
- Augmenting their love of nature with screensavers (on their Google Nest Hub Max) of the natural environment or nature, and playing country music; and
- Providing additional support for their daily routines during the COVID-19 'lockdown'.



Impact on physical health and mobility

- Participants balanced the convenience provided by smart devices with their desire to stay active;
- Smart light buttons enabled participants to create safely lit routes for walking around their home at night;
- The robotic vacuum cleaner provided additional cleanliness and convenience with reduced physical labour; and
- Google Home's voice call function presented new options in accident and emergency situations.



Mental activity, learning, and purpose

- The trial helped keep participants' minds active;
- Participants found Google Home's attempts to help them learn humorous and fun;
- Most participants were committed to the trial and to learning about the technologies;
- Most participants built confidence with the technologies as the trial progressed; and
- The trial provided participants with social and technical interactions that supported their physical and mental wellbeing.



Maintaining and supporting everyday routines

- Participants embedded the devices into their morning and daily routines;
- The smart home technologies complemented rather than replaced existing technologies;
- Participants adjusted their trial technologies on a flexible basis; and
- Participants augmented their daily routines with new physical, sensory and interactive experiences provided by the devices.



Embedding the devices in family relationships

- The devices were used within the participants' unique family dynamics;
- Family members provided participants with additional technical support;
- Relationships within the home were central to the ways devices were used and to how participants evaluated their suitability; and
- Interactions with the devices by pets influenced the way they were used.

**Maintaining financial security and minimising money worries**

- Financial security was closely tied to participant wellbeing;
- Participants appreciated that the trial was free and covered the cost of their participation; and
- Participants always declined to sign up to online subscription-based services or purchases.

**Supporting wellbeing with Google Home**

- Participants enjoyed listening to music; and
- Participants used Google Home to connect to nature and the region.

**Supporting independence with the robotic vacuum cleaner**

- The robotic vacuum cleaner complemented (but did not replace) regular cleaning services;
- The Roomba created a sense of wonder for some participants; and
- The robotic vacuum cleaner required the most monitoring and attention of all trial devices.

**Familiarity with the devices and a sense of comfort**

- Participants found Google Home's 'friendly' feminine voice comforting; and
- Familiarity with the devices created pathways for the participants to consider future possibilities with new technologies.

**Learning new skills and building confidence with technology**

- Being part of the trial was a key benefit to participants;
- The trial demystified digital technologies for some older participants; and
- Learning new digital skills was a key reason for and benefit to trial participation.



CHALLENGES AND RISKS

Risks to health and wellbeing

- The robotic vacuum's unpredictable actions caused distress for some participants;
- The smart kettle made it easy to see heating and temperature but was too heavy for some participants; and
- Some participants found accommodating the devices into their homes difficult.

Technical, security and privacy challenges and risks

- Participants relied heavily on remote and on-site technical support throughout the trial;
- Participants encountered challenges in learning to use the devices and integrating them into their routines;
- Some participants expressed anxiety about the 'black box' installed in their homes; and
- Some participants were concerned about potential privacy and security risks but most were unaware.

Dependency risks

- The complexity of smart home device interconnectivity reduced participants' ability to troubleshoot or fix small technical issues on their own;
- Some participants were concerned about becoming dependent on the devices or the technical support team; and
- In coupled households, one person was more likely to take responsibility for learning how to use and maintain their smart home technologies.

Challenges with operating voice-activated devices

- Participants needed support to learn and remember Google Home commands;
- Participants were uncomfortable with the etiquette of Google Home commands;
- Participants experimented with the commands when they could not remember them; and
- Participants sometimes unintentionally altered device configurations.



Hearing, vision, lifting and tactile usability challenges

- Participants encountered difficulties hearing, understanding and being understood by Google Home;
- Google Home's 'personality' affected the way participants interacted with this device; and
- Some participants found operating the push buttons, key fob and touch screens difficult.

MODIFYING THE PROJECT DURING THE PANDEMIC

Part-way through the trial, the novel coronavirus began to spread in Australia, resulting in physical distancing restrictions across the country. Given the vulnerability of the older participants in this trial to contracting the virus due to their age and, in some cases, their immunocompromised health status, the Project Steering Committee put in place extra precautions to minimise physical contact between participants and the project's research teams.

While the necessary restrictions imposed by the Australian government during the pandemic directly impacted the planned research activities and opportunity to interact face-to-face with participants, they also created several opportunities for methodological innovation in the project.

Doing research with the devices through remote and virtual ethnography and exploring the impacts of the devices in exceptional circumstances

Due to physical distancing restrictions during the COVID-19 pandemic, the research was partly undertaken remotely using the smart home devices – where possible, participants were engaged in video calls with the research team via their Google Nest Hub Max device.

The conditions created by the pandemic provided a glimpse into a possible future where fewer physical support services are available to older people living independently in their homes, and where there is less access to social networks and interaction. This provided unique research insights.

Use and benefits of the devices for supporting wellbeing during the pandemic

- Participants looked for opportunities to use their devices to support their activities during the pandemic;
- The devices helped participants' maintain social connections during the pandemic;
- The robotic vacuum cleaner helped participants maintain their standards of hygiene and comfort during the pandemic;
- Some participants were less likely to ask for technical support during the pandemic; and
- Participants were already experts in 'home-based routines' which helped them cope with the pandemic.

SHORT TERM FUTURE CONSIDERATIONS

Future vulnerabilities

Being older, most participants were aware of their own vulnerability, and that a fall or small injury could mean they could no longer live independently. This impacted their approach to using the devices in various ways, such as:

- Being cautious about making large new investments in smart home technologies; and
- Thinking short term about their own future.

This short term outlook makes off-the-shelf and easily replaceable or removable devices like those installed in this trial particularly relevant for older households.

Reflections on the trial

At the end of the trial, McLean Care administered a brief survey to participants in conjunction with the collection of user reviews on the trialled devices. Participants were asked to report on a scale of 1 to 5 how likely they are to recommend the types of technologies trialled in the project to others. On average, the score was 3.9 out of 5. Participants also provided feedback on what they enjoyed most about the project and what they would recommend the project team do differently next time.

Keeping the technologies

The survey asked participants whether they would consider keeping:

- the Google Home devices;
- the Google Nest Hub Max specifically for video calling;
- the Roomba robotic vacuum cleaner; and/or
- the Fibaro smart button to remotely operate the bathroom light.

Participants expressed an interest in keeping all of these devices, with a slightly higher rate of interest shown in the Google Nest Hub Max specifically for video calling, and the Fibaro smart button to remotely operate the bathroom light.

More than half of the households (14) opted to keep the technologies for three months beyond the completion of the trial at no cost. Based on the success of the trial, and the positive outcomes reported by participants, the three month extension was extended indefinitely. McLean Care has also committed to exploring the re-use of any returned devices by expanding access to the technologies to other funded aged care programs.

RECOMMENDATIONS: OPPORTUNITIES AND ENABLERS FOR OLDER PEOPLE

- Provide smart home technologies as optional extras for in-home services for older people ageing in place;
- Close the gap to accessing health care and technology services for older people living in rural, regional and remote locations;
- Personalise the type and number of smart home devices for each household;
- Deliver smart home technologies as part of integrated and sustained service provision including training and ongoing technical support;
- Provide opportunities for participation and learning as well as encourage all older people to gain 'digital living skills';
- Provide affordable, reliable and equitable Internet services;
- Design smart home technologies to support older people's specific usability requirements;
- Design and install smart home technologies that support older people's independence, mobility and memory;
- Test and verify suitability of all smart devices for older people before deployment;
- Provide smart home technologies for older people as part of flexible and hybrid 'crisis ready' care systems; and
- Consider older people's extended families.



1 INTRODUCTION

The Department of Health's Commonwealth Home Support Programme (CHSP) helps senior Australians access entry-level support services to live independently and safely at home. Aged care provider, McLean Care, is a specialist not-for-profit provider working in regional, rural and remote communities to deliver the CHSP program as well as a range of other aged care services. The heartland of McLean Care's service footprint encompasses the New England region of NSW and the Darling Downs region of South-East Queensland. Spanning a wide geographic area, the predominantly farming and primary production communities in these areas have been significantly impacted in recent years by periods of prolonged drought and the summer bushfires of 2019-2020.

Research confirms that older Australians in rural and remote areas such as these have lower levels of access to services and poorer outcomes against a range of health and wellbeing indicators.¹ The 2019 Australian Digital Inclusion Index (ADII) also shows substantial differences in the rates of digital inclusion between Australians living in rural and urban areas, and for Australians who are aged 65 or older.⁴⁷ Research confirms that older Australians are increasingly concerned about being 'left behind' in the digital age, and highlights the concomitant need for proactive policy and research initiatives to help close this gap.²⁸

Against this background, in 2019, McLean Care made a successful application for a CHSP innovation grant from the Department of Health to trial smart home technologies in older people's homes. The project – Smart Homes for Seniors – aimed to:

- Understand how smart home devices can support older people in improving wellness outcomes and living independently in the home;

- Evaluate the benefits, opportunities and challenges of incorporating smart home devices into older people's homes and lives; and
- Understand the usability challenges, expectations, hopes and anxieties older people have of smart home devices in assisting them to live more independently and improve their wellness and wellbeing.

McLean Care partnered with specialist researchers from Monash University's Emerging Technologies Research Lab and Deakin University's CADET Virtual Reality Training and Simulation Research Lab to undertake the project.

The smart device trial and research activities were conducted between November 2019 and June 2020. The devices used in the trial included smart power plugs (smart switches), digital voice assistants, smart light bulbs and robotic vacuum cleaners. All devices are commonly known as 'plug and play' or 'set and forget' smart home technologies that are easy to remove if needed and don't require hard-wiring to be installed. The research tracked findings across the trial households for a period of 4-6 months depending on the timing of installation. An interim report summarising the project and providing preliminary findings was published in June 2020. This final report provides a full evaluation based on the unique interdisciplinary research methodology that combines ethnographic insights, electronic data from the devices showing participants' usage patterns, user reviews and a short end-of-trial survey.

As far as the project team is aware, the trial is the first of its type in the world exploring the experiences of older people when using smart home devices through a combined lens of ethnographic and technical research in a unique applied industry-research partnership.

The trial involved five key components.

1. McLean Care recruited 23 older households and provided them with a wide range of commercially available smart home devices from different vendors and with diverse functionalities.
2. Deakin University collected electronic data from the different devices to analyse what was used and how.
3. Monash University undertook ethnographic research (interviews, home visits, video tours and technology demonstrations, observations, follow-up phone calls and in-depth video calls) to document and understand participants' experiences with the technologies.
4. McLean Care collected reviews from the participants on the devices that were trialled and published them on a user review website (<https://intelligenthomesolutions.com.au/technology/>). These are intended as a reference for other older Australians who may be considering using similar devices in their own homes.
5. McLean Care administered a short end-of-trial survey to capture participants' interest in keeping the devices, paying for them in the future and overall feedback on the project.

The project delivers significant insights for older Australians, the Department of Health, aged care service providers, smart technology designers, and researchers by capturing the experiences of older Australians' use of emerging smart home devices.





RESEARCH BACKGROUND



2 PRIOR RELATED RESEARCH AND KEY CONCEPTS

2.1 RESEARCH BACKGROUND

Given the rapidly ageing worldwide population, there is increasing interest in 'smart home' technologies that can assist older people to continue living at home. Contemporary research confirms that technology can support positive ageing and create increased opportunities to age in place without loss of independence. Despite this, older people have typically been a marginalised or undervalued group in the design of smart home devices, and as such have been insufficiently accounted for in user studies.²⁹ This project responds to the subsequent research and knowledge gaps relating to older people's use of smart home technologies and evaluates their potential for supporting older people's wellbeing and independence.

Supporting older people to live independently at home

The recent availability of a wider range of affordable and reliable smart home technologies has enabled social scientists, technology designers, industry and policy stakeholders to investigate how these devices can support people in their everyday lives.

There is a common expectation by technology designers that smart devices will be used as preventative health measures, to address social isolation, reduce and respond to accidents, support the work of both formal and informal carers, improve access to health services, and reduce caring costs amongst ageing populations.^{10, 25, 9} User research has subsequently focused on barriers to technology adoption or user attitudes towards specific technologies. Existing studies show that digitally monitoring older people's activity is the most common form of technological intervention. This raises questions about what functions smart assistive technologies are designed to perform, and who they are intended to assist (for example, those ageing in place or their carers). The assumptions that underpin these

studies have also been critiqued for failing to adequately consider how technologies are (or are not) integrated into everyday life, and for providing an overly optimistic view of technological interventions, which are commonly presented as a panacea to diverse health and care challenges.²⁶

There have been few 'in the wild' smart home trials with older people (e.g. trials where technology is deployed into people's homes).^{21, 24} Trials that have been undertaken have tended to focus on a single product or showcased a particular supplier.^{5, 43} In response to the subsequent knowledge gap, the project reported on here trialled a wide range of commercially available smart home products and brands, featuring a range of functionalities.

Research insights from previous user studies

User-centric approaches to the design of technology consider the diverse uses and users of the technologies, and the various contexts into which they may be integrated. Such research is typically less techno-optimistic and -deterministic, meaning that it seeks to understand (rather than predict) the diverse and evolving ways in which technology is used by real people in everyday life. It may also integrate qualitative or (less commonly) ethnographic research. Insights from user-centric approaches in the literature and relevant to this research include suggestions that:

- The successful integration of healthcare technologies into everyday life depends on a number of so-called "little arrangements" (p.91)²⁶, which represent diverse forms of social and material accommodations (such as using a notepad to write reminders to check blood pressure);²²
- Smart and assistive technologies are often used in conjunction with existing tools or unconventional methods in order to address local, specific needs (such as taping over unneeded buttons on a device to prevent those

with dementia from using them, or combining diverse smart technologies to create a bespoke telecare system);^{14, 23}

- The use of new technologies and systems often depend on human mediators to integrate technologies into a person's home.^{15, 16} These mediators may be formal (i.e. professional) or informal carers, and may assist with installation, maintenance or troubleshooting; and
- User interfaces for technologies such as smart phones need to better account for the diverse perceptual, motor, and cognitive abilities of older people.⁴⁰ For instance, providing users with larger buttons is an example of adapting to the specific needs of (some) older people with tactile or visual challenges.⁷

Guiding older people towards options that suit their needs

The Australian Aged Care Industry's recent technology roadmap notes that "the plethora of available technologies brings the need for mechanisms and processes to guide end-users in their selection" (p. 33).³⁹ Likewise, consumers need to understand the possibilities offered by technology, and be able to access and navigate information from a "trusted source" relating to how technologies address their needs, provide "user-friendliness" and deliver affordability (p 33).³⁹

To date however, there are limited options and information available for older people who are interested in exploring the integration of smart technologies into their everyday lives. The reviews that are available online tend to focus more on the technical aspects of the devices (for instance their interoperability, operating platforms, security and privacy practices); or offer technical reviews from general users rather than older people themselves. Others are more of a 'how-to' guide for family members or carers when introducing smart home devices to older users. The project reported on here was designed from the outset to collect reviews of the trialled devices from the participants themselves with the intention of publishing this information in an accessible online format to help guide older people who may be considering using these types of technology.

2.2 KEY CONCEPTS

The research conducted in this trial builds on or mobilises a number of key concepts to understand how smart home technologies can support older people to age in place.

Wellbeing

In the project reported on here we were concerned with how smart home devices can contribute to older people's wellbeing. Our focus was on the aspects of wellbeing specifically related to independence, and the experience of ageing in place and in one's own home. The term wellbeing is widely used however it is neither easily nor uniformly defined in the ageing in place literature, and is used inconsistently by both researchers and laypeople.⁴¹

Broadly defined, wellbeing is associated with being content, healthy or comfortable.³³ The Organisation for Economic Co-operation and Development (OECD) (2015) states that "well-being is multidimensional, covering aspects of life ranging from civic engagement to housing, from household income to work-life-balance, and from skills to health status" (p. 17).³² The Australian Institute of Health and Welfare understands wellbeing as a product of determinants of wellbeing (including material resources and family functioning), welfare services and supports, and contextual factors (such as ageing).¹ Wellbeing indicators (that make up overall welfare), include material living conditions, health and vitality, environment, work, personal safety, skills and learning, and community engagement.

While informed by these definitions, the research reported on here was qualitative and undertaken in place. This meant that we were careful to work with research participants in order to understand their own definitions of wellbeing, and what independence with smart home devices meant to them.

Ageing in place and independent living

Ageing in place is the accepted terminology describing older people remaining in their homes or communities as they age, and can be defined as “remaining living in the community, with some level of independence, rather than in residential care” (p. 133).⁸ Ageing in place typically contrasts with institutional care, such as that provided in nursing homes or similar facilities. Independent living is less commonly defined in the literature. This may be because the term “has a different meaning for each older adult” (p. 832).² Nonetheless, independent living commonly suggests a lack of dependence on others to complete everyday tasks, the capacity to live an active life and remain mobile, or simply the ability to live at home rather than in an aged care facility.

Smart technology and the Internet of Things (IoT)

Smart technology is a contested term, but commonly describes Internet-connected devices that can be automated and remotely controlled. Touch screen and voice activation are common ways to interface with smart devices. Examples of smart devices include smartphones and tablets, digital voice assistants like Google Home, and smart lights. The integration of computer chips, sensors and wireless connectivity into everyday devices is also referred to as the Internet of Things (IoT). The term ‘IoT’ is often applied to smart appliances or devices which haven’t historically had an network connection, this includes; Wi-Fi, Bluetooth and radio frequency identification (RFID), such as an electronic door lock. IoT devices can ‘sense’ information without the need for human intervention.¹⁷ They are essentially part of a network of things, in which information and communication systems are invisibly embedded into everyday environments. Automated and robotic devices like vacuum cleaners or sensor lights may also be included under the banner of smart technology, as they were in this project.

Assistive technology

Assistive technology refers to a much broader range of technologies than those considered ‘smart’, and is widely adopted in the ageing in place literature. A 2004 World Health Organisation definition

describes assistive technology as “an umbrella term for any device or system that allows individuals to perform tasks they would otherwise be unable to do or increase the ease and safety with which tasks can be performed” (p. 10).⁴⁹ In the context of this research, some of the smart home technologies selected for the trial can also be considered assistive technologies, such as the Roomba robotic vacuum cleaner. However, as we and others have explored in relation to past trials of smart home technologies intended to enable improved safety and ease, the claimed benefits or intended outcomes of assistive technologies are not always realised.^{31, 43, 44, 45}

Digital voice assistants

Digital voice assistants like Google Home that was used in this trial, and others such as Amazon’s Alexa, are fast becoming some of the most ubiquitous devices in the world. Some industry observers predict that by 2021 there will be more voice assistants on the planet than people, which is a growth rate that exceeds the mobile phone’s.³⁸ Also known as conversational agents, chatbots and smart speakers, digital voice assistants provide voice-activated access to information available on Internet search engines (such as Google), and can connect with other smart home and IoT devices to enable voice-activated control of these technologies. In most markets, including Australia, digital voice assistants like Google Home are sold with a female voice as default.⁴²

Service robots

The robotic vacuum cleaner used in this trial belongs to the service robot suite of technologies. In personal and domestic use settings service robots mainly include vacuum and floor cleaning, lawn-mowing robots, and entertainment and leisure robots, including toy robots, hobby systems, education and research.¹⁸ According to ISO 8373, robots require “a degree of autonomy”, which is the “ability to perform intended tasks based on current state and sensing, without human intervention”.¹⁹ Robotic vacuum cleaners are the most highly adopted computational robots in the world.³

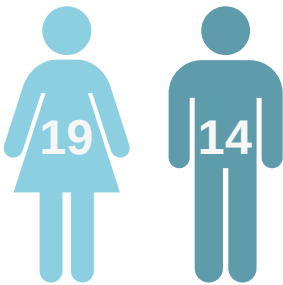
RESEARCH PARTICIPANTS



3 TRIAL HOUSEHOLDS

SUMMARY OF TRIAL PARTICIPANTS

Total Participants



33 Participants
23 Households
19 Women
14 Men

Ongoing Device Use



Household Composition



9 Single-Occupant
(7 women, 2 men)
11 Dual Occupants
2 3+ Occupants

Pets



3 at 3 homes
1 at 1 home
7 at 4 homes

Age

Average age: 81.8
Age Range: 73-93

Age Breakdown:

70-74: 1 Participant
75-79: 10 Participants
80-84: 13 Participants
85-90: 7 Participants
90-94: 2 Participants



Born overseas: 1 participant
Aboriginal Australians: 2 participants



Home ownership

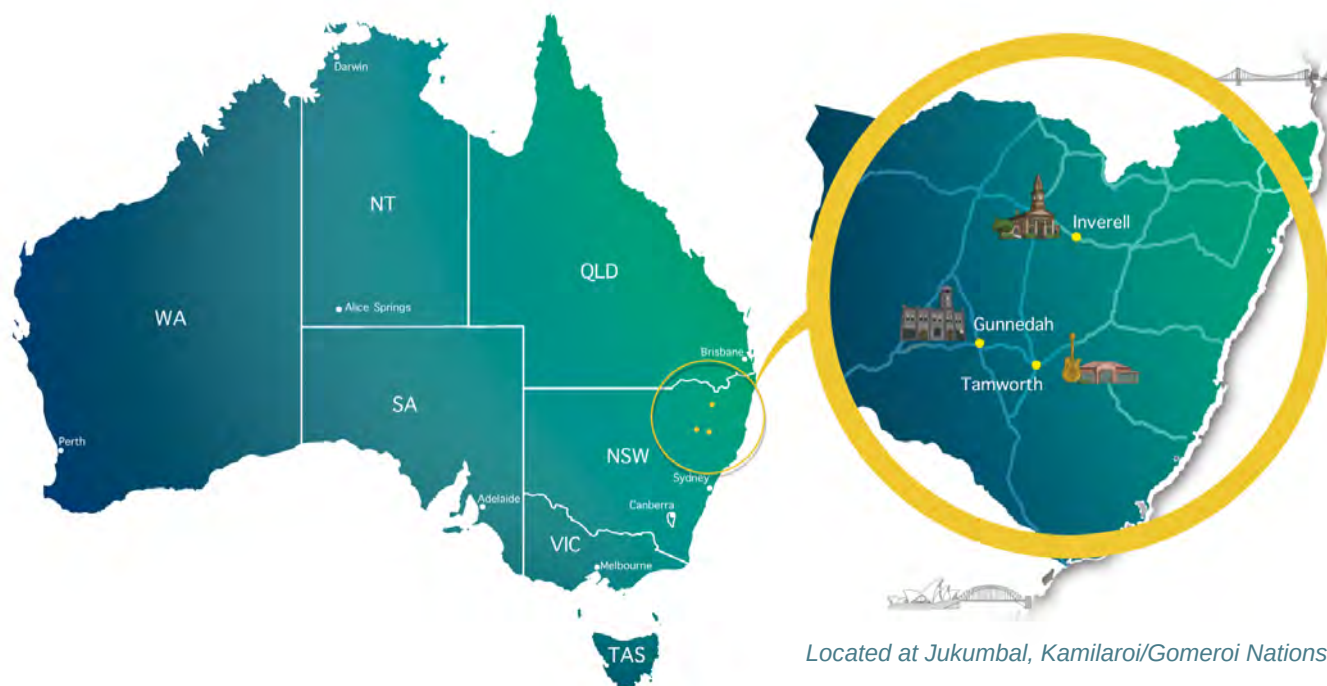
Home owners: 14
Shared-ownership: 5
(with family or third party)
Undisclosed: 3

Location

Gunnedah, NSW: 6 households (9 participants)
Tamworth, NSW: 4 households (8 participants)
Inverell, NSW: 12 households (16 participants)

4 RECRUITMENT, PARTICIPANT TRAINING AND SUPPORT

Map: Community locations for households participating in the trial



Located at Jukumbal, Kamilaroi/Gomeroi Nations

Participant households were recruited by McLean Care from their existing CHSP client base in the regional NSW communities of Inverell, Tamworth and Gunnedah. Participants were deemed eligible for the project if they:

- Were a CHSP recipient (aged 65+ or 50+ for Aboriginal and Torres Strait Islander people);
- Were not living full-time with anyone under the age of 65 (or 50 for Aboriginal and Torres Strait Islander people) as this may have caused interference with the devices and impacted the reliability of the research results;
- Had reliable mobile phone reception in their home (required to operate the devices); and
- Did not have any visual or hearing impairments which would impact their ability to operate the devices.

Potential participants were randomly selected from a list of McLean Care's CHSP clients and contacted by telephone by the project manager. During the phone call, further information was provided about the project and its aims. The eligibility of potential participants to participate was

verified and they were given the opportunity to ask any questions, including what their participation would entail at a practical level. All participants were advised that participation in the project was voluntary and would have no bearing on the services they receive from McLean Care. Possible impacts of the project, such as slight variations in the participant's household energy consumption and power bills were also discussed.

Overall, a total of 33 participants were recruited across 23 households. In some coupled households, both partners were CHSP recipients. This final number of participants exceeded the participation target set for the project by more than 60%.

Deakin University and Monash University research teams each received Human Ethics approval from their respective Human Ethics Committees. As a thank you for their time, each household received a \$50 supermarket gift voucher after completing the first and final stages of the ethnographic research (up to 2 vouchers per household).

Following recruitment, the McLean Care project technician visited each participating household to further discuss the project and gain signed consent to participate. This initial meeting was also used to understand the layout of the participant's home and consider which devices might best meet the household's needs. Participants were shown a sample of each of the devices from which they could select their preferred combination in consultation with the project technician.

At the second visit, the selected items were configured and installed and the technician gave participants basic training in how to operate them. Simplified user guides for each device (prepared by the project team) were also provided and left with participants for their reference as required.

During the life of the project, participants could ring the technician for troubleshooting support. For instance, on some occasions, the technician was able to guide participants to reboot the vacuum cleaner, highlighting both the willingness and ability of participants to learn technical fixes over the phone. Remote monitoring of devices also enabled proactive provision of support when a notification was received that a device was offline or dormant for an extended period of time.

Where issues could not be solved over the phone, the technician visited people in their homes. During the COVID-19 pandemic additional infection control and safety measures were implemented and in-home visits were limited.

A Project Steering Committee with key staff from each of the three partner organisations was established to provide oversight and governance for the life of the project. The Committee met regularly throughout the project term and worked together to track progress against project milestones, to troubleshoot any emerging issues and to actively monitor and mitigate risks. This was particularly important as the project was impacted by both the summer bushfires of late 2019 and early 2020, and the global COVID-19 pandemic. Both events required the team to adapt their approach to travelling in the regional communities where the

project was undertaken. Overall, the combined expertise, knowledge and contribution provided by the three partner organisations was considered to be a fundamental aspect to ensuring the project's success.

As part of the Committee's commitment to continuous improvement, a self assessment was conducted at the conclusion of the project in June 2020. An anonymous online survey was developed to gauge the Committee members' feedback in relation to the effectiveness of the governance model used, project outcomes, the utility of the three-way partnership model, what worked well and what challenges were encountered. All Committee members completed the survey and the results showed that the team members considered that:

- The Project Steering Committee:
 - Was effective and fit-for-purpose;
 - Delivered on what it said it would do;
 - Actively monitored and managed issues and risks; and
 - Was an effective forum for inter-organisational collaboration.
- The project:
 - Achieved its intended outcomes and was effectively delivered;
 - Was delivered in accordance with the funding objectives;
 - Made a worthwhile contribution to the field;
 - Contributed new insights to the field; and
 - Had a positive 'real life' impact on the participants.
- The people involved:
 - Had the right skill sets;
 - Knew what they were doing; and
 - Pulled their weight and did what they said they would.
- The collaborative partners:
 - Worked well together;
 - Would consider working in a collaborative arrangement again;
 - Would specifically consider working with the same partners again; and
 - Found the project professionally satisfying.
















5 INSTALLED DEVICES

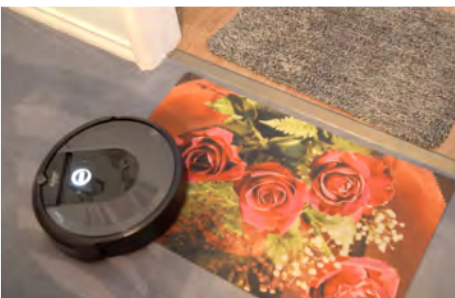
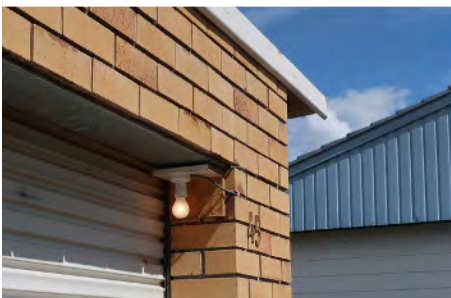
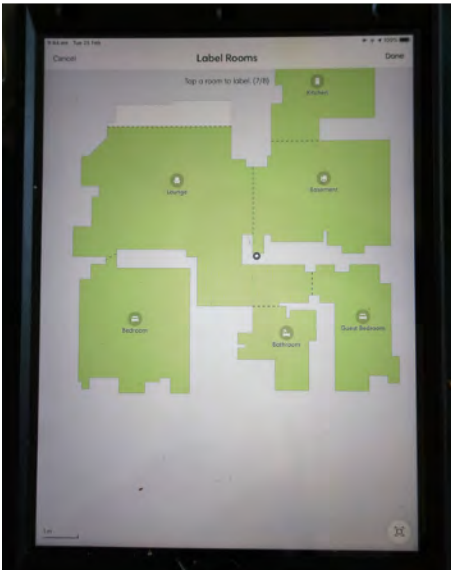
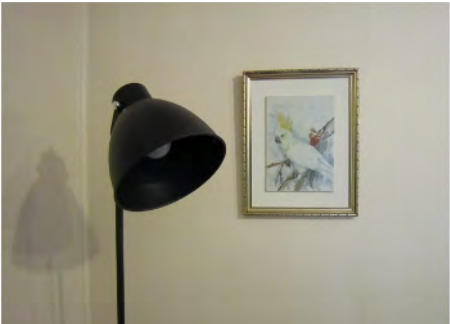
The project team undertook an internal selection process to identify smart home devices that would be used throughout the trial. The selection process looked at functionality, capability (e.g. communication protocols, proprietary technologies, closed or open systems) and connectivity (Internet, network and other requirements) of a range of commercially available smart home devices. The availability of stock also influenced the final selection of devices. Only 'plug and play' devices that could be easily removed if required and did not require hard-wiring or permanent modification to participants' homes were used.

The device selection process was carried out completely independently of any advice or incentives provided by device manufacturers or distributors.

Participants were guided by the project team to select from this suite of devices. Table 1 provides a list of devices installed into each of the participating households. For more detail on the devices installed in participants' homes, see Section 7.2.

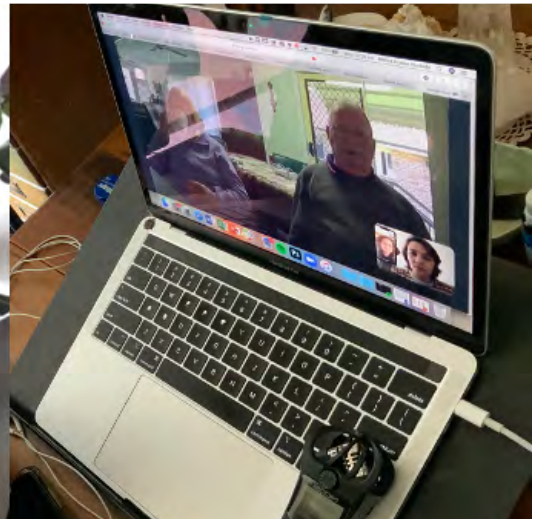
Table 1 – List of smart devices installed into participants' homes

Home (as per trial)	 Google Home	 Aeotec Smart Lights	 Aeotec Smart Switch	 Fibaro Smart Button	 Aeotec Motion Sensor	 Fibaro Door Sensor	 Fibaro Key Fob	 Roomba Vacuum	 Kogan Smart Kettle	 Sonos Speaker	 Remotec Air-conditioner IR Controller	 Netamo Weather Station	 Fibaro Flood Sensor	 Clock	 iPad	Withdrawal Date
Home 1	4	3	1	3	1	0	0	0	0	0	0	0	0	0	1	3/6/2020
Home 2	3	2	0	2	0	0	0	1	0	0	0	0	0	0	1	
Home 3	4	3	0	3	0	0	0	0	1	0	0	0	0	0	1	
Home 4	4	2	1	3	0	0	1	1	1	0	0	0	0	0	1	5/4/2020
Home 7	4	4	1	3	0	1	1	1	1	0	1	1	0	0	1	
Home 8	4	2	0	2	0	0	0	1	0	0	0	0	0	0	1	
Home 9	3	1	4	2	0	1	1	0	0	0	0	0	0	0	1	22/5/2020
Home 10	4	2	4	6	0	0	1	1	1	0	1	0	0	0	1	
Home 11	3	4	0	3	0	1	1	1	1	0	1	0	0	0	1	
Home 12	3	2	0	2	0	0	0	1	0	0	0	0	0	0	1	21/6/2020
Home 13	4	0	1	1	0	0	0	1	0	0	0	0	0	0	1	
Home 14	3	3	1	4	0	0	0	1	1	0	0	0	0	0	1	
Home 15	4	3	0	2	0	1	0	1	1	1	1	0	0	0	1	21/6/2020
Home 16	4	2	0	2	0	0	0	1	0	0	0	0	0	0	1	
Home 17	3	2	1	2	0	0	1	1	1	0	0	0	0	1	1	
Home 18	4	3	0	3	0	0	1	0	1	1	0	0	0	0	1	22/6/2020
Home 19	4	2	0	2	0	0	0	1	0	0	0	0	0	0	1	
Home 20	4	6	0	4	0	2	1	1	1	1	0	1	2	1	1	
Home 21	3	3	0	2	0	0	1	0	1	0	0	0	0	0	1	28/2/2020
Home 22	3	1	3	4	0	0	1	0	1	0	0	0	0	1	1	
Home 23	3	4	0	2	0	2	0	0	0	0	0	0	0	1	1	
Home 24	3	2	1	3	0	0	0	0	1	0	0	0	0	0	1	18/2/2020
Home 25	3	2	0	2	0	0	0	1	0	0	1	0	0	0	1	
Totals	81	58	18	62	1	9	10	15	13	3	5	2	2	4	23	
Homes	23	22	10	23	1	6	10	15	13	3	5	2	1	4	23	



6 PROCESS AND RESEARCH METHODOLOGY





Research team in action during fieldwork visits: Mick, Melisa, Rex, Sarah, Yolande and Larissa are seen interviewing, filming, testing devices and doing home tours with the following participants: Francis, John and Shirley, Edna and Bob, Mary and Ian, Robert, Hilda and Owen, Helen and Ken.

The interdisciplinary methodology developed in this project is innovative and a world first in bringing together visual, digital and virtual design ethnography methods from the social sciences developed by the Emerging Technologies Research Lab at Monash University with home data collection and technical monitoring methods developed by the CADET Virtual Reality Training and Simulation Research Lab at Deakin University. The project provides an example of how interdisciplinary methods can be tailored to specific socio-technical research questions as well as establishing a transferable template that can be used by others in future projects relating to understanding everyday smart device and service use and design.

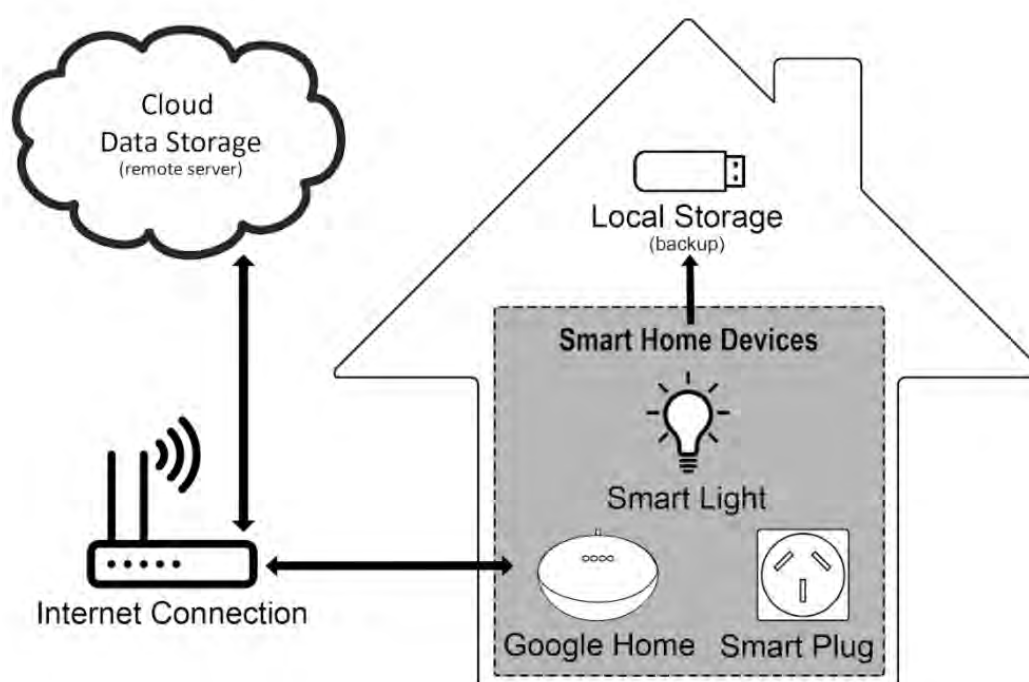
6.1 SMART HOME DATA COLLECTION AND MONITORING

In order to support the operation and monitoring of the smart home devices as well as the corresponding data collection activities, the Deakin University team developed a bespoke data collection framework as shown in Figure 1. The framework was designed specifically to monitor the operation of the smart home devices and to report on issues affecting their operation

such as a loss of Internet connection or whether a device was not operating as intended. If the Internet connection within a home was interrupted the home would be detected as being offline and an email would be sent to the research team alerting them of the issue. Potential problems with the smart devices were also flagged if there was no activity detected for an extended period of time.

The framework also supported the research team in acquiring, collating and analysing research data from the smart home devices in participants' homes. Data was only collected subject to receiving informed consent from participants. Collected data included when a smart light bulb was used, or when a voice command was made to a Google Home device. The acquisition of data was achieved by monitoring all smart devices for changes and then storing information when a change occurred. The data collected was then collated into a standardised format and securely stored both locally and in the cloud. This meant that data could be securely logged even when the internet was unavailable with a local backup of collected data.

Figure 1. Smart home monitoring and data collection configuration used during the trial



6.2 ETHNOGRAPHIC RESEARCH

Monash University used an ethnographic research process involving video ethnography and digital ethnography methods and approaches that the Emerging Technologies Lab leads in internationally. The methodology was innovative in two ways. Firstly it involved interventional ethnographic techniques of collaborating with participants to explore their experiences of and learning with the devices (rather than observation which tends to dominate in user studies). Secondly, it developed new online video research methods in the context of the COVID-19 pandemic, which enabled researchers to maintain their close discussions with participants in their homes using video conferencing and mobile platforms.

The ethnographic research was designed to:

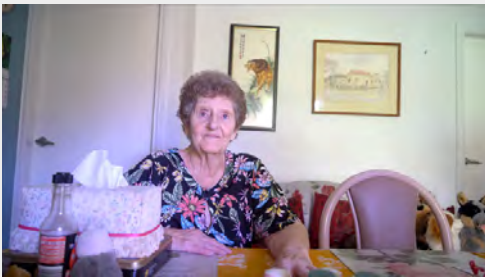
- Take researchers into the everyday lives and worlds of participants in situ in their homes in order to understand the complexities of the circumstances in which they experienced the devices;
- Reveal otherwise invisible aspects of participants' sensory, emotional and practical experiences of using the devices; and
- Understand how participants learned to use the devices, how they were beneficial and where they presented challenges.

The research was undertaken in three stages, and was complemented by the device data collection undertaken by Deakin University.



Stage 1: The Monash research team undertook video ethnography which involved a series of face-to-face activities with participants in their homes, all of which were video and audio recorded, and transcribed. Researchers explored with participants the details of their experiences of using the devices, how they had become part of their lives and everyday routines and the challenges they faced with them. These deeply engaged encounters included, for instance, communicating with Google Home and

using the devices with participants, as well as touring their homes to understand how the devices had become embedded in their home life. During these home visits, a Deakin researcher would troubleshoot any technical issues, and then worked with participants to ensure that they could continue to use the technologies. Before leaving, the Monash team invited participants to keep a diary of their experiences with the technologies, which we would review with them at the next stages in the research process.



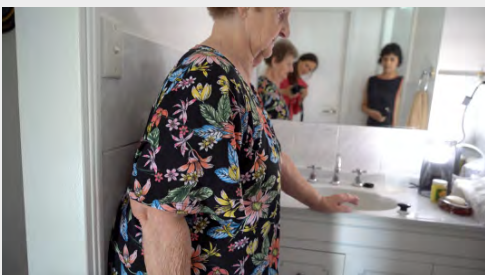
The Monash team interviewed Edna and her husband, Bob at their kitchen table.



As Edna got up to take us on a tour of her house she started to discuss her experience of the technologies with us further ...



...in conversation with Bob who showed us how he had encountered using the fan.



We worked in teams of two researchers, one video recording and the other audio recording. Here we are discussing Bob's successful use of the smart bathroom light with Edna.



Our tour of the home included Edna and Bob's bedroom, where Edna demonstrated to us how she used Google Home to play her favourite music by Andre Rieu, while she made the bed during her morning routine.



Our tour ended in the living room, where Edna sat in her favourite chair from which she could give voice commands to Google Home. She asked the smart kettle, which she told us she only used for guests, to boil some water so she could make us a cup of tea.



Finally, we sat down with Mick from the Deakin research team (who was in the background setting up the technologies for remote data collection) so that Edna and Bob could discuss the challenges they had encountered with the technology and how these might be resolved.



In stage 3 we interviewed Edna and Bob via video call finding a new way to be in her home with them. Edna sat in the same chair in her living room, where she had spoken to us during our visit, using the iPad for the call.



She turned the iPad to Bob, sitting in his own favourite chair, repeating our questions to him so that he could hear.

Stage 2: Monash researchers made a series of short follow-up phone calls (10-20 minutes) to representatives from each participating household. Where possible, participants also used and experimented with the devices during these calls. The impact of the COVID-19 pandemic was covered in relation to any changes in use of the devices due to spending more time at home.

Stage 3: The third and final round of Monash fieldwork was undertaken remotely due to COVID-19 restrictions and because the participants belonged to a vulnerable group. Virtual home visits involved using digital platforms and devices such as mobile phones and tablets for voice and video calls. These calls enabled researchers to access participants in their homes using both audio and video, bringing with them the prior research knowledge of the layout and use of the home gained in stage 1 in order to ask follow-up questions as well as participants' evaluations of and reflections on the devices themselves and the trial. Diaried experiences were discussed with the research team where available.

6.3 SMART HOME DATA AND ETHNOGRAPHIC ANALYSIS:

Smart home data analysis:

- Smart home device data for the smart lights, smart buttons, motion and door sensors, smart switches, and key fobs were collected directly from the Fibaro Home Centre 2 gateway;
- Google Home device data, including voice requests, was collected from the associated Google accounts using the Google Takeout feature;
- Usage data for the smart kettle and robotic vacuum were determined indirectly based on voice requests made to Google Home to interact with the devices;
- All usage data collected throughout the trial was stored in a secure and centralised database; and
- Data was then analysed at the device, home, and aggregate levels using standard data analysis techniques and tools.

Ethnographic analysis: The video and interview materials were analysed by the Monash research team where each participating household represented a case. Each case was analysed in two ways. The first was to use a set of questions developed by the Monash research team corresponding to the aims of the project. The second was to derive additional recurring themes and corresponding insights from the case materials. These findings were aggregated to detect patterns and overall findings and insights.

Cross-analysis between the research teams: The Monash and Deakin research teams met regularly to analyse and discuss the findings at key stages in the project. This was approached using a number of different methods including:

- Reviewing the available technical data and contextualising and interpreting the usage trends and patterns through the ethnographic insights; and
- Identifying the ethnographic insights and cross-checking these with the available technical data to confirm insights and identify anomalies.

6.4 USER REVIEWS

At the end of the trial period, participants were collaboratively engaged by the McLean Care project team in a process of co-design, to determine how the devices should be reviewed and what the most user-friendly design would be for displaying this information online. This was considered important to ensure that the design of the website and display of the user reviews would be easily accessible for older people who may access the website.

This process resulted in surveys examining how easy each device was to use, its look and feel, its reliability (how well it worked), and the perceived overall benefit of using it. Each participant was also asked to rate each device out of five and was given the option to provide general comments about the devices. These reviews were then published on a dedicated project website, with the intention of providing other older people with a useful point of reference when potentially considering the use of similar devices in their own homes.

6.5 FINAL SURVEY

In conjunction with the user reviews, participants were also invited to complete a final survey about the project administered by McLean Care. The survey explored how likely participants were to continue using the Google Home suite of devices (comprising the Home, Nest Hub Max, and Mini) for general use, the Google Nest Hub Max specifically for video calling, the Roomba vacuum cleaner, and the combination of the smart button and smart light in the bathroom. Participants were also asked if they would be willing to pay to use the devices in the future, whether they thought other people may be willing to pay to use the devices, and how likely they would be overall to recommend the devices to others. Participants were also asked to provide general feedback on the project in relation to what they had particularly enjoyed, and what could be improved in the future.

6.6 HOW TO READ THIS REPORT

The remainder of this report is focused on presenting the combined technical and ethnographic research findings analysed by Deakin and Monash University research teams, supplemented by user reviews and a final survey administered by McLean Care.

All participant data collected from devices, user reviews and survey data are anonymised throughout the report. For the ethnographic findings (particularly quotations and vignettes presented throughout), real names are used where participants gave permission; and pseudonyms are used for all other participants and marked with quotations (e.g. "Jodie").

Quotes, user review comments and Google transcripts are included verbatim to preserve participant language and demonstrate Google's (mis)interpretations of participants' voice commands. Text contained within parentheses [square brackets] is included inside some participant quotes to provide contextual meaning or information. Ellipsis points (...) indicate that the text inside a quote has been edited for brevity and clarity.

Photographs and video stills of the devices, researchers and participants that appear throughout this report were taken by the Monash research team during ethnographic fieldwork, and are reproduced here with the participants' and researchers' consent. The photos of participants' homes are not only illustrative; they also form part of the ethnographic findings and show how the devices are integrated into participants' lives.

RESEARCH INSIGHTS





7 USE AND UPTAKE OF DEVICES

7.1 EXPECTATIONS FOR TRIAL PARTICIPATION

Based on feedback collected during the recruitment process and from the ethnographic research team, participants' expectations for the trial fell into three key themes.

1. Learning about innovative technologies and exploring the personal benefits these could bring to their homes and lives.

"Well, if you don't give it a go, you'll never know. So I thought, 'Well, nothing gained, nothing lost.' You don't know until you have a go, do you?"

Barbara

2. Providing benefit to other older people, who were older or more physically restricted than the participants. A third of participants were sceptical about the benefits of the devices for their own household but felt their participation in the trial would help others, and all saw their participation in the trial as a contribution to the ageing community. Therefore the research outcomes of the trial were part of participants' expectations.

"I think it's [the smart technology] a good thing to have if you're not very mobile or if you – I think it would be a good thing to have if you weren't that well."

Robin

"If it's [my participation's] been any help to other people, well I'm glad I was able to have been of some assistance."

Francis

"I thought, you know, if we're going to do a trial, we might find out something for other people as well."

John

3. Giving their families and loved ones some peace of mind by having additional help at home from the devices and the trial team.

"I think for enabling ageing people to be able to stay at home. I think it could be really, really beneficial, especially when our aim is to try and stay at home as long as we possibly can to try and keep our independence and still feel like you're a part of a community instead of feeling like you're segregated in a residential care facility. I like the way that it is adaptable so it can be adapted to each person's individual needs."

Daughter of participant

Other reasons participants gave for their participation included to:

- Maintain and diversify their social connections;
- Improve their sense of safety, comfort and convenience;
- Facilitate ageing at home, autonomy and preparation for the future;
- Try new technologies offered as part of the trial (for example, several participants observed that they had seen the robotic vacuum cleaners advertised and were interested in trying them out); and
- Express their gratitude for the services and support they received from McLean Care.

"When I heard about Google, I thought it was quite good. Is there an ad on TV about it or something?... I thought gee that sounds different. Then when this [the trial] came up I said 'Oh I wouldn't mind having a go' because I didn't know anything about it."

Robin

"We like to stay at home and be more independent and if we can get more technology like this into our homes, that will make life so much easier for us."

Hilda

When potential participants provided a reason for declining to participate in the project during the recruitment process, these predominantly related to:

- Having other commitments such as planned holidays away with family or known hospital stays that clashed with key project dates;
- Having recently returned home from hospital or recovered from an illness or injury and not wanting any additional considerations to factor into their daily routines during recovery;
- Concerns that they did not have sufficient technology skills to participate (despite reassurances provided by the project manager that prior knowledge and skills were not a prerequisite for participation);
- Concerns that using the technologies may actually diminish their independence or impact on their levels of physical activity; and
- Concerns about the safety and security of the technology itself.

7.2 USABILITY INSIGHTS ABOUT INDIVIDUAL SMART DEVICES

As earlier shown in Section 5, participants had a variety of different smart devices installed into their homes, based on their own unique household composition, housing layout, preferences and needs. This section provides a snapshot of the usability insights for all devices used in this trial.

GOOGLE HOME



The Google Home suite of technologies installed included:

- Google Home;
- Google Home Mini; and
- Google Nest Hub Max tablet installed with the Google Duo application.

Functionality

The Google Home devices provided:

- Voice-activated control of other smart home devices (smart light, smart kettle, Roomba vacuum cleaner, smart switch);
- Voice-activated access to music, news, weather and other information available via Google's search engine; and
- Touch screen and voice-activated tablet interface for video calls (mediated with Google Duo App) and screensavers (via Nest Hub Max).

Installation

81 Google Home devices were installed in 23 homes.

Location

- Google Home devices were placed in kitchens and lounge rooms to achieve larger coverage of areas within the home;
- Google Home Minis were mostly positioned in bedrooms; and
- Google Nest Hub Max devices were placed in areas of most use during the day, at dining tables or side tables next to lounge chairs in living rooms.

The coverage provided by the Google Home suite of devices ensured that participants could access these and activate other devices with voice commands from most locations in their homes.

Usability highlights

Functional applications:

- Enabling the voice activation of lights, kettle, and vacuum;
- Providing access to Internet-related sources of information, including news, weather and facts; and
- Asking for phone numbers and making calls (especially through the Nest Hub Max during COVID-19 physical distancing restrictions).

Entertainment applications:

- The novelty of engaging in conversation with a device;
- Enjoying Google's music, jokes, and trivia;
- Experimenting with the device in relation to daily routines and family relationships; and
- Displaying beautiful and inspiring screensaver pictures on the Nest Hub Max's screen.

User reviews

When reviewing the Google Home Mini, a number of participants commented that it was useful as a bedroom radio – noting that it only took up a small amount of space. However, others found that it was unreliable as it did not always work.

All reviews ranked specific devices out of 5, where 1 meant very limited/ poor and 5 meant very good/ excellent.

Google Home Standard

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.4	4.3	3.9	4.1	4.2

User Reviews

"OK with ABC. No local radio station."

"Mostly reliable but wording for request must be word perfect or I will get a long winded reply and request denied."

"When working great. Tells us to reset. David plays music often and asks for information for songs etc. Also to settle arguments for friendly banter."

"Very good."

"Frustrating when it decides not to work."

"Did not always respond to commands."

"The Google Home is very good. When Ross delivered the Google hub, the use we had had from it has been outstanding. From music, telephone numbers and addresses, recipes, French phrases, talking with our son Neil; there is so much more."

"This worked most of time but sometimes told us it wasn't available or we had to repeat command."

Google Home Mini

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.2	4.2	3.6	4.0	4.1

User Reviews

"Can be useful as a bedroom radio, weather information etc. [It only] takes up a small space on the table."

"Unreliable."

"When working real great but often says it has to be programmed and to check your modem. Yet half an hour later it works."

"Did a good job most of the time but sometimes had to use smart button to turn light off [because the voice command didn't work]."

"Located in bedroom and probably not used enough [to comment]."

"Used mainly for music. One in bedroom for bathroom light and music."

Google Nest Hub Max Tablet

User Reviews

"The Google Duo is very good for world news - cooking recipes - making a shopping list - playing music - phone numbers and contacting people and having an on screen image while conversing - also trivial pursuit."

"[I] enjoyed being able to play music on Google."

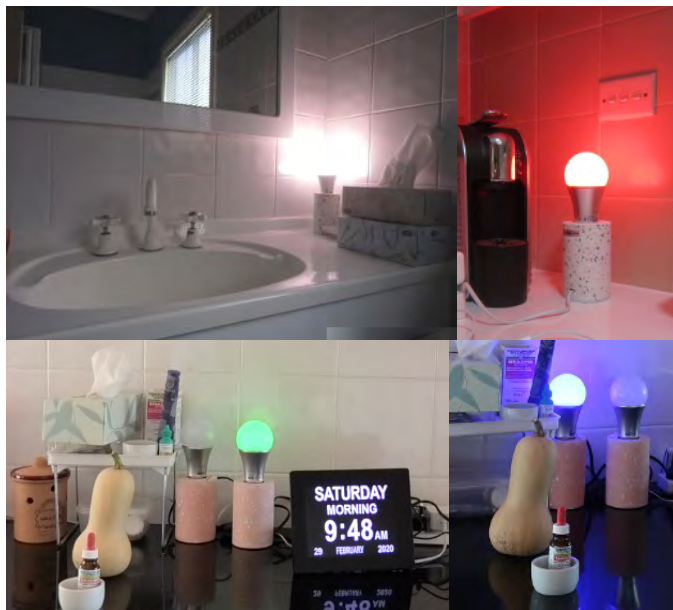
"Mum enjoyed talking to Google."

"Google becomes frustrating at times when replying that you need to do this or that; or is not programmed - yet soon after, without altering anything, it works on the first command. Some of her jokes are very dry. But news and weather of a morning are great."

"To be able to turn light on in ensuite bathroom or the living room through the Google hub is good. Especially late at night."

"Tell google to behave. All she gives me sometimes is angina with frustration."

AEOTEC SMART LIGHTS



The smart lights consisted of:

- Aeotec smart light bulbs (installed in existing lamps in participants homes, or in lamps provided by the project) to light up rooms and pathways at night; and
- Sensor-activated coloured lights to remind participants of everyday activities (medication, garage doors).

Functionality

- Lights (installed in lamps) were controlled by voice activation (on Google Home), push buttons, sensors, fobs, and/or tablets; and
- Coloured lights were programmed with sensors (water, motion, schedule) for different reminders.

Examples from the trial included:

- Red light scheduled for medication routines;
- Green light indicating the garage door was left open;
- Blue light activating in case of water flooding; and
- White light placed at the front door which was activated with movement (from visitors).

Installation

58 Aeotec smart lights were installed in 22 homes.

- Voice- or push button-enabled smart lights were installed in 22 homes; and
- Lights triggered by either motion, water or door sensors were installed in nine homes.

Location

- Voice- or push button-enabled smart lights were located in bathrooms, bedrooms, dining and living rooms, halls and kitchens; and
- Lights triggered by either motion, water or door sensors were located in kitchens and at front doors.

Usability highlights

- Red lights for medication reminders were highly valued and participants with this light reported never forgetting their daily medications during the trial;
- Push buttons for the lights were conveniently placed at side tables;
- Voice commands worked best for participants who found the push buttons challenging. People who got used to using the voice commands were more likely to experiment with levels of light brightness;
- Some participants appreciated these lights' tone and quality, but continued to activate them from the traditional wall switch; and
- Participants used the smart lights at night to light up walkways (e.g. from bedroom to bathroom), or main rooms (e.g. kitchen and living room). They also used them while doing other activities (e.g. crocheting, reading and watching TV).

User reviews

Participants rated the lights strongly, even though their user reviews indicate that they had mixed experiences with the devices.

Aeotec Smart Bulb “Smart Light”

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.6	4.7	4.1	4.2	4.2

User Reviews

“Very easy to use.”

“Works sometimes. A break in electricity will fix it sometimes. A storm: no.”

“No problem. Good to use”

“Like other times, google doesn't work every time.”

“Electrical storms affected use and reliability. Did not always work on Google's instructions.”

KOGAN SMART KETTLE



The Kogan smart kettle provided hands-free, voice-activated control of the kettle.

Functionality

- The kettle had a standard 1.7 litre capacity, which is the equivalent of approximately seven cups;
- The kettle weighed 1.17kg empty or 2.87kg when full;
- A blue light indicated when the kettle was on;
- The kettle could be turned on and off by Google Home using voice control;
- The kettle could also be activated using the physical button located on the top of the handle;

- The kettle was made of glass so that participants could see when the water was boiling; and
- The top of the kettle had a digital thermostat that displayed the real-time temperature of the water.

Installation

13 Kogan smart kettles were installed in 13 homes.

Location

- The smart kettle was located on kitchen benches in place of a ‘regular’ kettle;
- Kettles were situated next to water taps and jugs for convenient refills, and also located nearby microwaves and Google Home devices; and
- The placement of Google Home devices in other parts of the home meant that the kettle could also be turned on and off from other locations.

Usability highlights

- The smart kettle was mostly used to prepare tea and coffee, but some participants also used it for the quick preparation of boiling water for cooking meals;
- Most participants turned the kettle on while they were already in the kitchen, either using voice command or manually;
- Eight households experimented with distant voice activation of the smart kettle (e.g. from the bedroom or living room);
- Five households made distant voice activation of the kettle part of their daily routines;
- The kettle responded to specific commands that differed from participants’ familiar language. Instead of asking Google to turn on the “jug” they had to get used to a different style of communication: “Hey Google, turn on/off the smart kettle”;
- The digital screen gave participants additional signs of the water’s current temperature to confirm the boiling point and be mindful of not burning themselves;

- Some participants felt the kettle was too heavy for older people (in contrast to smaller plastic kettles). A way around this issue for participants was to only partly fill the kettle; and
- Participants were uncertain if there was a safety mechanism to prevent burn-outs. Being unsure of this meant that some preferred to be present at the moment of activation to ensure water levels were adequate. Others made filling it every night before going to bed part of their night-time routine.

User reviews

The Kogan smart kettle was rated highly by participants and mostly received positive reviews, with some specific usability concerns around weight and remote activation.

Kogan Smart Kettle

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.6	4.8	4.6	4.6	4.7

User Reviews

"The Smart Kettle is good, it works efficiently and saves legwork."

"Quite heavy for elderly people making it harder to pour."

"Often tells us to reset - so [we] used [the] manual switch at this time."

"It's too heavy; otherwise [it's] great to turn on from the bedroom."

"Very nice jug. But sometimes [I] have to ask google repeatedly to turn on. She has plenty of excuses. But [it's a] beautiful jug."

"Opening lid failed towards [the] end of [the trial] time. Took several attempts to get it open."

"So simple but so efficient."

"A bit temperamental to use."

"The jug has been great."

"[I'm a] fan of the jug"

ROOMBA ROBOTIC VACUUM CLEANER



The Roomba robotic vacuum provided participants with a hands-free and automated alternative to the manual vacuuming and cleaning services provided by McLean Care staff or undertaken themselves.

Functionality

- The Roomba vacuum was connected to Google Home, and activated by voice commands;
- Participants could also activate the Roomba via an app installed on the provided iPad tablet, and by selecting specific rooms of the house;
- The Roomba worked by 'mapping' the home based on the areas it vacuumed. This map was also available in the Roomba app;
- The Roomba was 'stored' in its charging base, which it automatically returned to when vacuuming was completed or when participants asked it to stop;
- The Roomba was self-cleaning and upon returning to the charging base would discharge its waste in a disposable bag; and

- The Roomba vacuum came with a virtual barrier, commonly referred to as 'stopper' by participants, in the form of a 12cm tall rectangular prism with an 8x8cm base. The stopper created an exclusion zone by emitting a signal to the vacuum. This helped participants to have control over areas that they didn't want the vacuum to enter.

Location

The Roomba's charging base was located in central areas of the home to facilitate easy navigation throughout the main areas that it was programmed to cover (e.g. kitchen, living and dining rooms).

Installation

15 Roomba robotic vacuum cleaners were located in 15 homes.

Usability highlights

- The Roomba vacuum was used by participants to complement the fortnightly or monthly cleaning services they received from McLean Care;
- The Roomba was generally used weekly in high traffic areas (e.g. kitchen, dining and living room);
- In some homes, the Roomba was also programmed to vacuum some, but not all, of the bedrooms. However, these were vacuumed less frequently and often left for the professional cleaners to do;



- At the beginning of the trial, some participants had difficulties remembering the commands needed to operate the Roomba via the Google Home. These challenges eased with time, practice and help from the project team;
- Participants were pleased with the cleaning results delivered by their robotic vacuum;
- At the beginning of the trial participants found entertainment and novelty in watching the robotic vacuum work. However, the early unpredictability of Roomba’s routes and charging cycles were also baffling, requiring time and patience to get used to; and
- After becoming familiar with the behaviour of the robotic vacuum, people often left the room where it was working, for practical and safety reasons (e.g. to get out of Roomba’s way).

User reviews

The Roomba vacuum cleaner was rated strongly positive by most participants, but was considered unreliable by some. User reviews indicated strong satisfaction with the device.

Roomba Smart Vacuum

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.2	4.3	3.7	3.9	4.1

User Reviews

“Excellent! Would love one.”

“The smart vacuum was [of] great assistance to me.”

“Most disappointing. Reduced me to tears at times because he won’t come out of [the] garage room to clean dirty areas (e.g. kitchen) but he does in his favourite room over and over.”

“Very good.”

“Don’t believe suction is as good as it could be.”

Roomba Smart Vacuum

“Found it vacuumed some areas a number of times and missed others completely. Did best job in [the] kitchen with no obstructions to work around.”

“There are some areas we don't use Roomba because it doesn't do a good job. The carpet pile is different - it is good on low pile industrial carpet which we have in the living room and hallway. It is ok on interlocking vinyl. Sometimes I need to use the iPad to send it out to clean. Overall it is a great labour saving device and can clean hard to reach areas e.g. underneath beds.”

“Brilliant.”

“This does a wonderful job but our house [is] too big and [there are] too many chair legs etc. Didn't use it to full capacity.”

“Can be a bit of a worry when it does things different[ly] to what is expected. A great cleaner, appreciated most of the time.”

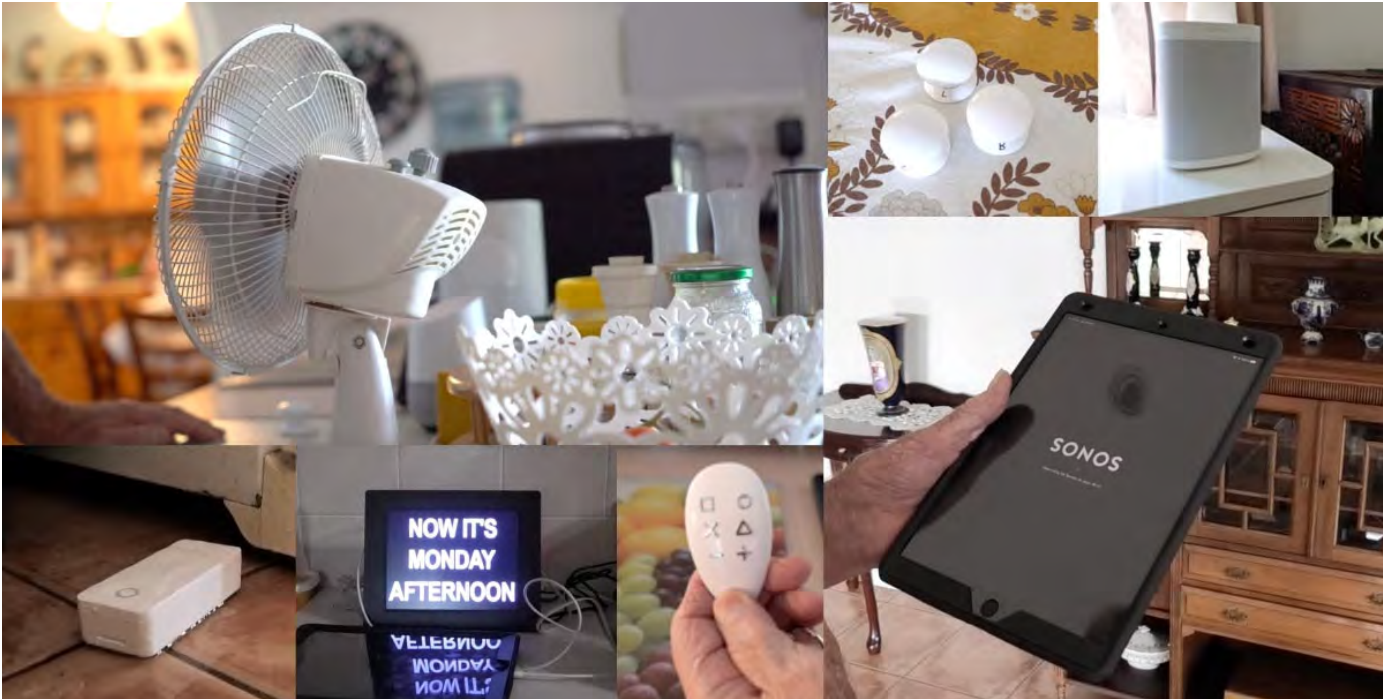
“Vacuum cleaner good but needs better suction.”

“Vacuum cleaner was great. [It is] like having a maid. I find that job hard going.”

“The smart vacuum would be ideal for single persons in smaller area or anyone who was unable to attend to their home cleaning.”

“I like [that] you do not have to do the whole house and can be selective.”

“We're in love.”



OTHER DEVICES

Black Box

A standard network cabinet ‘black box’ was installed in all participants’ homes and contained:

- UPS (Uninterruptible Power Supply) for battery backup;
- Nighthawk M2 modem to provide a mobile internet connection;
- Draytek network router for remote connection;
- Fibaro Home Centre 2, a gateway for smart home devices;
- Z-Wave automation bridge to improve integration of Google Home devices; and
- Raspberry Pi single board computer to capture smart home usage.

The black box was located mostly in hidden corners of living rooms, kitchen pantries or guest rooms. Only a single participant provided a review on the black box: “Smaller main box [would be preferable]. [It is] excessive[ly] large.”

Apple iPad Tablet

An iPad tablet was provided to all homes and pre-installed with several applications (including Fibaro, Automation Bridge, Roomba, Sonos and Google Home) that provided participants with a touch screen interface to control smart home devices installed around the home, including smart lights,

smart switches, Sonos speakers and Roomba vacuum. The iPad was generally located within the kitchen where most participants charged the device.

Sonos Speaker

Sonos music speakers were trialled in three homes and could be controlled by voice activation from Google Home. They were located in dining and living room areas.

Sonos Speaker

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.5	4.5	4.5	4.5	4.5

User Reviews

“I have enjoyed the sonos sound which we use to play music selected on the iPad. e.g. Jazz or classical piano.”

“Just amazingly wonderful.”

Netamo Weather Station

Two weather stations were trialled in two households providing location-specific weather information accessible via tablet voice requests. Weather stations had sensors located both indoors and outdoors to provide weather information for both environments.

Easy Read Digital Clock

Four households trialled digital clocks providing day of the week, date and time. These were located mostly on benches and walls in the kitchen.

Aeotec Smart Switch

Ten households trialled smart switches connected to existing appliances (e.g. pedestal fans) that could be controlled by smart buttons, voice activation, sensors and/or tablet. These were mostly located in living rooms and kitchens.

Aeotec Smart Switch

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.7	4.6	4.7	4.5	4.7

User Reviews

"Used this one all the time for bedroom lights."

"Used for fan – very useful to command."

Fibaro Flood Sensor

Two water flood sensors were trialled in one household. They were both located in the kitchen. The sensors were installed to alert the participant of water leaks from the fridge or from the dishwasher with an alarm and a synchronised blue coloured smart light. These did not report any flooding during the trial.

Fibaro Smart Button

Smart buttons were installed in homes to control smart lights and switches (e.g. pedestal fans). A total of 62 smart buttons were distributed across 23 homes in locations chosen by participants in consultation with the project technician (e.g. bedside tables, kitchen benches, lounge side tables). Some buttons were configured to control multiple devices. This was achieved through programming different functionality based on the number of times buttons were pressed. For example, a single button press controls a smart light in the bathroom, two button presses controls a light in the kitchen, and three button presses controls a smart switch connected to a pedestal fan.

Fibaro Smart Button

Ease of Use	Look & Feel	Reliability	Overall Benefit	Overall Rating
4.3	4.5	3.5	4.0	4.0

User Reviews

"Worked well – occasionally had to press again."

"Works well when Google is working."

"[I] use Google more [than the button]."

"Works sometimes."

"Will not come on – have to hit over a dozen times. Tried softly and firm no go."

"Worked well most times [I] used [it]. Occasionally had to repeat use several times before it worked. I probably pressed too heavily to start with."

"I use[d] to [have to] turn on bed light and bathroom light but with Smart Button I only have to press on and off."

"[I] used red smart button mainly for [the] fan - very good. Not so good with lounge room light."

"Does not work all the time."

Fibaro Key Fob

The Fibaro key fob was an additional method to control the smart devices and was installed in ten homes. This fob, in the form of a key-ring and six buttons, allowed participants to control up to six smart devices (mostly used to control smart lights).

Fibaro key fob

“Pendant requires more suitability for people with Arthritis”

“Great for use when needing to attend the bathroom in the middle of the night.”

“Had difficulty with this.”

“[I] hardly use [it].”

Aeotec motion sensor

Only one motion sensor was installed in a participant’s home. It was installed at the front door and connected to a smart light that was helpful to advise the participants when there were visitors (mostly grandchildren living next door), and for their visitors to easily find their way to the door at night.

Fibaro door sensor

Eight door sensors were installed in medicine cupboards, garages and back doors across six homes. Door sensors were combined with smart lights to provide functionality that reminded participants to either take their medication or warn them of doors that had been accidentally left open (see below for user reviews).

Remotec air-conditioner Infrared (IR) controller

Five air-conditioner IR smart controllers were installed in five homes to connect air conditioners to the smart home system. This offered participants the additional option to activate their air-conditioners with voice commands, smart buttons, key fob and tablet. Only one household provided a review of the air-conditioner smart controller, giving it ratings of 4 out of 5 across all review categories including ease of use, reliability, overall benefit and overall rating.

USER FEEDBACK ON SPECIFIC DEVICE CONFIGURATIONS AND FUNCTIONALITIES

In addition to providing feedback on individual devices, participants were also invited to provide feedback on three device configurations that were trialled.

1. Smart light linked to a Fibaro door sensor on the medicine cupboard

In four households, a Fibaro door sensor was installed in the medicine cupboard and combined with an Aeotec smart light. The light was put on a time-based schedule that related to when participants were required to take their medication. The light would remain on (displaying with a red bulb) until the door was opened when the participant accessed their medication. The three participants who used it for this purpose found it extremely useful. The fourth participant used it more as a safety system to monitor the medicine cupboard while grandchildren were visiting.

Smart light linked to a Fibaro door sensor on the medicine cupboard

Ease of Use	Look & Feel	Reliability	Overall Rating
5.0	5.0	4.8	5.0

User Reviews

“Never overlooked to take my medications.”

“Didn’t use to full potential. Only set up for the door if left open.”

“BEST THING. [It] is a great reminder - one that really helped me [to] take my many medications.”

2. Smart light in bathroom/ensuite linked to voice control and/or smart button

In this scenario, participants could use voice control through a Google device and/or the Fibaro smart button to activate the bathroom light remotely. Brightness of the smart light could also be adjusted for subtle night lighting and a lower wattage bulb was used for this purpose.

This configuration was of particular interest to a number of households as going to the bathroom at night was considered a high risk for falls. This was also useful for coupled households where turning on the main light also potentially disturbed their partner’s sleep.

This configuration was trialled in 11 households. Overall, most households with this functionality found it to be very useful; although some struggled with it not always working as it should.

Smart light in bathroom/ensuite linked to voice control and/or smart button

Ease of Use	Look & Feel	Reliability	Overall Rating
4.4	4.4	4.1	4.2

User Reviews

"Very convenient."

"Great to be able to turn on from the bedroom."

"Use voice commands as button is useless."

"Both the light and the button are very useful and the voice control is outstanding. The ensuite light can be voice controlled from the living room."

"Works well."

"Didn't always work."

3. Fibaro door sensor used for a garage or door warning light

In four households, a Fibaro door sensor was installed either at a garage or back door and combined with an Aeotec smart light. The light would remain on when the allocated door was open with a dedicated warning colour selected by participants. This allowed participants to quickly assess if their home was secure and important doors closed. Participants provided mixed reviews on this functionality.

Fibaro door sensor used for a garage or door warning light

Ease of Use	Look & Feel	Reliability	Overall Rating
4.7	4.5	4.3	4.5

User Reviews

"This light is [a] good security check because it is possible to forget to put the garage door down."

"Excellent."

"Did not suit the intended purpose."

"[Only worked] intermittently (due to distance)."

7.3 OVERVIEW OF DEVICE USAGE INSIGHTS AND TRENDS

Preference for particular smart homes devices remained constant over the trial with Google Home being the most commonly used device

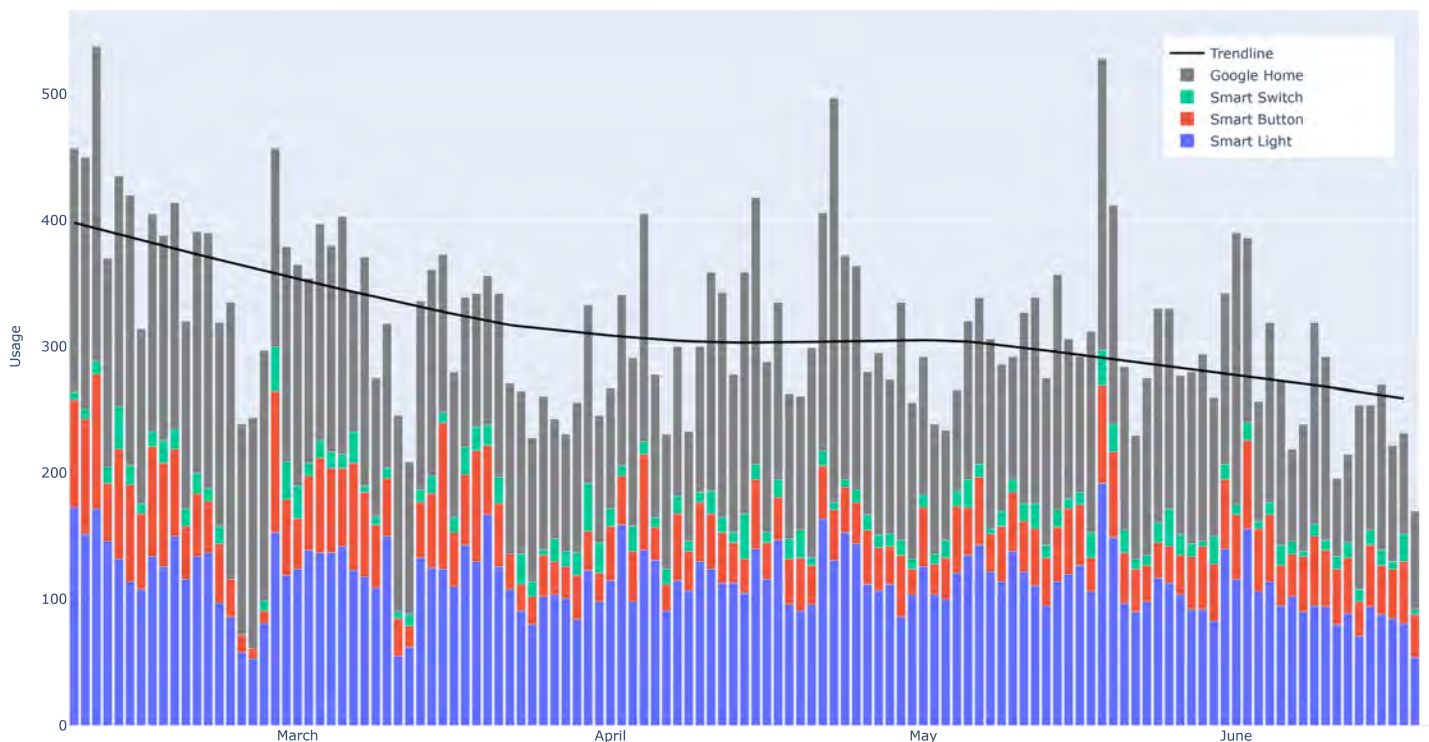
Smart device activity was collected throughout the trial at the device, home and aggregate level.

Figure 2 shows daily usage across all homes over the four month data collection period.

The Google Home suite of devices were the most frequently used devices and smart lights were the second. Participants primarily interacted with the

Google Home devices using voice requests and these voice requests controlled other smart home devices such as lights, switches, kettle and the Roomba vacuum. The trendline presented in Figure 2 demonstrates that the use of these four smart devices mildly decreased over the course of the trial. The initial drop in usage in March was likely due to the initial novelty of the smart devices wearing off. Usage was mainly consistent during April and most of May followed by a decrease in usage towards the end of May and during June likely due to some of the participants withdrawing from the trial.

Figure 2. Daily interactions with the most commonly used smart home devices



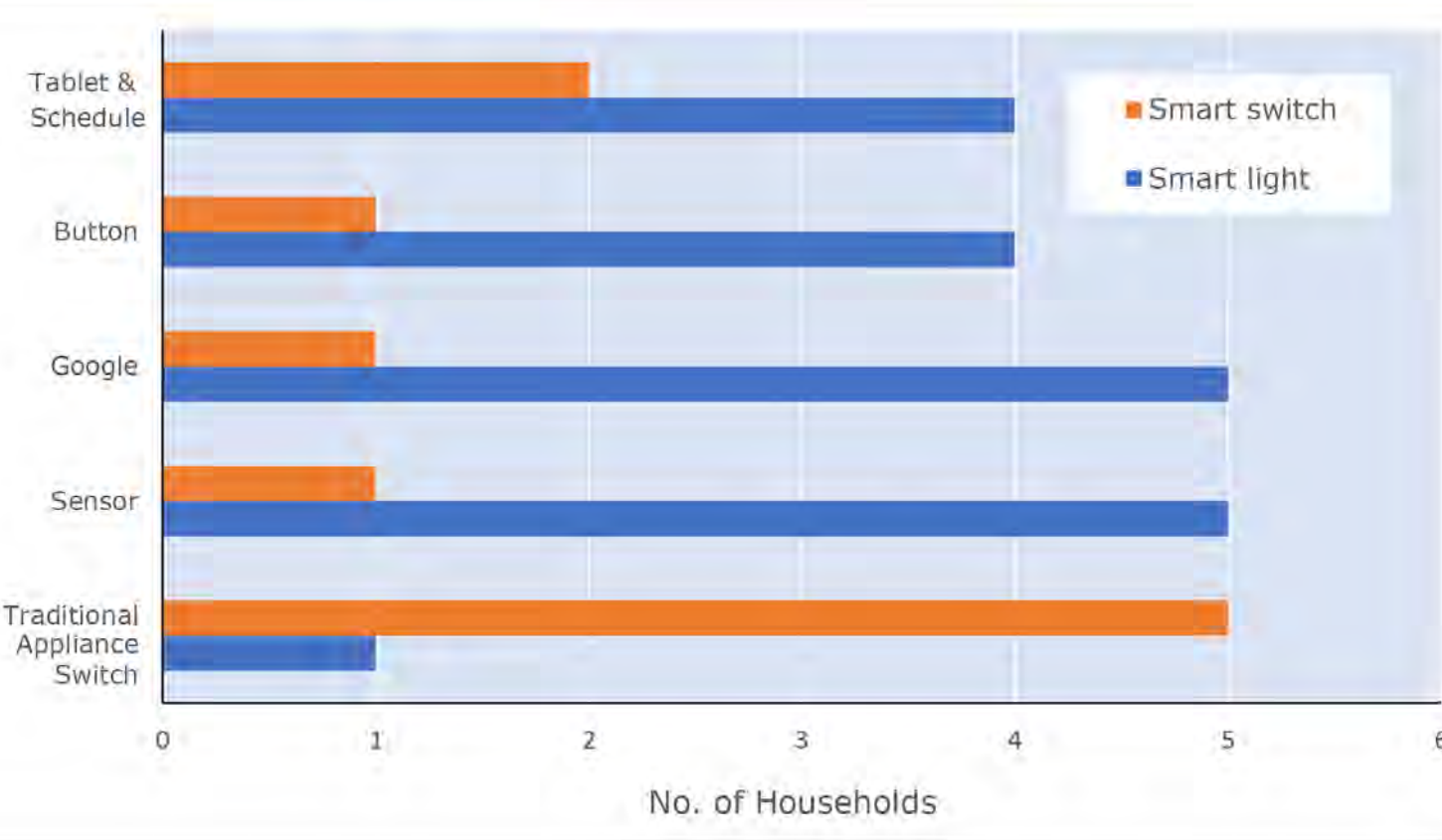
Usage of devices varied widely between households and was difficult to predict

Conversations during the installation of devices and subsequent visits provided little indication of which smart home devices would be used by each household throughout the trial. The research team observed that it took time for households to work out which devices they could confidently operate, and which ones were useful. Devices in which little interest was initially expressed were sometimes later embraced, while in other situations devices that were initially used early on in the trial slipped into disuse once the novelty had passed.

Usage of smart lights and switches varied widely between households and participants preferred different methods of control

Figure 3 shows the different ways in which households interacted with the smart home devices. Approximately half of all participants who had smart lights installed preferred using either a smart button or Google voice requests to interact with the lights. Seven homes had either an automated smart light or smart switch configured to turn on based on a schedule or by a sensor, and for six of these homes these were the devices that saw the highest level of interaction. Half of the households who had smart switches installed preferred using the traditional appliance switch (e.g. located on the fan) rather than interacting with the switch using a smart device.

Figure 3. Households preferred different ways to interact with smart lights and switches

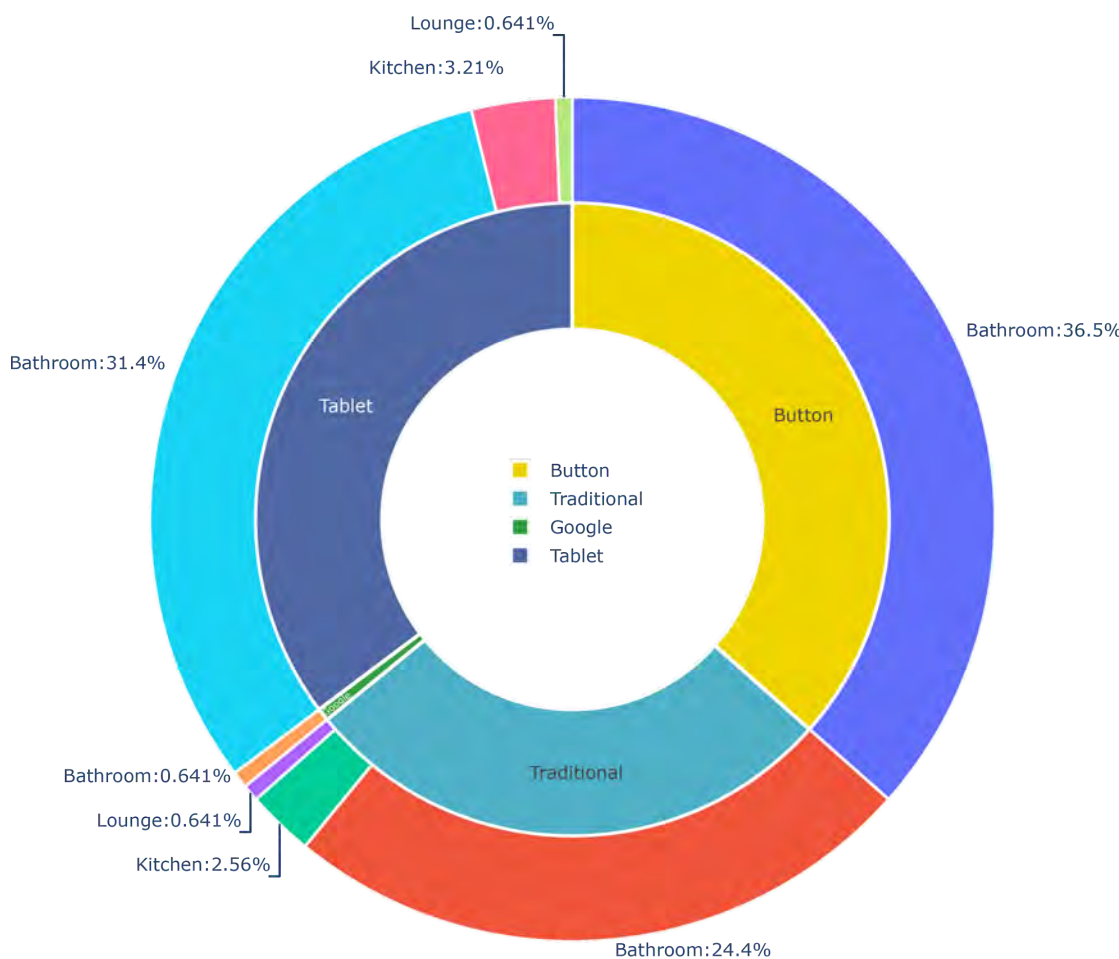


Some participants used a range of different ways to interact with their smart devices while others mainly used one particular method

Figure 4 shows the different methods one home used to interact with their smart lights. This particular home initially used a smart button to control the smart light in their bathroom but then later reverted to using the traditional light switch explaining to the research team that they didn't see a personal benefit in using the smart button, but could see benefits for others.

Other participants suggested that they embraced different methods for interacting with their smart devices due to convenience, reliability, tactility and their ability to memorise new functions.

Figure 4. Household that used a variety of methods to interact with the smart light



Inner pie refers to method used to interact with device, outer pie refers to how often the device was used in each of the rooms.

Figure 5 shows a household that had a strong preference for using Google Home voice requests to interact with smart switches. The smart switches located in the kitchen and family room were used heavily, whereas those in the bedroom and dining room were used far less. Participants that preferred using voice requests to interact with smart lights and switches suggested that the smart buttons were not reliable (particularly for those with tactile issues) and found it confusing to know which button, or the number of button presses, was required to interact with different lights and switches.

Participants comfortable using voice requests to interact with lights had the advantage of being able to change brightness levels of the smart lights, a feature not able to be accessed using smart buttons.

Figure 5. Household with a strong preference for using Google Home voice requests to control smart switches

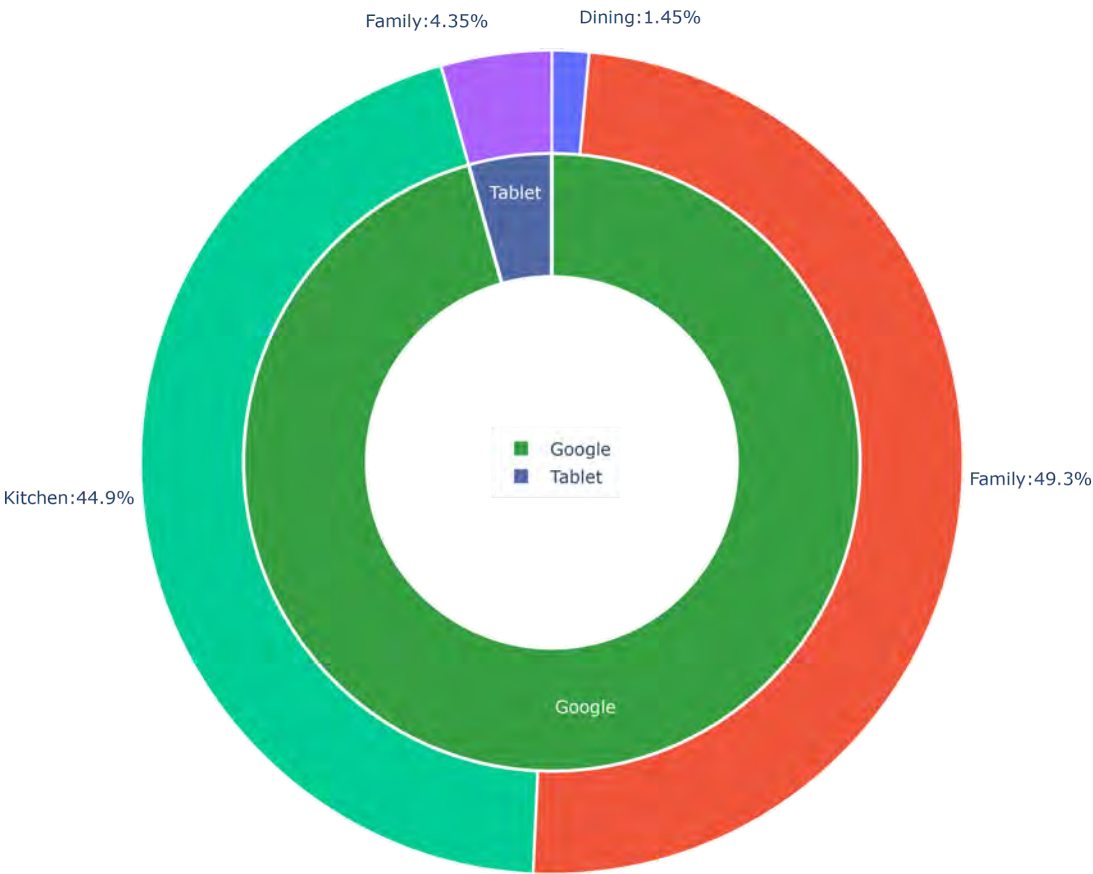


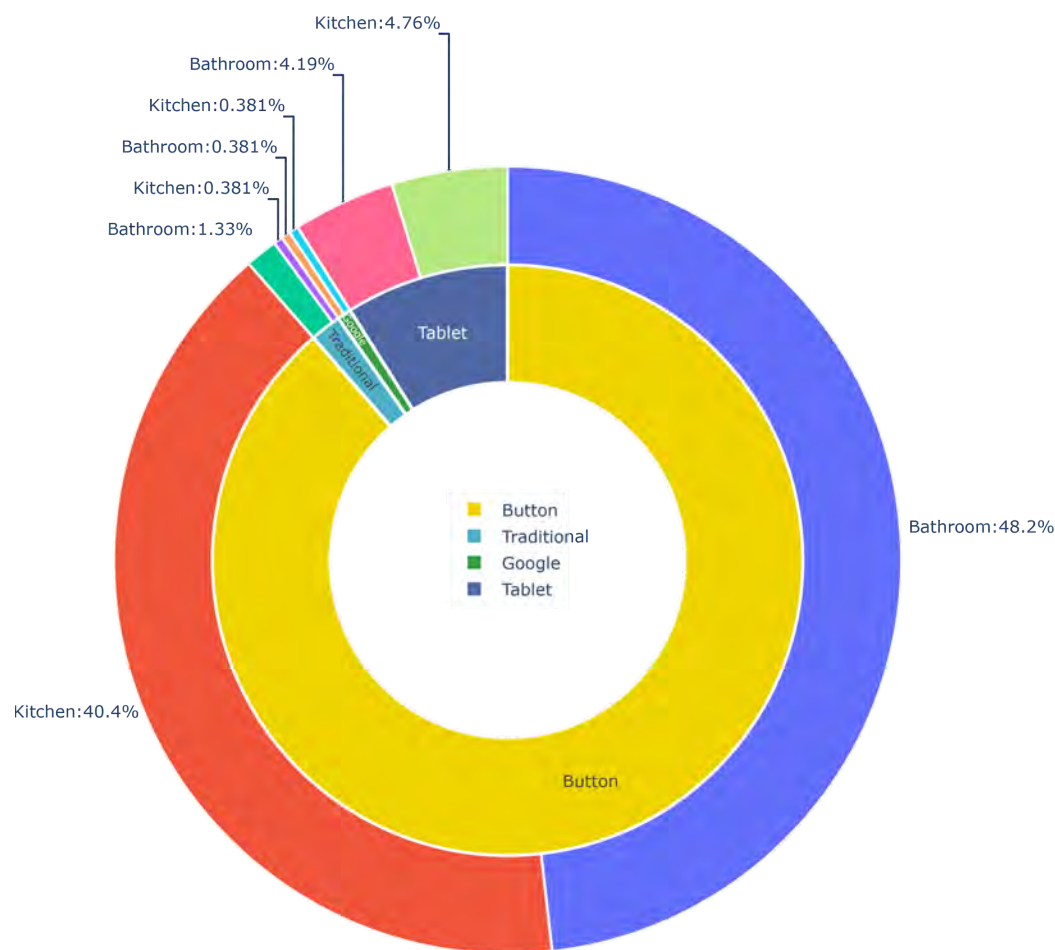
Figure 6 shows a household that had a strong preference for using smart buttons to interact with smart lights.

Participants that preferred using smart buttons to interact with smart lights and switches suggested that the smart buttons:

- Provided tactile feedback which was a more familiar method than making voice requests;
- Were more reliable than making voice requests;
- Were more conveniently placed; and
- Created less disturbance than voice requests particularly during the night.

There were instances when smart buttons failed, and some participants then tried using voice requests as an alternative, suggesting that having different options to operate smart devices added value.

Figure 6. Home with a strong preference for using smart buttons to control smart lights

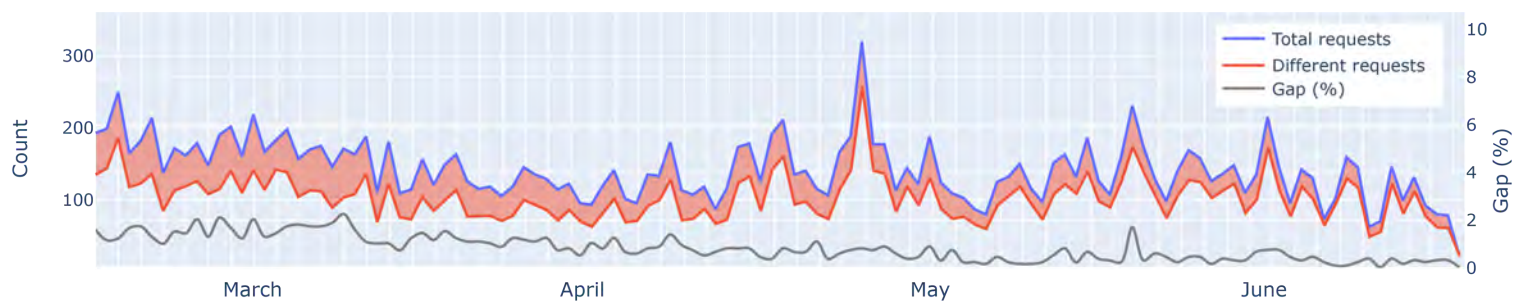


Google Home was used daily by participants and usage remained consistent over time with a slight shift to making more varied requests

Device uptake was contingent on how participants learned to use devices, developed in dialogue with the project technician and research team. While each home had a different set of smart devices installed, all homes had access to at least one Google Home device enabling comparative usage across participant households as shown in *Figure 7*.

Google Home was used daily by most participants with the total number of different voice requests increasing over time as a percentage of overall voice requests. This suggests that as participants became more confident in using voice commands, they started to use a greater variety of commands.

Figure 7. Daily voice requests to Google Home for all participant households over the trial

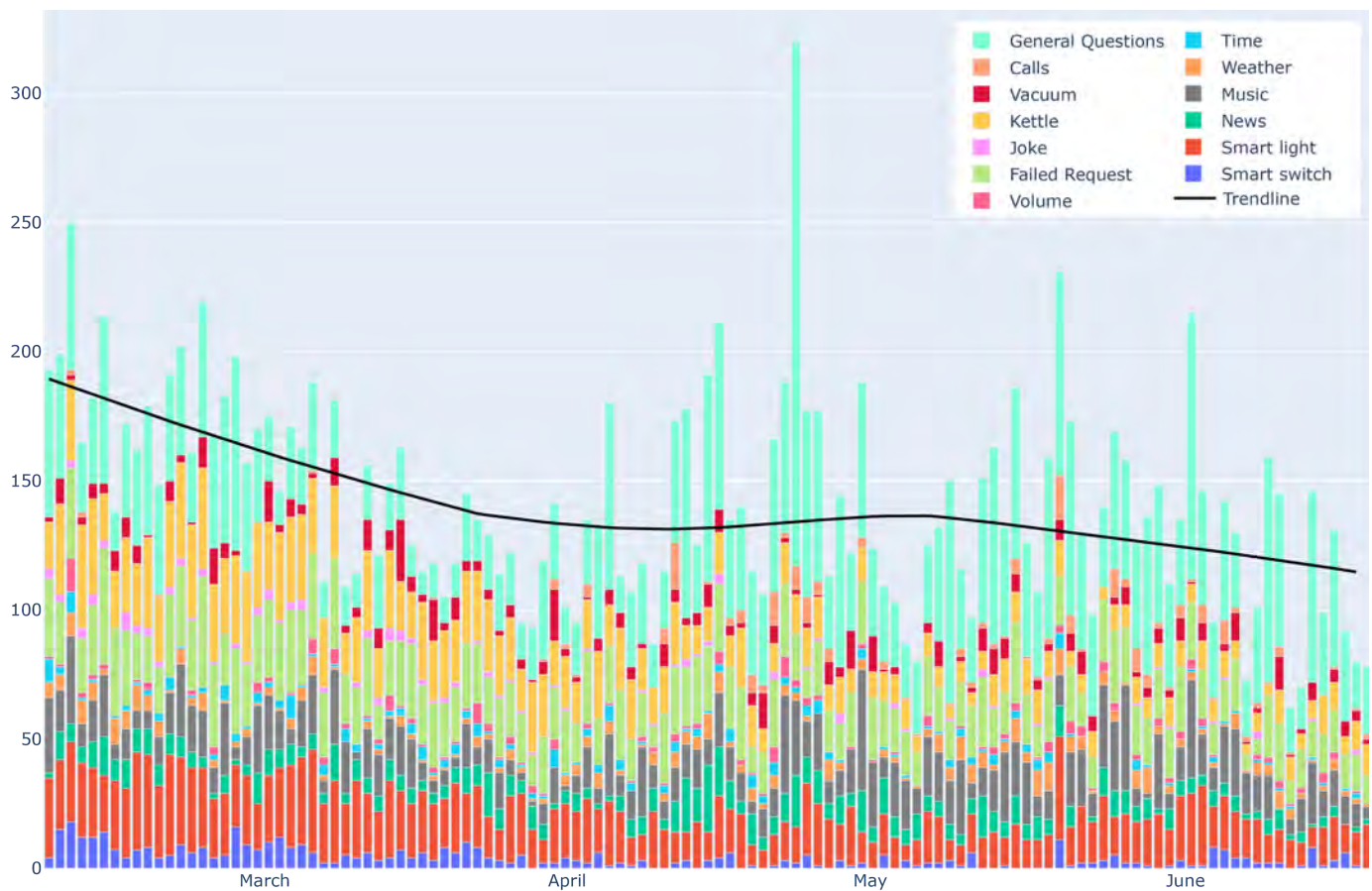


Google Home was a 'gateway' device, that enabled control of other smart devices and access to a variety of information and services

Figure 8 shows the number and types of daily voice requests made by all homes over the trial. The most common use of the Google Home devices (voice-activated) was asking general questions (28.2%).

The next most common use of Google Home was to operate smart devices with the most common requests being to operate the smart lights (14%) and smart kettles (12.6%). Google Home was also used to operate the Roomba vacuum cleaner (3.7%) and smart switches (2.8%) (connected to an existing appliance).

Figure 8. Google Home voice requests over time



Note: The functionality to make video calls using Google Nest Hub Max was added part way through the trial to support participants during the COVID-19 pandemic and help keep them connected with family and friends.

Google Home was commonly used to access music, news and other content

Participants enjoyed easy access to a variety of music via Google Home, which was the fourth most common voice request category (10.7%). Less frequent voice requests included accessing the news (5.2%) and asking for a weather forecast (2.7%). Features such as asking for the time or requesting a joke were only used 2% or less of the time.

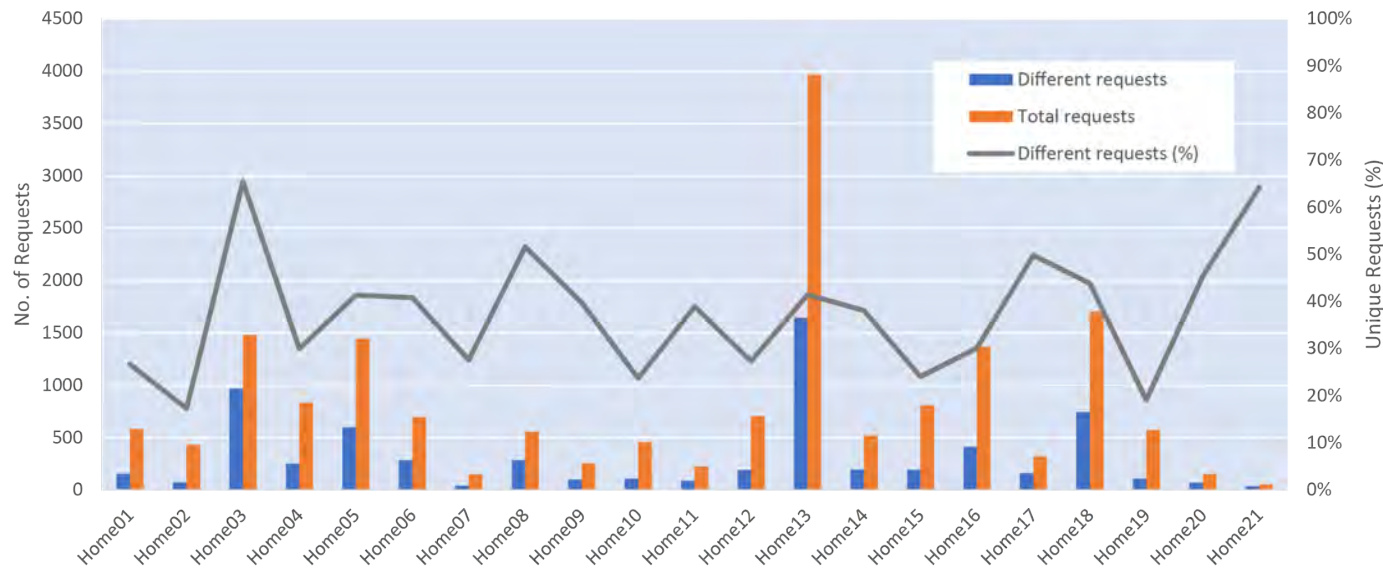
Participants used Google Home to make a wide variety of different voice requests

Figure 9 shows the total number of voice requests made to Google Home devices compared to the number of different voice requests by individual

households. It should be noted that due to the nature of voice requests, the same request can be made in multiple ways using different phrases. For example, “turn on light 2” and “turn on kitchen light” are seen as two different voice requests that could both turn on the kitchen light (if the light in the kitchen is designated as light no. 2).

The number of total voice requests (including unique voice requests) spoken to Google Home devices by participant households varied widely. The largest number of different voice requests made by one household was 1646. This household also made the most voice requests at 3967. The household that made the least, only made 36 different requests.

Figure 9. Number of different voice requests made to Google Home devices by each participating household



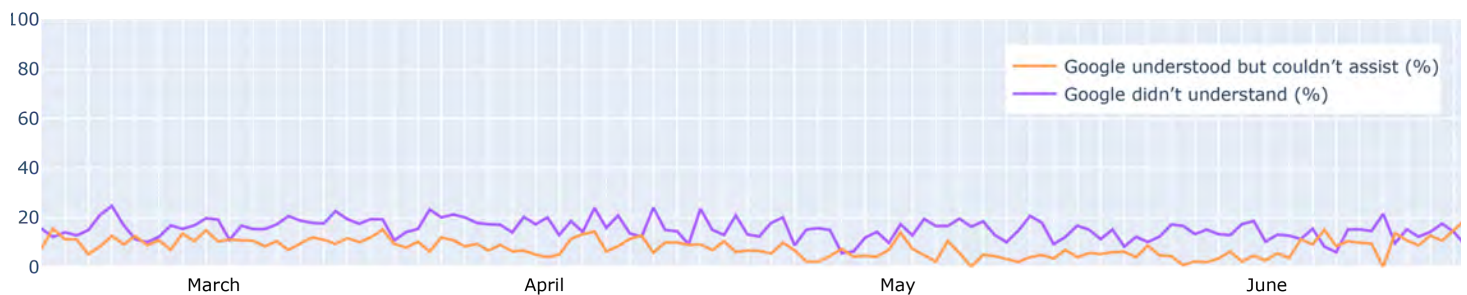
Both the number of voice requests that couldn't be understood by Google and those where Google Home wasn't able to assist remained consistent throughout the trial

Figure 10 shows the number of Google Home voice requests that Google failed to understand and the number of participant requests that Google understood but wasn't able to assist. These are both represented as a percentage of the overall requests made to Google Home by all participants.

When a particular request couldn't be understood by Google, the voice assistant didn't respond to participants and marked the requests as an "unknown command" in the device's transcript history. When a request was understood but Google was unable to assist, Google responded to the participant with "Sorry, I'm unable to help with that," or another similar response.

Across the trial the average number of overall requests which weren't understood by Google was 15.1%, and the average number of requests that Google understood but was unable to assist with was 8%.

Figure 10. Percentage of Google Home voice requests that weren't understood by Google, and where Google wasn't able to assist with the request





8 VALUING HEALTH, INDEPENDENCE AND WELLBEING

In order to better understand the role that technologies could play to improve the wellbeing of people living independently in their homes, we asked participants what was important for them in life to feel content. This enabled the research team to understand **a set of underpinning values and conditions** which were consistently important for this particular group of older people, in relation to their age, regional environment and circumstances (see Vignette 1).

Physical health was very important to the participants

Most participants emphasised the importance of their physical health in maintaining a sense of wellbeing. This was commonly expressed in terms of physical ailments which determined how daily routines happened or influenced how caring activities were done inside and outside the home.

“He’s [my husband] very protective of me. Very protective. He’s thinking of me all the time. That I might have a fall or something or other which I mean can happen, whether he’s here or not. But he made sure when he goes away somewhere that I feel comfortable staying here on my own which is good.”

Brenda

Participants also noted the fragility of their physical health, and were aware that one health crisis or accident might end their independence. For example, one couple who participated were both of ill health. While during the first stages of the trial they were able to live independently in their own home they described their situation to the research team noting that for them each day was precious. This couple left the trial part way through when they had to move into residential aged care. Other participants also emphasised their fear of falls as a threat to their independence.

“Anything to stop falls, because I mean, you get so many come in [to hospital] with fractures. And they don’t go on for very long, somehow.”

"Jodie"

Independence and physical mobility enabled participants to age in place

Health was directly interrelated with independence, particularly in terms of physical mobility which enabled participants to stay living in their homes and carry out daily activities by themselves, including caring for loved ones and pets at home. Independence and physical health was valued because it allowed these older people to go to the gym, visit the shops, attend a doctor’s appointment, visit family and friends, and volunteer for and participate in community clubs and services. Most participants still drove their own cars which they used for such activities as well as for longer trips away from home.

The project aimed to evaluate the potential of smart home devices to support older people to continue 'ageing in place'. In practice, ageing in place meant that participants lived independently in their own space, with their things, and with autonomy over their daily routines and activities. McLean Care’s services provided through the CHSP program already supported participants to age in place pre-trial, and were valued because they eased daily tasks, such as cleaning and shopping, and provided social benefits from personal interactions with McLean Care staff.

“To have good health... and I mean, to have good health you’ve got to be active and exercise.”

Barbara

Emotional wellbeing was central to participants' sense of health

Alongside physical health, participants' emotional wellbeing was important to them and influenced their everyday practices and approach to life. When we asked participants what was important for them to feel content in life their responses ranged from physical health, 'positive outlook on life', enjoying family and friends and living every day fully while they can.

"No worries... not having any problems."

Pat

"I'm a positive thinker. If negative starts to creep in, I push that away, that doesn't take you nowhere. It'll only drag you down, pull you down. I'm a real positive thinker. I never ever have a bad day. Never. It's not worth."

Hilda

Participants shared a connection with the outdoors and natural environment

Part of what made this project unique was that it was located in regional and rural areas, and specifically aimed to understand how smart home devices could support and benefit older Australians in these areas. Participants had long life experiences of living in regional, rural or 'country' environments with backgrounds and life skills of caring for large areas of land, crops, animals, and families, requiring resourceful problem-solving approaches to daily life. Even as retirees now living less remotely or in town, life in the country still shaped their daily lives.

For example, many participants regularly checked the weather forecast to keep updated on wider community developments and family property events (such as droughts, bushfires, rainfall and floods). Local weather information was accessed to help determine the timing of daily gardening, laundry, dressing and outdoor activities. Extreme and unpredictable weather events and power outages, some of which were experienced during the trial, were part of participants' daily lives. Staying connected to local events, news and weather information was important for navigating these issues and maintaining a sense of wellbeing.

"I was born here in Inverell, but I lived all my life on the property."

Ian

"We ran a holiday farm for 16 and a half years, a beautiful farm."

Mary

Keeping track of everyday routines gave participants a sense of wellbeing and security

Keeping track of weekly activities, schedules and routines contributed to participants' wellbeing and sense of independence in living at home.

Participants' everyday routines were filled with activities that structured their days and nights. These activities included: keeping up to date with local and global news; getting the morning weather forecasts (which influenced their laundry and gardening routines); having regular breaks for hot drinks; cooking; gardening; taking time for rest and naps; and keeping a diary for medical and social appointments.

"I think the older you are the more regimented you get. Things go to schedule. Now if anything goes out of sync that makes me unhappy."

Robin

Vignette 1.

Understanding wellness and the importance of family – insights from Beryl

The smart devices used in this trial were incorporated into the lives of older people, for whom health, wellness and independence were crucial aspects of staying comfortable in their homes for as long as possible. Each households' existing values and conditions shaped their reasons for being part of the trial, and how they took part and used the devices with their extended families.

Beryl and David live together in Gunnedah, and described themselves as “*home bodies*” who hope to “*live in... [their] home forever*”. As with many participants in this trial, family connection was very important to this couple. Their daughter had previously lived with them full-time and now stayed with them most weekends (although this changed with the COVID-19 physical distancing restrictions). Beryl also described how they were focused on maintaining a “*comfortable*” home filled with “*love*” so that their family of children, grandchildren and great-grandchildren could continue to visit and stay with them for “*as long as possible*”. At Christmas, for example, Beryl and David typically host a family of 15, with 12 people staying in the house during that time. For Beryl, wellness was expressed as being deeply rooted in this sense of family connection and staying at home:

“Wellness is health. Wellness is visitors, family coming to visit, and with us having our own home, and a big enough home to accommodate our family, they come as often as they can, which is quite often, and we’re very blessed that they can. And that is what home is, home is love.”

The couple hoped that the smart technologies made available to them during the trial would help them lead “*as comfortable a life as we can with our poor old bodies letting us down*.” They were interested in participating in the trial because they wanted to find ways of helping to support themselves – and other older people – to stay in their homes for as long as possible.

Beryl and David had many decorations and ornaments located around the house. Beryl took charge of the arrangement and placement of objects around the home, and was careful to ensure that everything was tidy and in the ‘right’ place. The importance of maintaining a homely and aesthetically pleasing environment shaped what devices Beryl was prepared to have in the home as well as their locations and the time period they were ‘welcome’ to stay.





9 POSITIVE IMPACTS ON HEALTH, INDEPENDENCE AND WELLBEING

9.1 OVERALL IMPACTS ON WELLBEING

Participants experienced small but significant comforts and conveniences from the trial technologies

The ways in which the devices used in the trial contributed to health, independence and wellbeing varied and changed as the trial progressed, as outlined below. Similar to past research,^{31, 43, 26} these benefits were observable in 'small' but significant comforts and conveniences that supported participants' values and life circumstances, such as:

- Having a smart light-enabled daily reminder for medications;
- Being able to vacuum areas of the home when needed with physical ease;
- Enjoying a range of functional and entertainment options from the Google Home (e.g. music, news, or controlling other devices with voice commands);
- Augmenting their love of nature with screensavers (shown on the screen of their Google Nest Hub Max) of the natural environment or nature, and playing country music; and
- Providing additional support for their daily routines during the COVID-19 'lockdown' and physical distancing at home.

"I have a light for telling me if I've left the garage door open and another one that reminds me early in the morning and late in the evening that it's medication time. As soon as I close the door on the medication cabinet, it goes out, which is magic."

Robert

9.2 IMPACT ON PHYSICAL HEALTH AND MOBILITY

Participants balanced the convenience provided by smart devices with their desire to stay active

Participants generally found operating the smart home devices (e.g. lights, kettle, vacuum) with

Google Home voice commands convenient and helpful, especially when their movement was limited, painful or tiring. The ways participants used voice commands to control their smart devices depended on their physical health, mobility challenges and values. Some participants kept a daily balance between using voice activation and their conventional routines of manual activation. This reduced their concerns about becoming too dependent on the technologies, or being less mobile in their daily lives. Other participants reported that the convenience associated with the use of voice commands encouraged 'laziness' and undermined their intention to remain as active as possible.

Seven households (4 single women and 3 couples) were concerned that by undertaking tasks they would normally do themselves, the devices encouraged sedentary behaviour, and that they would lose the exercise benefits associated with everyday activities such as getting up to turn a light or kettle on or off.

"I think it would make you a bit lazy, whereas if you've got to get up and go and do something or other, well, it gets to moving again."

Mary

Some took action to avoid this. For example, Hilda and Owen intentionally placed the push buttons far from their bed or couch to make themselves get up and walk, and stay active at home.

"I suppose we can have it closer [lights push button] but it's just as easy [to have it on the book shelf] – if we got it here [side table], that's not good for us because we need to move around. You can sit on the lounge and you just get too lazy."

Hilda

Several participants also mentioned that their children had advised them to be careful not to become too lazy by routinely using smart devices (such as smart lights) and therefore moving less.

“But as my son pointed out when he came home, ..., ‘if you’ve got these gadgets to do that, it makes you lazy’, which I thought, ‘Okay’, if I’m sitting there and I want to turn the light on, instead of doing it, I just switch it on instead of getting up and doing it, which actually, in the old sayings, ‘If you don’t use it, you lose it.’”

“Anna”

Despite these concerns, most participants identified the benefits of voice activation for days when they were less physically mobile, for their (less mobile) future selves, and for others with mobility challenges.

“Yeah well I think some of the devices could be quite good but for myself at the moment no, but you never know when I may need them in the future... Well I think it’s good to know that those things are there... Well if, you know, my mobility becomes non-existent or something like that, yeah well then I might even use Google if I wasn’t able to move about.”

“Anna”

Smart light buttons enabled participants to create safely lit routes for walking at night

When the smart light buttons were located on participants’ bedside tables, they enabled positive health and mobility outcomes by ensuring that walking routes to the bathroom or kitchen were well lit at night and able to be turned on before getting out of bed. This gave participants additional confidence about their safety and they believed it reduced their risk of falling at night.

Manual activation using remote buttons meant each person in the household could turn lights on and off at multiple locations without using voice activation and potentially waking up partners or pets.

“It’s a bright light and you do need bright lighting in the bathroom, at our age, because you can’t afford to have anything on the floor because you easily tripped over. So the light’s very bright which is excellent.”

Owen

“Yeah. I really like this light much better, we both do, because it’s nice and bright and you’ve just got to be careful at night when you get up because you can’t afford to have any falls or anything.”

Hilda



The robotic vacuum cleaner provided additional cleanliness and convenience with reduced physical labour

The robotic vacuum was welcomed by most participants as a device that allowed them to continue cleaning their floors between visits from professional cleaners. It also meant they didn't have to engage in the physically demanding activity that manual vacuuming requires. This helped reduce some participants' concerns about maintaining their desired levels of cleanliness, and contributed to a sense of wellbeing.

Activating the robot vacuum using Google Home voice commands or by selecting rooms on the iPad tablet also gave participants a sense of independence. However, the vacuum's activity still needed to be monitored by participants to ensure it did not become a trip hazard, become stuck on chair legs or uneven surfaces, and that it accomplished the required tasks. For instance, besides using the 'stopper' (vacuum's virtual barrier), some households began closing doors around the home to prevent the vacuum from moving around of its own accord.

"I was most interested in ... the vacuum cleaner because I only had the cleaning once a fortnight. Sometimes you know, floor does get a bit gritty and I could sweep up the kitchen floor with the hair broom with difficulty. Not so much the sweeping up but picking it up off the floor you know, getting it into the dustpan afterwards, that was a bit ticklish."

Francis

"I have to put this little piece in the doorway [referring to stopper], if I don't want it going to the kitchen."

Beryl

"And now he's [vacuum] put it in that room there so we can shut the door if the little thing leaves its bed [charging station], which it did do one night... next thing it's banging on the door because it's charged itself and it's ready to go back to work."

John



Google Home's voice call function presented new options in accident and emergency situations

The Google Home voice call function was used by some participants to make calls to their families. An incident in one household suggests that once this becomes habitual, then the same function can be an option for remotely calling emergency services that older people can confidently use (without needing to physically dial the number in a keypad or look up a contact in a smartphone). The participants in this household had tactile difficulties with the touchpad and used the Google Home voice call function to call their daughter every night of the trial (i.e. using only voice commands). When they had an accident at home it was subsequently easy to use the voice command to call their daughter for help. The availability of voice calls for help in emergency situations could offer additional security for participants once they have learned to confidently use this function.

"Supposing I passed out, get this virus that's going or something like that, if I can't get up, can I call on her for help. Like 'Hey Google, ring the ambulance.' Can I do that?"

Coreen

"It [the Google Nest Hub Max] was handy. ... I had an accident when I had a shower... We got in touch with [our daughter], and she knew straight away to get an ambulance... And that was good."

John

9.3 MENTAL ACTIVITY, LEARNING AND PURPOSE

The trial helped keep participants' minds active

Some participants viewed participation in the trial as part of their existing strategies to keep their minds active. Others found a renewed sense of mental activity during and because of the trial. As such, participants' engagement with the trial, the smart home devices themselves, and the research and support teams were experienced as ways to stay active in life. More than half of the participants

expressed that "I'm not a technology person" at some point during the trial. This self perception, however, contrasted with their enthusiasm to join the trial and try out the devices, and with the patience and persistence of nearly all participants to continue through to the end of the trial.

"it keeps your mind active I suppose to a certain extent."

"Claire"

"My husband and I, we want to keep our independence as long as possible. I think from this new technology it not only teaches you to hold your independence but it keeps your brain active because you've got your kettle and you've got your Google and you've got your lights and you're using different ways of using your brain. ...Your brain has sort of got to think hasn't it?"

Hilda

Participants found Google's attempts to help them learn humorous and fun

Challenges (discussed in Section 10.4) and learning opportunities experienced with devices like Google Home were mostly discussed positively, and participants also found humour in Google's attempts to educate them. Two participants, for example, described Google's advice and suggestions as a form of 'reprimanding' or 'scolding'.

"I did get reprimanded earlier in the piece, the first morning, Ross had said... ask G[oogle] for... the time and, you know, the weather and all that. So I asked individually the first morning, and she [Google] said, 'you know, you would save us a lot of time if you just said 'good morning'', and she said 'I'll tell you all of it, it's a spiel', so I got reprimanded. Yes. It was funny. Oh, yes. Make light of things."

Beryl

“And one night I asked Google to turn on the lights, it must have been half a dozen times, and then Google flashed on and really scolded me, she said, you should only be out ... only need me three times a night. Well I really had to laugh because she sounded so cross that I hadn't used her all day. And I said, have you been asleep Google? And she just closed up on me completely... So as I said I've had my fun experiences with it.”

Francis

Most participants were committed to the trial and the required learning

Participants demonstrated an inspiring determination in their daily experimentation with the devices and the range of functionalities. They often persisted even when interactions with these new devices were frustrating or not straightforward. They also explored different possibilities with devices like Google Home (see Box 1). This persistence was explained in terms of commitment to the trial, having time available to experiment with the devices, and being motivated to experience daily achievements in the learning process (e.g. getting the voice commands to work well).

Bert: “Hey Google, turn on electric kettle. Oh, I know what it is...”

Google: “Sorry, I'm not sure how to help with that yet. But I'm still learning.”

Bert: “So am I. Hey Google, turn on smart kettle.”

Google: “Okay. Turning Kogan smart kettle on.”

“We're learning, we're getting there... never mind, you do learn eventually”

Beryl

Box 1. Experimenting with Google Home: participant requests (from voice transcripts)

- “How do you cook a chocolate cake”
- “What time does Regional Airlines depart Inverell tomorrow for Brisbane Sydney”
- “What time does Big W in Tamworth open on Sundays”
- “Can you fix the door handle please”
- “Let's play Scrabble”
- “Can you sound like a bird?”
- “How long do cats sleep”
- “What is the estimated cost of Australia's future submarines”
- “Recipe for chicken stock”
- “What is the postcode for Ingham North Queensland”

Most participants built confidence in using the technologies as the trial progressed

Participants who started the trial feeling that they didn't know much or weren't very interested in the devices ended the trial feeling more confident from their technical learnings. This confidence was seen in two key ways:

1. Extending their views (and skills) about the ways in which technologies could help support their routines; and
2. Giving them the lived experience to make informed decisions about how and when to use these technologies, or not.

This was also demonstrated by the increased range of voice commands that participants used over time (see Section 7.3).

The trial provided participants with social and technical interactions that supported their physical and mental wellbeing

The trial as a whole provided participants with valuable physical, mental and social interactions.

These included:

- Being part of a selected group of participants with free access to new technologies, and being regularly contacted and consulted about their experiences;
- Having social interaction with the project technician and research team during the different stages (to install, fix or maintain, and share insights); and
- Having the smart home devices at hand (to use themselves and with their family or friends).

9.4 MAINTAINING AND SUPPORTING EVERYDAY ROUTINES

Participants embedded the devices into their morning routines

After experimenting and getting familiar with the possibilities offered by Google Home, nearly all participants started their days by asking Google for the news, and a few even started saying, “Hey Google, good morning”: a command that activated the news, weather and time. This information gave them a daily ‘compass’ for their activities, such as when to do the laundry or gardening. Participants developed uses of the devices that suited their own routines and activities, which included: asking Google (from their beds) to play music or turn the kettle on; or once in the kitchen turning on their Google Nest Max Hub tablet to watch world video news before doing housework or getting ready for the day.

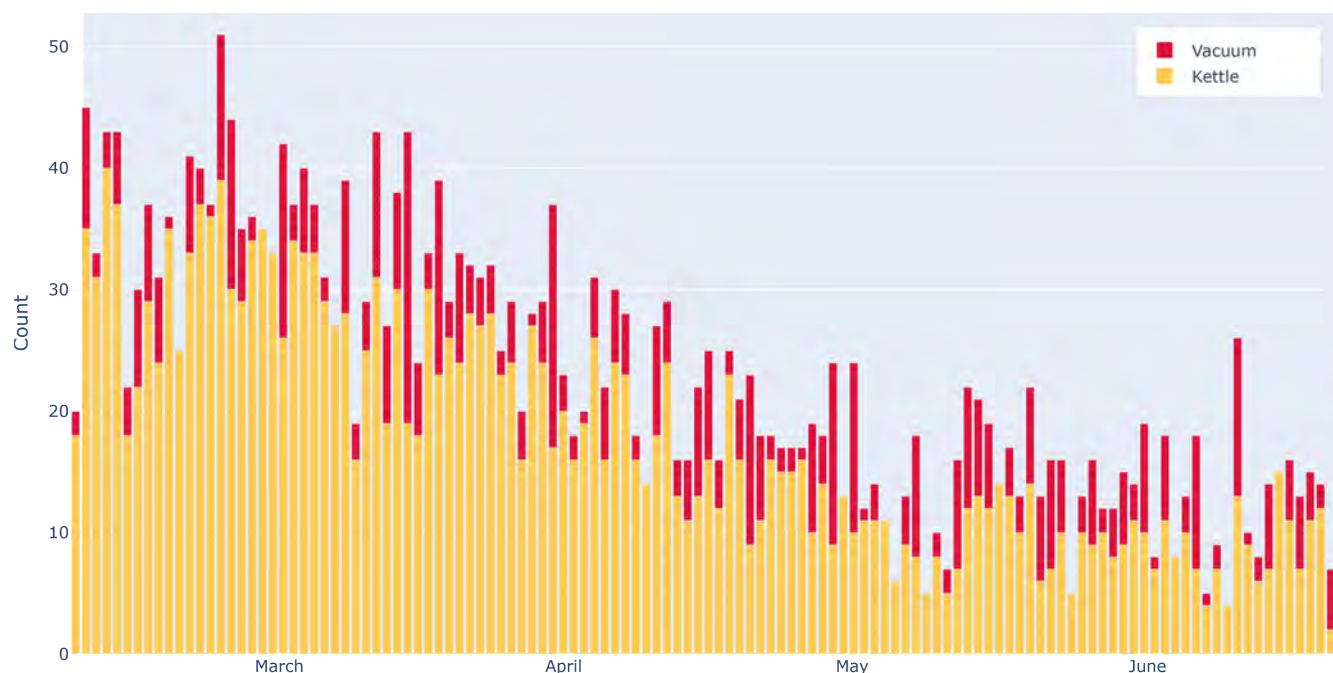
“I said, ‘Hey Google, what’s the weather going to be like?’ And he said it’s going to be sunny. And so that was good. I did my washing because it wasn’t going to rain. So, I got my washing dry.”

Shirley

Participants embedded the devices into their daily routines

Some participants used the smart kettle to boil water to help prepare lunch, and at times they asked Google for recipes. The Roomba vacuum was often activated in the afternoon, while participants had a cup of tea, did their crosswords, or went outside to do some gardening or shopping. While some homes saw value in using voice requests to boil the smart kettle remotely (e.g. from the bedroom), others transitioned to using the more familiar physical button on the kettle over time as shown by the downwards trend in *Figure 11*.



Figure 11. Percentage of Google Home voice requests made to the smart kettle and vacuum

In the evening, participants enjoyed sitting in their lounge chairs to read, catch up with others through phone calls, and watch television. The smart lights, and fans (during the summer), controlled by smart switches, provided comfort and convenience. In preparing for the evening, some participants incorporated low-lit smart lights into their evening routines. Others kept smart buttons at hand to manually turn them on only when needed.

“It’s handy to say, ‘Google turn on the lights’, instead of rushing all over the place to find a light switch.”

Robin

Smart home devices complemented rather than replaced existing appliances and technologies

The addition of smart home devices to participants’ routines and homes increased their options, resulting in their ‘old’ appliances and technologies co-existing with the new smart devices and complementing each other. For example, participants’ radios were still used for the local news and music, while Google Home diversified the news with global events, on-demand music, and more.

Similarly, smart lights installed in participants’ bedrooms, bathrooms and living areas lit the home at night at different light levels based on their preferences. However, these smart lights did not replace existing light sources, which continued to be important and used daily to complement the experiences of comfort and safety at home (including rooms lights, torches, LED/solar corridor lights, street lights, natural sun and moon lighting).

“The story, when he [Ross, project technician] told us about the bathroom light, was the point when we said yes, we’ll go with the trial, because that was one of our problems, you know... I’ve got a torch alongside the bed. Both of us have... But there’s a fair bit of light comes in through the bathroom window, especially on a good moonlight night.”

Shirley and John

Some participants did not use the devices' smart features, instead treating them as conventional appliances. For instance, in homes with more than one occupant, some participants activated the kettle with the voice commands, while others preferred to activate it manually. In some households, participants viewed having a variety of options as a 'fail-safe' approach if one should stop working or disappear.

"I'm quite interested in technology, so I thought go along. I heard about Google, but I didn't really know how it worked. Ross [project technician] was good installing it all and I've got that many failsafe things, it's amazing. The buttons and the switches. Actually we have had a couple of power cuts, but it's been all right. It's going good."

Robin

Participants adjusted their smart home devices on a flexible basis

Participants demonstrated flexibility in making technologies work for their own needs and lifestyles in unique ways. Based on participants' homes, capabilities and routines, preferences and device settings were originally set up with the assistance of the project technician and research team. Various functions and settings were also explained to participants at multiple points during the trial (during installation, home visits, and remote support calls). With the help of the project technician and research team, a few participants learned how to set up and adjust some device functions themselves as their needs changed, contributing to maintaining their sense of independence. The trust that developed between participants and the technical support team was also fundamental to generating participants' confidence to adjust and experiment.

Participants augmented their daily routines with new physical, sensory and interactive experiences provided by the devices

The smart home devices augmented the physical, sensory and interactive experiences of participants' daily routines (see Vignette 2). In some households, coloured lights were set up to provide different reminders (e.g. red light at medication times, blue to indicate water leaks, green to remind when the garage door was left open). The adjustable brightness of the lights enabled participants to adapt them to different activities including reading, or to provide night light and room ambience.

Devices also enabled possibilities for less frequent and more speculative interactions, such as viewing them as a form of companionship. For example, Google could become a source of company when asking 'her' for a recipe, to spell a word, or to settle a family argument with history facts.

"It [The Google NestbHub Max] becomes a little entertainment hub doesn't it?... so it would act as a companion I would think."

Ron

Vignette 2.

Embedding the devices into daily routines – insights from Robert

Like many of the participants in this trial, Robert found the smart devices beneficial in maintaining and supporting his everyday routines. He derived small conveniences and benefits from embedding the lights and music functionalities into his daily life. The range of lights Robert had installed were a safety reassurance when walking between rooms at night. He had the choice of controlling lights with either voice commands: *"It's wonderful just to say, 'Hey Google. Turn it down to 15%'",* or with push buttons that he said worked well downstairs: *"When I do have a guest, I tell them to use the button, and it does work most of the time".*

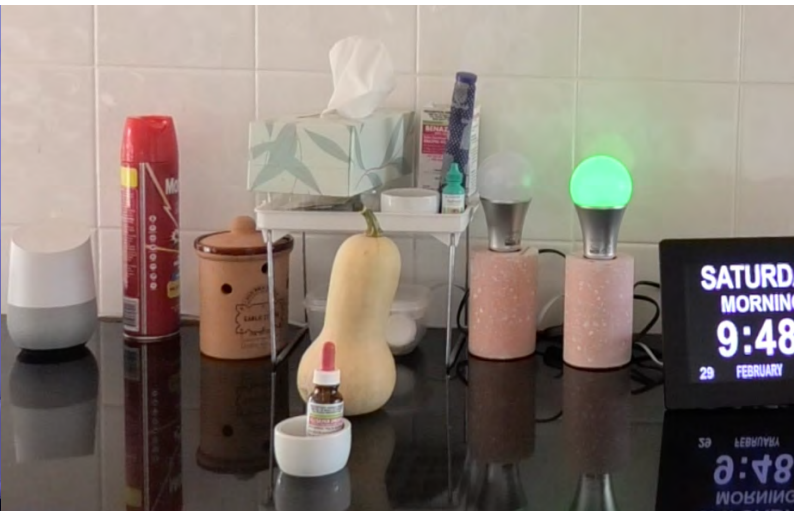
His daughter was also impressed by the devices, saying she *"thought it was magic."* Over time, Robert became more familiar with using the *"little fob button for the bathroom and bedroom lights"* instead of using the voice commands: *"I'm quite sure my little Phoebe [dog] appreciates the fact that I don't wake her up".* Robert also had sensor-activated lights: a green one to remind him to close the garage door in case he left it open, and a blue one alerting him in case of a water leak in the kitchen. A smart red medicine cupboard light also became part of Robert's everyday routines: *"The red light to remind me of my pills works beautifully, has never failed."* The lights gave Robert different options to support his memory, his physical health, mobility and sense of safety at day and night.

Besides the lights, Robert found other joys in the technologies trialled. A favourite addition to his home ambience was the music that he could play through his different smart speakers (Google Home and Sonos).

"I love it [the music]. I never stop... when I go to bed of a night time, I listen to ABC Classic 2, I turn it down low and leave it on all night. Then when I wake up, I swap it over to country and western... Then I probably put it [music] back after I've had breakfast and go back in to make the bed, I probably put it on soft piano music, or something like that, in the bedroom, but out on the big speaker out in the main lounge room, dining room, you wouldn't know what I might put on. I just try all sorts of things... I just say, 'Give me some Japanese traditional music', or, 'Some Chinese traditional music', or, 'Some nice relaxing piano music', and that little machine is very obliging... Something for every mood."

Robert also explored using the technologies to support his cooking routines from early in the morning. *"Well, it's great to have that kettle, sing out, 'Hey Google, have that kettle boiling by the time I get out of bed'."* Once up and moving, Robert said that *"every now and then I just ask it all sorts of questions, what's the time, what's the date... Yeah, and recipes, I get quite a lot of recipes off it... I love cooking, especially if I've got a guest I like to cook for."*





9.5 EMBEDDING THE DEVICES IN FAMILY RELATIONSHIPS

The devices were used within unique family dynamics

Family relationships were important for participants, although the extent to which family were involved in their lives on an everyday basis varied. Families were an important part of participants' everyday routines and the smart devices were used in different ways to mediate and accompany these relationships. Households participating in the study were composed of a diversity of family members. Some participants lived by themselves, others with their partners and all kept in touch with family (children and grandchildren) via phones or video calls. Where possible, family members also visited participants' homes for short or routine stays.

Family members provided participants with additional technical support

For all households, participation in the trial was embedded in family dynamics before, during and after the trial. For instance, joining the trial was a shared decision for coupled households, with different degrees of involvement and interest, but with both partners' agreement. For at least three households, joining the trial was a decision supported and encouraged by their children, who believed this was a good opportunity for their parents to learn about technologies that could help them at home. In two households, the participants' children discouraged them from continuing with the trial. This was mostly to give their parents peace of mind when they felt overwhelmed by the technology at the beginning of the trial.

"Well she [our daughter] arranged it and Ross [project technician] came and saw us and that, so we decided to do it."

Brenda

"My daughter set it all up, she's got everything working, so we've got to learn that a little more, yes... Actually, my daughter said to me, 'What we should be doing Mum, is setting one of those [sensor lights]... so that when we open the front door it comes on.'"

Beryl

"I thought I will never ever get used to this at all and our daughter-in-law said, 'Mum. Tell them to take it out of the house. You don't really want', or I think she said, 'You don't need it'."

"Jenny"

In nine households, participants' children or grandchildren provided additional technical support. Participants described using the devices and learning about them with family members as a fun and helpful experience, and in some instances leading to rounds of jokes with Google. These early experiments might be seen as a precursor for the way older participants and their younger family members used Google Home devices for keeping in touch via video calls (Google Nest Hub Max) during the COVID-19 pandemic (see Section 11.3)

"The granddaughter has [been helping with the trial]. She'll say, 'Are you going to talk to Google, pop?'"

John

They [grandchildren] love this [tablet], being able to talk to each other and see each other, and they say it's just so clear, everything is so clear to look at. And the two little boys, they love it. They come and talk to Grandpa and Grandma, 'What you doing, Grandma? What you doing, Grandpa? Where's Grandpa?' So they love to see us on it."

Edna

Relationships within the home were central to the ways devices were used and to how participants evaluated their suitability

The ways participants used the devices were embedded within their everyday domestic relationships in the home, and in 14 households these were relationships between couples. Couples were concerned with each others' wellbeing. Some participants cared for their partner by taking on the leading role in the use of the devices, while others 'specialised' in the use of particular devices (see Section 10.3 for a discussion on the risks with this approach).

For example, when a participant found it difficult to remember a specific sequence of voice commands their partner would do this for them, or when a person had mobility challenges meaning they found it harder to manage the vacuum or to lift the kettle, the other person took up these roles.

In some cases, however, it was difficult for participants to regulate the use of the devices within the home. For instance, participants who cared for a partner with dementia found that they needed to provide reassurance regarding the new devices, and to adapt their uses with consideration to how they impacted on their partner.

Careful consideration of the roles played by family members both within and outside participants' homes, as well as the ways these change as people age, can ensure that smart home devices bring wellbeing and independence benefits within family networks (see Section 13 for recommendations about future trials).

“They [my family] could see the adjustments we’ve got to get because where we are with our age. They don’t mind [us participating in the trial]. They help us. They support us well.”

Hilda

Pets interacting with the devices influenced the way they were used

Pets had an important place in the lives of eleven participating households where they contributed to the social life of the household and the caring responsibilities of the participants. As such, considering pets was integral to generating a sense of wellbeing and independence through smart devices. Similarly, pets were embedded into the social relationships and physical activities that the smart home devices supported, and their needs were accommodated for in the ways that participants used the devices and in how they asked for them to be configured. Examples of this included the need to set up the automated vacuum cleaner to go around a dog’s food and water bowls, and the need to enclose a cockatiel safely in one of its favourite hiding places during the vacuuming process (see Vignette 3).



Vignette 3.

Integrating devices into the home – insights from Edna and Cheeky the cockatiel

Integrating smart devices into homes and everyday routines involves considering how people live with their companion pets as well as the material and social aspects of their lives. As this example shows, small challenges presented by pets and their needs were easily resolved as participants learned (with the help of the technical team) how to use the devices.

Edna and Bob shared their home with Cheeky, their pet cockatiel, who featured often during the research and as part of the family. Cheeky's cage was just opposite the kitchen table where we sat with Edna and Bob for our first interview, and he also had a special favourite 'hiding place' behind the stove which Edna could close off if she needed to keep him out of the way. But much of the time Cheeky was free to wander in their home. He appeared on top of kitchen cabinets and was curious about our feet as we walked across the floor during our visit, and appeared on Edna and Bob's shoulders during our video call. Cheeky and the parts of the home he associated with had to be accounted for in order to adapt the robotic vacuum cleaner to Edna and Bob's home.

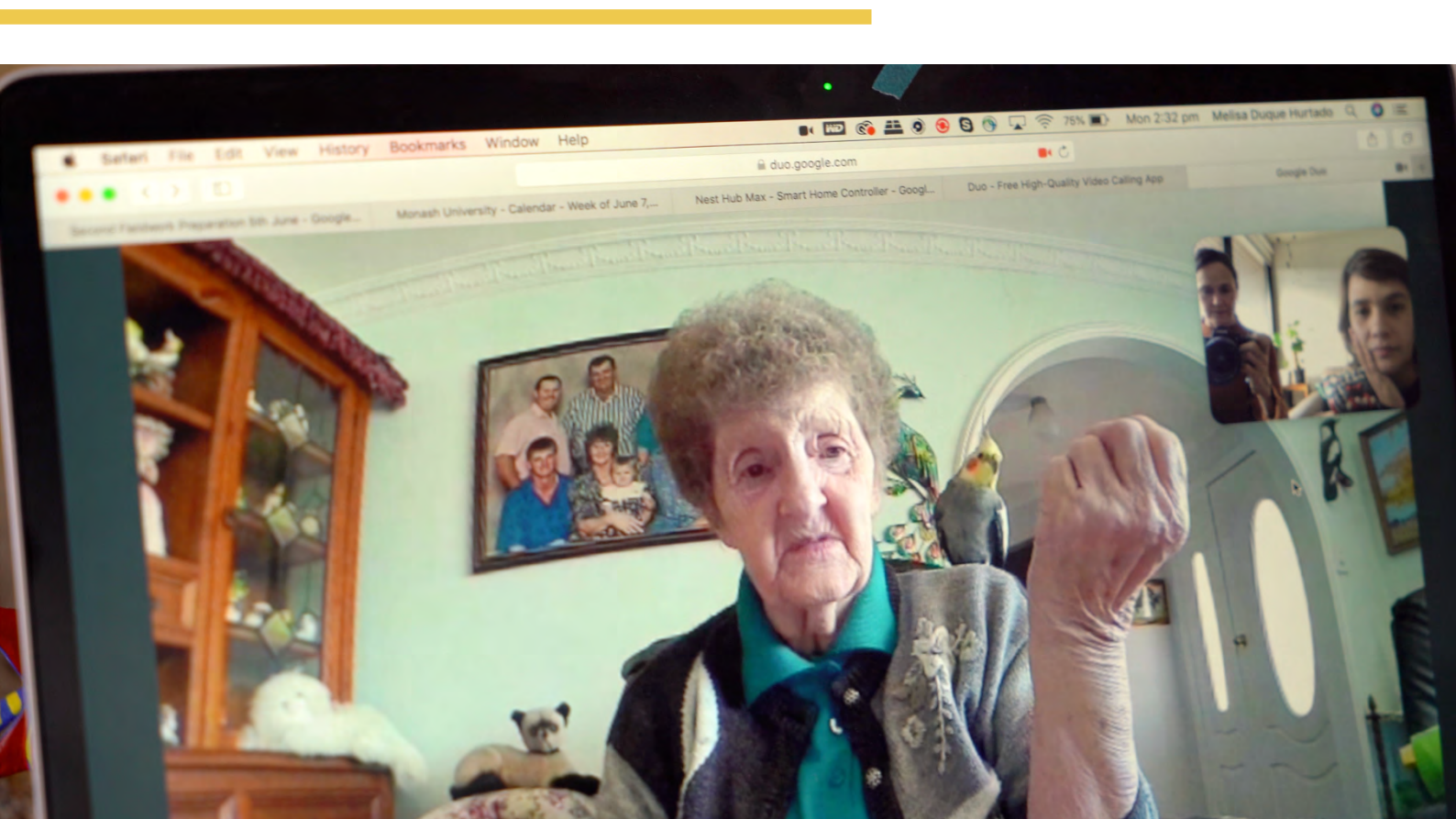
During the trial, Edna's use of the vacuum cleaner evolved. She had previously owned automated vacuum cleaners, but on our first meeting, Edna still had questions about how to use the Roomba. At that stage Edna told us that she had realised that the Roomba cleaned in a similar way to her old automated vacuum cleaner, but was concerned about it breaking the ladder to Cheeky's cage, amongst other things. Edna asked Mick (Deakin technical researcher) if she could use one of the sensors that came with the vacuum to avoid this, suggesting that: *"I can put that, say, in front of my birdcage and it will go around it"*.

Another consideration at this stage was how to accommodate Cheeky himself with the use of the vacuum. When we asked her how Cheeky felt about the vacuum Edna told us:

"He hates it, really hates it. So, if I lock him behind the stove. ... Just the noise. He thinks it's going to take all his things, so I'm better off locking him behind the stove and picking up his little ladder."

Four months later when we followed up with Edna on a video call she had been using the vacuum and had ensured that her own and Cheeky's needs had been accommodated, as she told us:

"I love the vacuum. You have to make sure there's no cords laying around or anything, because it gobbles them all up, and Cheeky's ladder into his cage, I've got to make sure it's put away or it gets gobbled up as well, but it is very, very good."





9.6 MAINTAINING FINANCIAL SECURITY AND MINIMISING MONEY WORRIES

Financial security was closely tied to participant wellbeing

Most participants in the trial were living on the age pension. As such, financial security and affordability were very important and closely tied to a sense of positive wellbeing. Most participants were homeowners, or had shared ownership with others (e.g. with children or McLean Care). This meant that participants wanted to ensure that the benefits of using the devices outweighed the financial costs associated with their use (see Section 9.2 on keeping the technologies).

"It's all right [to keep using these smart technologies in the future] if you could afford it, put it that way... Yes. It's a matter of how much it'd cost." ...

"Money's very, very important... We get by, by paying all our bills and I don't know how people manage, you know, if you have to pay off a house, you know, on a pension. It'd be really hard."

Mary and John

"Well, have to be a bit realistic here... if you were an elderly man on his own or a woman and you could sit here and say put the jug on or vacuum the floor or turn the light on, yeah, I suppose I can see it but I don't know what the cost of having it compared to the convenience."

Mary and Ian

Participants appreciated that the trial was free and covered their costs of participation

Economic considerations were mentioned by most participants as a key aspect when considering whether to buy new technologies or subscribe to technology-related services. For this reason, participants appreciated that the trial was free and that costs associated with running the devices and Internet access were covered.

Participants always declined to sign up to online subscription-based services or purchases offered by Google Home

When using Google Home devices to make music and audio book requests, participants were frequently offered automated options for online subscriptions and other purchases. Some of Google Home's responses to these requests suggested that a greater level of access is provided to those who have subscriptions, as shown in Box 2. Participants always declined these subscription offers.

"It plays [music] for a certain amount of time and then it goes on with the advertising about YouTube and how much you're going to get YouTube for at premium rates and all that sort of thing. That's a bit of a downfall with it, but it's only periodic, so you can still enjoy the music. Where else don't you get advertising? It's on everything, isn't it?"

Ken

Box 2. Google Home responses with subscription offers (from Google response transcripts)

Youtube

- "To do that on YouTube Music, you'll need a Premium subscription."
- "Choosing songs is only available for YouTube Music Premium members."
- "It looks like Classical is a playlist that's only available for YouTube Music Premium members."
- "It looks like 70's Music Hits Playlist - Best of 70s Music is a playlist that's only available for YouTube Music Premium members."

Box 2 continued**Spotify Subscription**

- “Choosing songs is only available to Spotify Premium subscribers.”
- “Playing albums is only available to Spotify Premium subscribers.”
- “Choosing songs is only available to Spotify Premium subscribers. But give this Spotify Zorba the Greek: Zorba's Dance station a listen. Playing on Speaker...”
- “Choosing songs is only available to Spotify Premium subscribers. But give this Spotify Killing Me Softly with His Song station a listen. Playing on Speaker...”

Google Play Books

- “It looks like there aren't any audiobooks in your Google Play Books library, but you can buy one on the Google Play Store.”
- “It looks like 37: Am Rio Negro isn't in your Google Play Books library, but here's a seven minute free sample.”
- “It looks like The Man from Snowy River and Other Poems isn't in your Google Play Books library, but here's a three minute free sample.”
- “It looks like Why Read Moby-Dick? isn't in your Google Play Books library, but here's a ten-minute free sample.”

9.7 SUPPORTING WELLBEING WITH GOOGLE HOME

Participants appreciated the convenient access to entertainment, news, weather, time and other information provided by Google Home. This could help with daily planning and organisation, and keeping up with current events, e.g. COVID-19 and extreme weather events.

Participants enjoyed listening to music

The options for entertainment available through Google Home included playing games and hearing jokes, but as discussed in Section 7.3 the most used and preferred choice was playing music. Participants experimented widely with this functionality and explored a range of different music options (see Box 3).

Music was played using the Google Home devices in all homes as an alternative to a radio or stereo, and participants listened to music when they were alone and as background sound when entertaining visitors. Three homes also trialled the Sonos smart speaker, where participants used the iPad tablet to find and play songs, and reported great appreciation for its quality of sound. These music options, as well as how easily music could be accessed and played, gave participants a sense of wonder and delight. In some cases participants were exposed to new artists and soundscapes that may not have otherwise happened. Wellbeing benefits of music for participants included:

- A sense of companionship and pleasure when alone;
- Access to a variety of genres and eras for exploration;
- Assistance in getting to sleep at night (see Vignette 2);
- Help with pain management routines (see Vignette 4); and
- Connecting to their region by playing country music that resonated with their location such as Australia's 'country music capital' of Tamworth where some participants resided.

Box 3. Music requests with Google Home (from voice transcripts)

- “Play some country and western”
- “Play some Elvis Presley”
- “Play some go to sleep music”
- “Play Triple J”
- “Play relaxing music on speaker”
- “Play some traditional Chinese music on speaker”
- “Play hip hop music”
- “Play some inspirational tunes”
- “Play Andre Rieu”
- “Play dance monkey”

Vignette 4.

Accessing music using Google Home to manage pain – insights from Helen

Helen, formerly a nurse, told us about several health issues that were causing her chronic pain and fatigue. The rheumatologist's advice was to play 'tranquillity' music to help her manage pain. Using Google Home as part of the trial had made it easy for Helen to play music when needed: *"it's remarkable just how much it does make your body relax... it's been a help for me"*. Since she'd had Google Home and the Sonos speaker, her cabinet full of CDs featuring classical and other calm music hadn't been used nearly as much. Both Helen and her husband Ken were very impressed by the quality of the sound and the available selection.

Helen's husband Ken said *"sometimes we select jazz or we select classics and it just plays for hours"* and the music is *"better than painkillers sometimes"*. Helen agreed, *"I can sit in the chair and go to sleep [laughs]. I've got the benefit of being relaxed and enjoying the scenery [on the Google Nest Hub Max tablet screen]"*.



Participants used Google Home to connect with nature and the region

Connection with nature and the local region (e.g. daily weather forecast) was also evident in how participants used the Google Home devices. The Google Nest Max Hub tablet provided screensavers showing images of nature that the participants enjoyed for their scenic beauty.

“Look, it changes every four or five minutes [screensaver images], and they’re just beautiful, absolutely, well, first to last photos of all sorts of things, but all nature. Just lovely, yep. I’ve actually taken with my camera the photo of a couple for myself.”

Robert

“You can get the weather everyday and we can do that another way but I think this device presents it better. You can call up the news, that helps.”

Ron

“I must say that I love all the photos that show on the screen. They’re lovely... A lot of them are scenes, autumn scenes and all that, very good. I can sit here and just watch that and really enjoy it. It’s really good.”

Brenda

9.8 SUPPORTING INDEPENDENCE WITH THE ROBOTIC VACUUM CLEANER

The robotic vacuum cleaner complemented (but did not replace) regular cleaning services

The Roomba robotic vacuum cleaner helped participants maintain a sense of adequate home cleanliness in between visits from McLean Care, but did not diminish the importance of fortnightly visits by McLean Care’s cleaning staff. For most participants it was complementary rather than a replacement for cleaning services provided by people (see Vignette 5).

Participants valued visits from cleaning staff and wanted to retain these. However, because these

visits were typically every fortnight, they found the Roomba valuable in giving the option to vacuum high traffic areas (corridors, living rooms and kitchen) in between visits. The Roomba gave a sense of independence in taking care of an otherwise physically demanding cleaning task.

“They [cleaners] only clean a couple of them [the rooms]. I don’t let them clean the lounge room because the robot [Roomba] does that and they only clean the rooms that it doesn’t.”

"Betty"

The use of the Roomba in participants’ homes helped professional cleaners save time cleaning. For example, the Roomba could reach less accessible areas (such as underneath and behind beds) more easily than professional cleaners. Most participants were satisfied with the quality of vacuuming provided by the Roomba and valued the convenience it afforded (such as its ability to charge and clean itself at its base station).

“I was just so grateful actually, I was thinking, oh, isn’t this marvellous, he’s [the robotic vacuum] cleaning the place up and really cleaning.”

"Jodie"

“We have a girl [professional cleaner] come every fortnight that has 2 hours and she vacuums right through, and the other one [Roomba] only vacuums the living area, like the kitchen and the bathrooms and stuff, yeah. So, every fortnight... the floors are vacuumed but I might go and get Methuselah [nickname given to Roomba, reminiscent of a biblical patriarch known for living the longest of all figures mentioned in the Bible at 969 years] to have a run around because it hasn’t been vacuumed for a week sort of thing.”

Mary

Vignette 5.

Complementing cleaning routines with the robotic vacuum cleaner – insights from “Betty”

Although the robotic vacuum did not fully replace the cleaning routines in any household in the trial, these devices were amongst those most highly valued by participants. This is because the robotic vacuums were able to complement the cleaning services provided by McLean Care through the CHSP program, and support the cleaning undertaken by participants themselves, as illustrated by the experiences of Betty.

When we visited Betty, she was living alone in a large 4-bedroom home, and receiving cleaning services from McLean Care’s staff once a month to assist her with housework. As Betty suffered from back pain and had significantly reduced vision, McLean Care staff typically undertook the more physically demanding or complex cleaning tasks that she was unable to perform herself, such as mopping or whole-house vacuuming.

Prior to the trial, Betty supplemented these visits from McLean herself with a small monthly clean. Betty’s housework typically involved dusting, sweeping the kitchen floor, and lightly vacuuming high-traffic or dirt-prone areas of the home. Betty performed the latter with a manual stick vacuum, which she found easier on her back. Due to Betty’s inability to bend down, she was unable to pick up the dirt and dust collected during sweeping, and would leave a small pile in a corner for McLean staff to remove during their monthly visits. This housework was not only important in terms of achieving a clean home; it also enabled Betty to express her independence and gave her something to do: *“Sometimes [the cleaners] finished early and ask me, would you like me to do the dusting. As I say, I’ve got to have something to do so the dusting doesn’t bother me.”*

During the trial Betty was able to supplement the visits from McLean staff by using the robotic vacuum, which her adult son had programmed to operate once a week. Although the frequency of this schedule was ultimately reduced with help from the research team during the visit to her home, Betty appreciated the ability to engage in cleaning herself (through the robotic vacuum) to complement the housework undertaken by McLean Care. Due to Roomba’s help, Betty was able to fully undertake her kitchen cleans without relying on McLean Care staff to finish the task: *“I’ve found the vacuum is a wonderful thing, you could get hooked on it.”* However, as Betty also wryly noted, the vacuum required some supervision because while one could get hooked on the vacuum, *“it gets hooked on things. One day I had to rescue it....”*





The Roomba created a sense of wonder for some participants

Some participants were fascinated by seeing Roomba at work, describing it as “pet like” and a “good mate” or appreciating the technical achievement required to make it work “right” for their home.

Ken: “I do the labouring for the room, but I shift the things that need to be shifted, so it can go wherever it wants to. It’s magic. It goes under the beds and everything [laughs].”

Helen: “It brought out a pair of socks that belonged to our son, and then the other day it brought out a plastic bag that was under the bed. It’s good when you can’t get down to do that sort of thing.”

The robotic vacuum cleaner required the most monitoring and attention of all devices in the trial

Of all the devices included in the trial, the vacuum required the most monitoring and attention from participants (on their own or with the team). This included learning the commands to operate the Roomba, working around the unpredictable routes the vacuum took when creating its initial house map, moving furniture out of its way, and changing the household’s vacuum cleaning routines.

“I usually send it [the vacuum]... First [to] the dining room, and then the family room so we can move the furniture, and then it tracks up and down and plans it and then we put that furniture back... I do the labouring for the room, but I shift the things that need to be shifted, so it can go wherever it wants to. It’s magic. It goes under the beds and everything [laughs].”

Ken

Our findings are consistent with past research on robotic vacuum cleaners, which has shown that they often require additional “digital housekeeping”.^{31, 45, 12} In this trial, this ‘housekeeping’ was undertaken by participants and the project team. This ensured the Roomba operated smoothly without getting ‘stuck’ under or between furniture, that it didn’t pick up objects it shouldn’t, or didn’t go into certain areas.

“The only thing, I have to be very careful, I have two lounge chairs, single ones, and I lost it one day and I couldn’t find it anywhere... but somehow it had sneaked in, it was upside down in there, turned off, and everything, and it took me ages to find it... Now, otherwise we just listen and we know which room she’s in and we keep a check to make sure that it’s done it all”.

Beryl

9.9 FAMILIARITY WITH THE DEVICES AND A SENSE OF COMFORT

Participants found Google Home's 'friendly' feminine voice comforting

While participants did face some challenges in learning to use the devices – including the Google Home commands (see Section 10.4) – a growing familiarity ultimately resulted in a sense of comfort with them. For many participants, Google Home's 'friendly' woman's voice felt like speaking to a person and was found to be comforting. This feeling of comfort was augmented by Google Home's role in providing services to participants.

"I use Google the most, yes, I would say that's been the friendliest of the two, because it talks back, it does talk whereas Roomba doesn't."

Francis

"Oh it's just [a] friendly voice. And it's quite amusing because, you know, I'll say, 'hey Google'... And it'll say, 'got it', you know, in that jovial voice. Yeah. So it's quite funny. It's quite good... I don't know, I think she's got a lovely voice."

Robin

Familiarity with the devices created pathways for the participants to consider future possibilities with new technologies

The role of Google Home in accessing the services provided by other devices (e.g. lights, vacuum, kettle), gave participants a taste of the wide range of possibilities offered by smart devices, as well as the confidence to consider expanding their use of them. Participants' experiences with older technologies were also key to the ways they valued the new devices and to how they conceptualised future possibilities. For instance, participants saw the routes created by the robotic vacuum cleaner as similar to the process of mowing the lawn (back and forth and tracing the edges), which led some participants to consider the possibility of having a robotic lawn mower (see Vignette 6).



Vignette 6.

Building on positive experiences with technology – insights from Hilda and Owen

Hilda and Owen, an Aboriginal Australian couple in their mid-seventies, were already involved in learning about new technologies before joining the trial, with the specific intention to maintain their independence and keep their minds active. This included participating in a government program offered at their library, in which Hilda had learned to use Apple's voice assistant, Siri, on her smartphone. The couple hoped that the trial would further strengthen their skills and confidence with technologies. Hilda told us that: *"we like to stay at home and be more independent and if we can get more technology like this into our homes, that will make life so much easier for us".*

Initially they had found the trial *"a little bit scary"* but found that with patience *"once you get to use it, like get to know how to use it, like turning the switches on and off and it's not hard at all"*. In time, Hilda who said she used Google Home just as she had used Siri on her phone, felt that living with Google was *"just like every day. It's just like you're talking to a person"*.

Hilda and Owen demonstrate how people build on their past experiences to incorporate technologies into their present lives, and also how learning to use new devices can enable them to imagine their future with technologies. For example, learning about the robotic vacuum cleaner made Hilda wonder what a robotic lawn mower could offer them:

"This lawn grows very quickly so ... that would be another excellent thing for the aged, or for any age really, because lots of people don't like mowing you know... If we had the lawn mower, because the block is fairly big, that would really help my husband, yeah."

Based on their own experiences with technology both before and during the trial, Hilda and Owen felt very positive about the role of new devices in their own lives and the lives of others. Hilda emphasised that: *"I think if they can find anything that the Elders can benefit by it, well I just think that's great. We've got to make life a little bit easier for us."*





9.10 LEARNING NEW SKILLS AND BUILDING CONFIDENCE WITH TECHNOLOGY

Being part of the trial was a key benefit to participants

Most participants appreciated being part of the trial and embraced the opportunity to experience and learn about new technologies. As such, it was difficult to differentiate the positive impacts smart devices had on wellbeing from the positive impacts arising from trial participation itself. Participants enjoyed the opportunity to learn, discuss, contribute and interact with the trial and the project team, even when they did not normally consider themselves as 'tech-savvy'.

The trial demystified digital technologies for some older participants

Some participants began the trial with little or no experience with digital technologies, and felt overwhelmed by the arrival of the devices and systems. Participation enabled them to gain an understanding of how to use the devices, the possibilities they offered, and the confidence to both use these devices and evaluate their own needs in relation to them.

While many participants were already learning about or familiar with using computers and searching the web with Google, they didn't necessarily associate the Google Home suite of devices as being related technology. Learning about this relationship impressed them, and allowed them to better understand the ways in which these technologies worked and where the information was coming from (i.e. an Internet search engine).

Learning new digital skills was a key reason for, and benefit to, trial participation

The trial was viewed by many participants as an opportunity to upgrade their home technologies while receiving associated technical and social support. Participation in the trial was a chance to learn skills that could help to postpone as well as better prepare for a scenario where participants' independence at home could be compromised.

Participants mentioned that becoming familiar with the technologies required continual practice and patience and involved ongoing trial and error. The participants did, however, express a sense of satisfaction and achievement when they were able to work things out and when benefiting from the additional options supporting them in their everyday routines.

"If I can get Roomba to behave himself and do what I want him to do which I haven't tried today, but when I'm in the right mood to battle with him... it's just that it's got to be worded differently, it's got to be worded perfectly or it just doesn't happen, it just won't respond [to] a lot of things, yeah... So, Ross gave me a lot of hints so I need to experiment with that next, that's the main thing."

One week later:

"I just had blast, it worked perfectly... Roomba was such a good boy."

Coreen

For example, with guidance from the project technician, participants learned how to reboot the Roomba system, which resulted in a confidence boost that compensated for frustration that occurred when devices didn't operate smoothly. This autonomous device brought new understandings about artificial intelligence and automated technologies' capacity to learn and function according to participants' specific needs.

Learning by participants as well as the research team was critical to the success of the project. The combination of different approaches (McLean Care technical support, Deakin quantitative data, Monash qualitative insights) gave the project team ongoing insight into successes and challenges throughout the trial. Continuous dialogue with participants, as well as within the project team, meant that challenges could be identified early and that learning was constantly evolving (see Vignette 7). The success of this approach has resulted in one of the project team's key recommendations for future research (see Section 13).

Vignette 7.

Facilitating learning with the devices in the trial – insights from Ross, the project technician

The project technician, Ross MacMahon, was integral to developing the learning process between participants and the project team, and to building technical skills and capacity amongst the older people participating in the trial.

Ross supported the learning process by meeting with participants in their homes to talk with them about how they currently live, by considering the layout of their home and the existing lights and appliances, and in establishing which devices might be suitable for their household.

In addition to evaluating the need for each device and its suitability for each household and participant, Ross helped to educate participants about how to get the most out of the smart home devices installed. Ross saw education as a critical part of his role as the project technician, and as such prepared a range of different educational materials – such as user videos – to help participants become more independent in troubleshooting day-to-day issues with the devices.

Ross was himself engaged in learning throughout the project. Towards the completion of the trial, Ross reflected on how he had *“experimented with [voice command] words”* across the whole project, and would now *“be better able to teach them [the participants] how to use them [the devices].”*

Throughout the trial participants also routinely referred to Ross and the training he provided. Beryl, for example, joked about how *“Ross reckons I’m a technician now, because the other day, between us we fixed the [modem]”*. Suggesting that the participants were technicians was something Ross often said to participants who were able to troubleshoot issues themselves. In our interview with him, he commented how he liked to congratulate participants on their technical abilities and skills to give them a *“personal boost ... because they had fixed their own problem.”*

The COVID-19 pandemic meant participants’ needed to work together with Ross or Mick (Deakin researcher) on the phone to resolve some of the technical issues. Ross reflected on how, during the peak of concern about COVID-19, he wasn’t performing visits to participants’ homes and how he *“had to actually push them a bit harder to fix their problems, so they had to get down to the box and pull out the battery and so forth.”*



10 CHALLENGES AND RISKS

10.1 RISKS TO HEALTH AND WELLBEING

The robot vacuum's unpredictable actions caused distress for some participants

Unforeseen robotic vacuum cleaner activities, such as unexpectedly vacuuming during the night and potentially posing a tripping hazard, caused distress for some participants and concerned others. To respond to this, McLean Care implemented additional safety reviews, the Deakin team made technical adjustments, and the Monash team discussed participants' experiences and concerns during the interviews. In two cases, participants found the robotic vacuum too stressful and asked for it to be removed.

"I get cross especially when it's late at night and 'he' [robotic vacuum] decides he wants to vacuum the whole house."

"Jodie"

"I got so upset there once or twice with the vacuum cleaner, I think, I ended up with angina for the rest of the day. I ended up with heart trouble. So, it was meant to be helping me, not hindering me... it's just that sometimes there's frustration... and I thought, 'It's not worth that technology going wrong and me getting upset'. It was silly I got upset about it, but ... something wasn't working and I couldn't do anything about it."

Ernest

The smart kettle made it easy to see heating and temperature but was too heavy for some participants

Six households were concerned about the weight of the kettle – describing it as potentially too heavy for some older people. While all participants in the six households were able to lift the kettle, not all were comfortable in doing so, and some were concerned that other older people might not be able to lift it.

"I thought, for someone in senior years, that is much too heavy a kettle... You need something that probably only holds about three cups or four cups, nothing more."

Edna

The ability to activate the kettle from a distance was mostly seen as unnecessary, however a few households did find it convenient and continued to use the feature throughout the trial.

"Well, I have the smart kettle, which I love because I've realised now that when I wake up in the morning, I go, 'Hey kettle. Turn on'. It's ready for a cup of tea or coffee when I walk out to the kitchen."

Robert

Some participants found accommodating the devices into their homes difficult

Smart devices were installed in participants' homes and decisions to adopt particular devices came with a range of considerations, including having available space to accommodate and use each device. For example, in smaller houses, the amount of space needed by a device was weighed up against the value it would provide. Whereas in a larger house space wasn't as critical therefore less frequently used devices could be more easily accommodated. Digital connectivity was another consideration that contributed to the placement of devices in the home. For example, in one home digital connectivity was limited in some areas, posing limitations on where devices could be installed.

Aesthetic considerations also informed the placement of devices in the home. This was particularly so in homes that participants had spent a lifetime creating (see Vignette 1). In some households, devices that were initially installed in locations that were convenient for their functionality were later moved based on the location being inconvenient, impractical or non-aesthetically pleasing for participants. For example, the project technician and research team members helped some participants find a location for the vacuum cleaner base that was less visible but still avoided tripping hazards.

“I’d put it [the Roomba] away if it was there full time, but [for] us to get used to it and everything else, it’s not a problem. Six months’ holiday, it can have.”

4 months later:

“Well, actually at the moment it’s beside the table, the coffee table, we put it in the corner there, yes. And that’s where, well, she finds home base without any trouble, yes.”

Beryl



Location of Roomba robotic vacuum cleaner in Beryl's home during the first research visit.

10.2 TECHNICAL, SECURITY AND PRIVACY CHALLENGES AND RISKS

Participants relied heavily on remote and on-site technical support throughout the trial

Installation of devices, and keeping them operational during the trial, required a high level of remote and on-site technical support (provided by the project team and informally by some of the participants' family members). While this provided learning opportunities, contributing to participants' wellbeing (reported above), it did also cause frustration for participants and there were periods when devices were inactive or not working at all.

Some of these periods where devices faced technical challenges were caused by power and Internet outages. The project technician reported resetting the modems in almost all the households during COVID-19 and storm activity.

The most common technical issue encountered throughout the trial was the loss of mobile Internet connectivity and the subsequent failure of the modem to reconnect automatically. The mobile Internet modem (Nighthawk M2) had a battery providing at least 12 hours of use when mains power wasn't available. This battery meant that it was difficult to restart the modem through power cycling like one would normally do by switching the device on and off using a button on the device or the power switch located at the powerpoint. Restarting the modem when Internet connectivity was lost required participants to either request a visit from the project technician to remove the battery and restart the modem, or wait 12+ hours until the battery had drained so the device could be restarted and reset.

The number of requests for technical support varied greatly between households. The household who received the greatest level of support received eight home visits and made ten support calls. The lowest level of support received was from two households, who both received one home visit and made one support call. The average amount of technical assistance provided per household was five phone calls and 4.2 home visits.

Due to the complexity of smart devices, participants were rarely able to resolve technical issues on their own. Some participants turned to family members for technical support (see Section 9.5). The detailed user guides (see Appendix 1) provided to participants at the start of the trial, with step-by-step visual instructions for how to operate the devices, were not commonly used.

Coreen: "Now what if I use these devices and become reliant on them and then they refuse to cooperate, what do I do then?"

Melisa (interviewer): "Then you call a human and tell them to help you."

Coreen: "Thank goodness, there's some humans. You're not all robots."

"When we were having the electrical storms there, like you know, January, February, March area, it went out every time... it just wasn't doing anything half the time. ... And I didn't know how to make it do it you know. Whereas somebody younger, who's a bit savvy with these things probably could have got it working. I mean let's face it, when Ross came and serviced it yes, it worked alright straight after that, but ... next time we had another storm, out they went again."

Francis

Participants encountered challenges in learning to use the devices and integrating them into their routines

Participants found it challenging to integrate smart devices into their everyday routines to replace more conventional technologies. For example, replacing lifelong learned habits such as flicking light switches on and off or turning on appliances at the powerpoint with voice commands using Google Home was difficult.

Learning how to use and becoming familiarised with the new devices required patience and trust as well as understanding that they are IoT devices and interconnected to other devices and systems.

Participants also needed to learn about engaging with the type of technical support provided throughout the trial. Research shows that older people may experience difficulties in learning new habits when using new smart home technologies.²⁷ Some participants were more willing and patient to learn, while others felt it was too complex and too different to what they were already familiar with.

“Talking to a thing that turns a kettle on.
It is a bit silly really, isn't it?”

Claire

“I was patient with it and I said no, I'll just try it again.”

Hilda

“I still think that my little touch light was a lot easier, and my torch.”

Francis

Some participants expressed anxiety about the ‘black box’ installed in their homes

To support the smart homes devices, a ‘black box’ (small network rack) was installed into participant homes and housed all the hardware required to connect, monitor and record the smart home devices as well as providing battery backup (see Section 7.2). The black box also helped participants understand some of the complexity of the interconnectivity underlying their smart home devices. The black box was designed by the Deakin

research team in such a way that it worked as a centralised point able to be accessed locally and remotely for support and maintenance.

The size of the black box was inconvenient for participants who didn't have much spare space at home. Some participants also expressed concern about the amount of energy the black box was consuming. The ‘mysterious’ ability of the black box to allow the technical and research team to connect to their home remotely made some participants uncomfortable about their privacy, even despite the project technician and research team's significant efforts to explain how the box worked.

“What's this going to do to our power bill?... I'm concerned about that, but I'm more concerned about having a bad storm and something starting a fire in our house. That concerns me more than anything.”

Edna

“I would say, universally, every time I turned up with the black box, I got a, ‘oh my goodness, that is a big black box, I didn't expect it to be that big’.”

Ross, project technician

“The results have been okay when it's worked, but if it means that I've got to have those big black box to make everything work, that is the biggest obstacle I think.”

Francis

Given that the black box caused concern (size, cost, potential fire and security risks) for some participants, depending on the particular smart home device configuration, it would be possible to remove it. An equivalent similar setup could be achieved using an existing Internet service (preferably fixed line) and just the Fibaro Home Centre 2 gateway.

Some participants were concerned about potential privacy and security risks but most were unaware

As demonstrated in other studies, smart home technologies can introduce privacy or security vulnerabilities to older households.^{6, 13} Some participants raised general concerns about privacy and security in relation to technology use – not just in relation to the trial devices but also other technologies and online platforms that have become widely used (e.g. smartphones and Internet banking). Participants often put these concerns aside for the trial, perhaps because it was delivered by a trusted provider (McLean Care), and because they were receiving personalised technical and security support from the project team.

Despite some participants being aware of the inherent privacy and security risks, the findings from this trial indicate that many older households are likely to remain under-equipped to manage these risks if acquiring and using these devices on their own.

“It’s an age where you’ve got to be terribly careful you’re not gullible and you get talked into things. I guess that’s why sometimes you want to be isolated from the world a bit because of what’s going on. You don’t want to be taken down and I think a lot of people, like I say, our age, yeah, we respect people with the old age and now we’re a bit frightened.”

Ernest

10.3 DEPENDENCY RISKS

The complexity of smart home device interconnectivity reduced participants' ability to troubleshoot or fix small technical issues on their own

Smart devices are dependent on access to other technologies and services, such as reliable home Internet and sufficient data, or on ‘gateway’ devices, such as Google Home (used to operate a number of other smart devices), meaning that some home activities became more complicated as a result of using them. Aside from this complexity, the costs for households choosing to retain the devices post-trial could be an issue as well as potential vulnerability if essential technologies were to no longer work when needed.

The complexity arising from this underlying interconnectivity meant participants were less likely to be able to troubleshoot or resolve technical issues with their smart devices. This added a sense of dependency on the external support team for activities or actions that previously may not have required this support (e.g. turning lights on and off at the switch). However, the participants highlighting these concerns did recognise that for people with health and mobility challenges, these technologies offered great potential.

“As I say it can be quite useful if you spend the time with it but if you’re more or less haven’t got the ability to be mobile and stuff it’d probably be a lot more useful in using the information on how to learn things and that. But me, I’m not a person who likes sitting down too long.”

"Claire"

Some participants were concerned about becoming dependent on the devices or the technical support team

Participants in eight households were worried about becoming dependent on the devices or the technical support provided by the project team. For instance, one participant who had recently experienced health problems was grateful for the medication reminder light on his cupboard because he was concerned about forgetting to take his medication regularly. When the light was removed due to personal life circumstances however, he struggled to remember to take his medication and how to implement a new reminder system. Other participants were also concerned about what would happen if or when they no longer had access to a device they were becoming increasingly dependent on (due to completion of the trial, or an Internet or power outage).

In psychology, this phenomena is commonly referred to as “cognitive offloading”, where an increasing reliance on the Internet (or the technologies it enables) can affect people’s ability to independently engage in problem solving, recall and learning.⁴⁶ The concerns raised by participants in this trial reflect the concerns identified by other researchers that an over-reliance on the Internet can reduce people’s memory capacity.

Melisa (interviewer): “How are you feeling without the red light?”

Ernest: “Yeah, I’d get lost without the red light. I’ve already missed two or three medications. That was a really good one that one. It was tops, yeah.”

Melisa (interviewer): “So, how are you remembering now the medication? Do you have a strategy that helps you remember?”

Ernest: “I’ve got a watch. My wife gave me a watch, but I haven’t been able to set it properly yet. Yeah, I’ve got to be careful.”

In coupled households, one person was more likely to take responsibility for learning how to use and maintain their smart home technologies

Consistent with past research on the division of labour in the installation, monitoring and management of smart and networked home technologies, we found that in coupled households, the responsibility for troubleshooting technical issues was normally taken up by one person rather than both.^{44, 20} The person who took on this role (commonly referred to as ‘digital housekeeping’⁴⁸), typically did so because of a pre-existing interest or curiosity in new technology.

While this reflects commonly observed divisions of labour in coupled households, in older households it also presents a potential dependency risk, if the more technically-competent and -capable partner becomes ill, requires a higher level of care, or dies.

“I wouldn’t say I was hopeless [with technology]. But I’m learning all the time. I never knew much before my husband died and now I’ve got into the banking and all that because I had to, or I wanted to really. It’s easy to pay bills through the computer.”

Robin

Ken: “I wish she [Helen] could [learn to use the technologies]. I tried a number of times to get her to learn, to go to the tech or, or one of the places where you can learn, but she just doesn’t seem to want to, you know.”

Larissa (interviewer): “Not your thing?”

Helen: “Well to tell you the honest truth I’m frightened of them [technologies] and, and it’s just so easy to make a mistake these days [referring to concerns about potential scams] ... If the worst comes to the worst if I’m still here and he’s not well I said there’s always the phone to get in touch.”

10.4 CHALLENGES IN OPERATING VOICE-ACTIVATED DEVICES

Participants needed support to learn and remember Google Home commands

Google Home was unable to understand 15.1% of all the voice requests participants made. Google also misunderstood or couldn't provide assistance for 8% of successfully transcribed voice requests and therefore gave negative responses. For example, one participant commented that Google Home didn't communicate the local news but instead connected them to national news broadcasts, and in another case Google Home could not connect to the Bible audiobook as requested. More examples of negative responses are presented in Box 4.

Some households experienced frustration or a sense of failure when the smart home devices were difficult to operate, unreliable, didn't recognise participants' language commands, or were insufficiently sophisticated to source desired, specific information (e.g. 'local' information). It was essential for participants to have social and technical support in order to learn and use the commands effectively.

"There were other times that it, you know, it just told me that it couldn't help me with that. And then if I asked it again, it would help me. So, I don't know what's going on with it."

"Susan"



Box 4. Google Home requests that received negative responses (from voice and Google response transcripts)

Smart Device Related

- Voice Request: "Send Roomba vacuuming"
- Google Response: "Sorry, I didn't understand"
- Voice Request: "Turn off number to light please"
- Google Response: "Sorry, I can't help with that yet."
- Voice Request: "What's happened to the clock Google"
- Response: "Sorry, I can't find news on clock"
- Voice Request: "Turn on Kogan Smart kettle"
- Google Response: "Sorry, I don't understand."

Music Related

- Voice Request: "Said Greek music on speaker please"
- Google Response: "Sorry, I didn't understand."
- Voice Request: "Pause"
- Google Response: "Sorry, it looks like Speaker isn't available right now."
- Voice Request: "Skip track"
- Google Response: "Sorry, that mode isn't available for the Dining Room."
- Voice Request: "Play country gold on Sonos"
- Google Response: "Sorry, I couldn't reach Sonos. Sure, playing the Spotify playlist called Country Gold on Dining Room..."

General Questions

- Voice Request: "How do I get out of here"
- Google Response: "Sorry, I don't know how to help with that yet."
- Voice Request: "Changing of the guard Windsor times?"
- Google Response: "Sorry, I didn't understand"
- Voice Request: "Said what time does Regional Airlines depart Inverell tomorrow for Brisbane Sydney"
- Google Response: "Sorry, I'm not sure how to help with that."
- Voice Request: "Said open Facebook"
- Google Response: "Sorry, I can't access Facebook yet."

Participants were uncomfortable with the etiquette of Google Home commands

Most participants felt that Google Home commands were lacking in 'manners'. They would have preferred the terms 'please' and 'thank you' to be part of the commands, because this better represented their culture and values. Many participants disliked using the term 'hey' which felt unfamiliar, impolite or unnatural to them.

"See, I think that's rude to say, "Hey Google". I'd rather say, "Excuse me, Google. Could you do this?"... "Hey, you, do this". Well, that's not a language that we normally use."

Edna

"The other day I said, 'thank you' and she [Google Home] said, 'oh you're welcome'... So... I don't know whether it [Google] can learn more than what's been put into it."

Mary

Vignette 8.

Interacting with gendered and humanised devices – insights from Beryl

Interacting with the Google Home voice assistant, which sounds and speaks like a human woman, is something that generated unique dynamics between the participants and their devices.

Beryl referred to both her Google Home and Roomba devices with female pronouns (she/her), and felt that this was appropriate because *“women do the housework”*. She wasn't comfortable with her husband referring to the device as *“darling”*, and was very careful to maintain respectful interactions with the device, as if *“she”* were another person in the home.

Beryl explained how she liked to say 'please' and 'thank you' when talking to Google, even though she acknowledged that *“it's only habit”*. Reflecting the values and manners she'd been taught growing up, she felt that it was appropriate to say 'please' to Google because that's what you do when *“someone's helping you”*. Beryl noted that *“now and again”* Google responded to her thank yous with *“you're welcome”*, which reaffirmed Beryl's desire to maintain polite interactions with the device.

Using commands like *“Hey Google”* was strange and hard to remember at first, but Beryl was open to learning these methods for getting the device to respond. As she put it, *“if it's getting their attention, it's not a problem.”*

Occasionally Google was brought in to settle disputes or debates between different household members or visitors to Beryl and David's home. For example, when Beryl's husband and his two brothers got into disagreements due to differing opinions, Beryl asked Google to step in to settle the argument, using 'her' as the source of truth.

“So I say now, ‘Go on, talk to Google’ and off they go, she settles it, so no, that's very good.”





Participants experimented with commands when they could not remember them

Most participants had difficulty remembering the specific sequences of words forming the commands, such as those required to instruct Google Home to activate (e.g. “Hey Google” or “OK Google”) or operate the Roomba robotic vacuum cleaner. This led to various permutations. In some cases the project technician and research team found that participants were more successful when they used the term “OK” rather than “Hey” and recommended that participants switch to that command.

“Well, I think we were using the wrong terminology.”

John

“It’s a new language. And as I say I find some terminology what I call childish, to me. To me the terminology is so different it’s a bit like shorthand.”

“Claire”

Participants sometimes unintentionally altered device configurations

Participants developed ‘workarounds’ to support their preferences and routines, and these could change the configuration of the devices. For example, if smart lights and kettles were switched off manually, Google Home voice commands and the push buttons couldn’t connect until the smart device was manually switched back on again.

“She’s [my wife] not computer minded. As I said, she just switches the kettle on, and then when it gets to the boiling stage, she switches it off at the wall. Of course, that upsets Google, then I’ve got to go through the procedure of setting up re-programs.”

“Peter”

10.5 HEARING, VISION, LIFTING AND TACTILE USABILITY CHALLENGES

Participants encountered difficulties hearing, understanding and being understood by Google Home

Participants experienced difficulties in both hearing Google Home’s ‘quiet’ voice, and in making

themselves loud enough to be understood when giving voice commands. Both of these challenges were gradually resolved as participants learned to speak in such ways that the commands were understood, and to use voice commands to adjust the volume of Google Home to make it louder. However, one participant told the research team that she could not hear Google Home’s responses to her commands at all when she took her hearing aid out at bedtime, but that this did not matter since the device followed her commands well.

“I think you know, it’s got limitations in the fact that... it depends on the inflection of your voice, or depth of your voice, or what it’ll give you commands, I don’t know what it is, but ... or whether it’s the clarity of your speech, I just don’t know. But that makes it, you’ve got to be able to sort all those things out before it could be, say to be a perfect job, I would think.”

Francis

While participants learned to adjust the volume levels, they could not adjust the speed of Google Home’s speech, which for some would have been desirable.

“I’ve only asked for the news once or twice, but as I say they seem to talk so fast that I wasn’t picking it up anyway. I think that sometimes it’s been the depth of the voice because with my hearing I find low pitched voices are harder to hear than high pitched voices. But then if you get a too high a pitched voice it can ... the words can all run together. It’s, I mean I’m useless without hearing aids now.”

Francis

Google Home’s ‘personality’ affected the way participants interacted with this device

The Google Home voice assistant also impacted on the sensory and emotional feel of the home, through its ‘personality’. The way it was used was however restricted by this, since for instance participants avoided voice command conversations with Google Home at night in order to avoid waking a partner. Google Home also sometimes joined conversations uninvited, which could trigger

privacy concerns. Participants reacted differently to this: some laughed, some unplugged it from the wall, others were mindful of their conversations.

“I had a friend coming in and she didn’t like to have it on [the Google Home] because she thought that it could pick up your voice and the things that you were saying, not that I’ve got any secrets or anything, but I think it was partly because she didn’t want to have her voice recorded anywhere. Like, do a voice identification or something like that. So, she unplugged them all.”

“Anna”

Some participants found operating the push buttons, key fob and touch screens difficult

Several devices could be operated using touch commands, which were used as an alternative to voice commands. Remote push buttons provided participants with walking difficulties the ability to activate devices remotely. Push buttons were also effectively used by some participants who had arthritis in their hands. However, participants experienced challenges using the buttons. For example, push buttons sometimes required one, two, three or four pushes to activate the correct device depending on the number of lights in the home. Most participants found it difficult to get used to the number of times and degree of pressure required to activate the devices using the push buttons.

The key fob was particularly difficult for participants to use due to its small size, shape and command structure of its buttons (e.g. *, +, -, o symbols). Some participants also experienced trouble memorising the function of each of the fob’s six buttons, further reducing its intended function as a singular remote for various smart devices.

“They’re [the fob] not suitable for people with... anything wrong with their hands. They were too hard to get to use. If they had better buttons they’d be all right, but as they are, they’re, I mean we couldn’t get it to work most times because you put your finger on it and they didn’t, nothing worked. ... Nobody takes into account that one day you might get old, you know.”

John

Some participants also found using the touchscreen on the iPad challenging because it did not pick up the movement of their “cold fingers”.

“My fingers are very cold and your machine doesn’t like cold fingers... Virtually for us it’s not going to be any good [touch screen] because we’ve got problems with our hands and fingers, and my fingers are too cold, and John’s got too much electricity in his body.”

Mary

11 NAVIGATING THE COVID-19 PANDEMIC

11.1 MODIFYING THE PROJECT DURING THE PANDEMIC

Part-way through the trial, the novel coronavirus began to spread in Australia, resulting in physical distancing restrictions across the country. Given the vulnerability of the older participants in this trial to contracting the virus due to their age and, in some cases, immuno-compromised health status, the Project team put in place extra precautions to minimise physical contact between participants and the project and research teams. These included the following measures:

- **Home visits made by the project technician to support participants' use of the devices were stopped.** Where possible, troubleshooting was conducted remotely (over the phone). Where visits were considered absolutely necessary, the technician adhered to strict hygiene protocols, including the use of personal protective equipment (PPE) whilst in older peoples' homes, disinfecting equipment and minimising actual time spent inside the home;
- **An in-person co-design workshop with older people was cancelled.** The workshop was intended to inform how the user reviews of the devices would be collected and the preferred format and design of the user review website. The workshop was replaced with a paper-based survey that was mailed to participants for their feedback and followed up with a phone call;
- **The Google Nest Hub Max device was added to the trial during the pandemic.** Twelve households received this device and used it to support their connections with the research team and in their daily routines. It was most commonly used to diversify their news, music, video, and information outlets; and for video calling family and friends to stay in touch;
- **The Stage 3 ethnographic research was undertaken remotely, using the devices (e.g. Google Nest Hub Max tablets) where possible.** A combination of video and voice calls replaced planned face-to-face visits to participants' homes; and
- **Participants were invited to keep their smart home devices for an additional three months (until September 2020).** This extension was put in place to maintain the benefits being experienced by participants (such as video calling family during the pandemic) and to reduce the risk associated with face-to-face contact, alleviating participants' concerns about having a project team member visit their home. Fourteen households took up this extension.

11.2 METHODOLOGICAL INNOVATIONS AND INSIGHTS DURING THE PANDEMIC

While the necessary restrictions imposed by the Australian government during the pandemic directly impacted the planned research activities and opportunity to interact face-to-face with participants, they also created several opportunities for methodological innovation in the project.

Doing research with the devices through remote and virtual ethnography generated unique insights

The pandemic provided the Monash research team with a unique opportunity to engage the participants in remote or virtual ethnography, involving the devices. For example, some participants used their Google Nest Hub Max to connect with the research team via video calls, as well as to communicate with their families. Five participants had their first video call experience with the research team, which encouraged them to continue exploring this functionality with their families. Participants were not only engaged in research about their use and interactions with the devices, they were also engaged in doing research with them.

The virtual and visual ethnography methods developed in this project demonstrated the benefits of bringing together face-to-face and virtual research and the different types of information that can be accessed through each method. They offer a template through which future face-to-face research projects can be adapted to new circumstances, and demonstrated the value and richness of virtual follow-up methods.

The pandemic presented an opportunity to explore the impacts of the devices in exceptional circumstances

The research team explored the value and impact of the devices during a unique period of history when participants were largely staying at home, without full access to their support networks and CHSP services (such as McLean Care's in-home services). This provided a glimpse into a possible future where there are fewer physical services available to support older people living independently in their homes, and where older people have less physical access to their social and family networks.

11.3 USE AND BENEFITS OF DEVICES FOR SUPPORTING WELLBEING DURING THE PANDEMIC

Participants looked for opportunities to use their devices to support their activities during the pandemic

While participants didn't show a significant increase in their overall use of devices during the pandemic, some participants used Google Home to help them access news and information about the coronavirus (see Box 5). Some participants also told us how they used the devices more frequently or in new ways due to their self-isolation.

The devices helped keep participants entertained, comfortable and informed while spending more time at home (see Vignette 9). Participants from six households mentioned that during COVID-19 they were listening to more music, having more cups of tea using the smart kettle, and using the Google Nest Hub Max to connect with others because of physical distancing restrictions.

"We couldn't have used the vacuum cleaner more because with the self-isolation... we decided to give it its best shot with the robotic cleaning... and we certainly use the kettle so many times, because I'm a coffee drinker and Helen's a tea drinker, so we have numerous cups of coffee and tea. The lights, we use them on a daily basis. We couldn't use them anymore, and with the Duo, we find it excellent for the music and the phone. It's just so good.

Ken

Box 5. Coronavirus and COVID-19 requests with Google Home (from voice transcripts)

- "What's the latest on the coronavirus 19"
- "Listened to Coronavirus Daily Update Australia"
- "How many coronavirus in New South Wales today"
- "What viruses do bats carry"
- "What is covid-19"
- "Where did covid-19 come from"
- "How many people are affected with covid-19"
- "Are there any new cases of coronavirus in New South Wales"
- "How many people have died of the coronavirus in the USA"
- "How many countries is the coronavirus in now"

Vignette 9.

Supporting activities with the devices during COVID-19 self-isolation – insights from Helen and Ken

Due to the COVID-19 pandemic, participants were advised and/or desired to remain at home and avoid contact with others to minimise their risk of contracting coronavirus. During this time, the devices helped some participants stay comfortable and connected at home.

The support provided by the devices was illustrated by Helen and Ken, a couple in their mid seventies who lived in Inverell and enjoyed many hobbies, including gardening, reading, needlework and listening to music. As Ken said, they felt *“really lucky”* to participate in the trial and used the devices *“to the full extent”*.

Helen and Ken felt the impact of suspending in-home care services was manageable because the robotic vacuum continued to clean their home. Ken described the Roomba as *“extremely”* helpful during this time. He said, *“it’s amazing, actually, that technology.”* Without the robotic vacuum, Helen and Ken thought that they would have needed cleaners to come to the home, particularly because of Ken’s health considerations (knee replacement and open heart surgery) and also the large size of their home.

Ken noted that ‘lockdown’ *“gets a bit boring”* but the trial technologies assisted in several ways. Being reasonably confident with technology, Ken was able to implement some programming changes to the robotic vacuum cleaner with phone support provided by the project technician. The Google Nest Hub Max tablet was also used to video call with family using the Google Duo app.

“We ring our son in Sydney... we converse just as though he’s in the house... it’s good because it’s sort of more personal rather than just talking to a voice, to talk to somebody on the phone”(Ken).

As a background to other activities, Ken explained how images and sounds of nature (e.g. waterfalls and birds) on the Google Nest Hub Max tablet *“makes the day go quick when you’re working”*. The couple also used Google Home to test their trivia skills and tell them jokes.





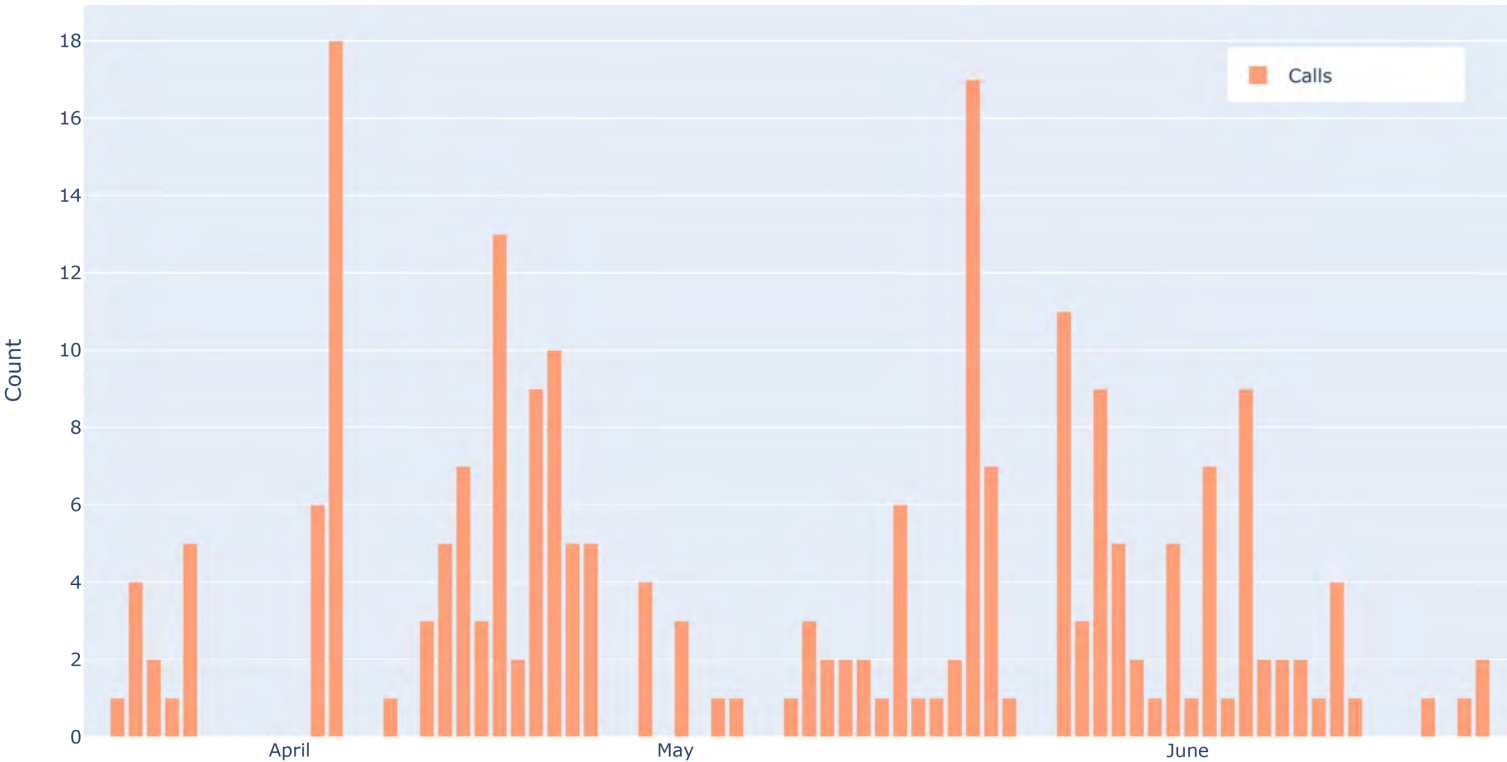
The devices helped participants to maintain social connections during the pandemic

Learning to use the devices built participants’ ‘digital living skills’ in ways that had positive impacts on their social connectedness and wellbeing (e.g. facilitating video-based communications with friends and family during COVID-19 social isolation). This was particularly important because many of the participants’ normal activities and routines were suspended during this time, especially those relating to their community roles and interests.

The devices gave participants alternatives to keep connections active. In nine of the 12 households with the Google Nest Hub Max, the Google Duo app installed on this device was used to make video calls with family members and the research team at least once. At least two of these five households integrated family video calls into their routines.

Figure 12 shows the number of voice requests made to Google Home after the introduction of the Google Nest Hub Max that enabled video calls via the Google Duo app.

Figure 12. Google Home voice requests related to video calls





Helen and Ken sitting at the kitchen bench and talking to Yolande and Melisa (interviewers) on their Google Nest Hub Max during virtual fieldwork.

The robotic vacuum cleaner helped participants maintain their standards of hygiene and comfort during the pandemic

With the arrival of COVID-19, many participants became increasingly concerned about managing their potential exposure to the virus and subsequently restricted visitors to their homes. In some cases, participants chose to suspend the CHSP services they would normally receive from McLean Care – such as cleaning services. Having the robotic vacuum cleaner was therefore very reassuring for those participants. Even in households where participants expressed considerable frustration with this device they still used it often (once or twice a week) during the pandemic. These findings indicate the importance of creating flexible and hybrid care systems, where face-to-face and smart technologies are part of the same ‘crisis-ready’ service.

Some participants were less likely to ask for technical support during the pandemic

Participants reported feeling less connected to the trial and project team during the pandemic, and were less likely to ask for technical support. This may have related to their wish to comply with physical distancing restrictions, and/or concerns about the potential risk of infection due to interaction with the technician visiting their home.

“Part of the challenge came with all this COVID thing, because I got these [installed] just in time and then basically COVID hit... and unfortunately as well some of them when they were having problems they were going, ‘oh jeez I better not ring Ross because he’ll come in my house,’ you know, that was there.”

Ross, project technician

Participants were already experts in 'home-based routines' which helped them cope with the pandemic

The participants' experiences in living through other significant social, health and economic disruptions, and knowing how to live self-sufficiently at home, were an ongoing inspiration for the project team. Despite being part of a vulnerable cohort, the expertise of older participants in having well established home-based routines gave them unique advantages during the pandemic 'lockdown'. Their insights are of value for all generations required to 'age in place' due to COVID-19 physical distancing restrictions.

"I haven't found the self-isolation sort of business hard to take really, but because I've always found plenty of things to fill my time... I've slept in instead of having an alarm going off at 6 o'clock, so I can be at a place by 9.30 or 10.00. So that's just the difference... And that's something that I haven't been able to do virtually all my life, is just to lie in bed and always [be] nice and cosy in bed these mornings [of lockdown]."

Francis

"We've always got plenty to do here. We've got gardens front and back and the little things we're doing all the time. It wasn't much different from normally."

Ernest

"Well I do a bit of sewing and I spend a bit of time in the garden. I was knitting for a little while. Something I haven't done for a while but I've had two new great-grandchildren and I was knitting booties for them... And I play the organ, or I used to play a bit, so I've been doing that when I decided I was a bit bored [from lockdown] and didn't have anything much to do, and I haven't touched it for years. So I'm back to doing that just to keep myself amused."

Pat

12 SHORT TERM FUTURE CONSIDERATIONS

12.1 FUTURE VULNERABILITIES

Being older, most participants were aware of their own vulnerability, and that a fall or small injury could mean they are no longer able to live independently. This impacted on their approach to the devices in various ways:

- They were cautious about making large new investments in smart home technologies; and
- Their visions of their own futures were short term. For instance, one couple described how due to both of them having health conditions, they lived for each day, and found only those devices that supported them in the moment to be useful. Another participant described how she did not think about the devices supporting her in the future, since she was aware that she was just one fall away from being in residential care.

This makes off-the-shelf and easily replaceable or removable devices like those installed in this trial particularly relevant for older households. More permanent installations or systems are likely to be less appealing for this demographic if they require retrofits to their current homes.

“I’m a day at a time girl; what I do today gets me through, and then I worry about tomorrow when it gets here. I don’t try looking at the future too far ahead.”

Edna

“We just make the most of what we’ve got. And just hope for the best, you know. That’s all you can do. You can’t do any more... I mean, like, we’re not young. We’ve had, we’ve got a fair bit behind us. So, you know. And we’ve had good lives.”

John and Shirley

“To be together, that’s what we want most of all... Obviously it’s going to happen one day that one of us is not going to be able to stay here anymore... we’re going to try and put off that day for as long as possible.”

Ken and Helen

12.2 REFLECTIONS ON THE TRIAL

At the end of the trial, McLean Care administered a brief survey to the participants in conjunction with the collection of user reviews on the trialled devices. Nineteen participants responded to the survey (but not all responded to every question).

Participants were asked: **What have you enjoyed most about the project?** Their responses broadly fell into the following five categories:

- Interacting with the project team (e.g. one participant commented, “meeting the lovely people”);
- Using particular devices (e.g. the vacuum cleaner) or specific device functionalities;
- Being part of the project as a whole;
- The novelty of the experience and the opportunity to try new technologies; and
- Learning new skills (e.g. one participant commented, “learning a new way of communicating”).

Participants were asked: **What would you recommend we do differently with this project next time?** The responses broadly fell into the following two categories:

- No changes required (e.g. one participant commented, “nothing really – you’re always there if we needed you”); and
- Specific feedback on frustrations with particular devices or device functionalities.

One participant also suggested that they would have preferred more face-to-face meetings to allow for more questions to be asked about each device. Another suggested it might be easier to conduct the project with people who were more “computer literate”.

Finally, participants were asked on a scale of 1-5 how likely they are to recommend the types of solutions trialled in the project to others. On average, the response rate was **3.9 out of 5**.

12.3 KEEPING THE TECHNOLOGIES

The survey administered by McLean Care at the end of the trial period also asked participants whether they would consider using four of the most commonly used devices in the future: the Google Home suite (Home, Nest Hub Max, and Mini) for general use, the Google Nest Hub Max specifically for video calling, the Roomba vacuum cleaner, and the combination of the smart button and smart light in the bathroom.

Figure 13 indicates that there was interest in ongoing use of all of the devices; however participants expressed the greatest interest in keeping the Google Nest Hub Max specifically for video calling and the combination of the smart button used to remotely control a smart light installed in the bathroom.

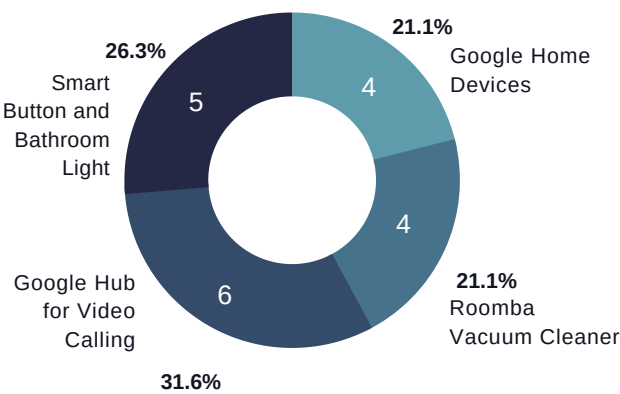


Figure 13. Would you consider using this device in the future?

Participants were asked if they would be willing to pay for the use of the devices in the future. The results indicate that participants were most likely willing to pay for the Roomba vacuum cleaner (see Figure 14).

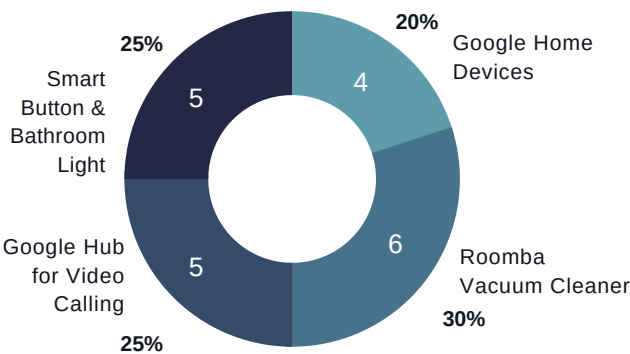


Figure 14. Would you be willing to pay for the use of these devices in the future?

Participants were asked which of the devices they thought other people might be willing to pay to use (see Figure 15). The Roomba vacuum cleaner was again identified as being the device participants thought other people would be most willing to pay to use.

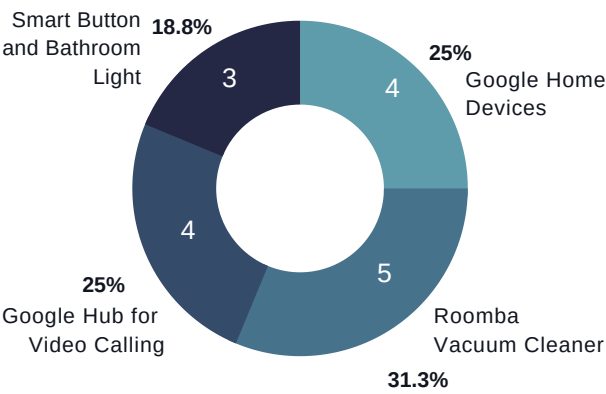


Figure 15. Do you think others would be willing to pay for the use of these devices in the future?

These survey responses support the ethnographic and technical findings showing that smart home technologies will not be of interest to or suit all older households. However, some participants do see value in paying for these devices to maintain access to their potential benefits.

More than half of the households (14) opted to keep the technologies for an additional three months post-trial completion. Recognising the value and benefit the devices were providing many participants, McLean Care subsequently offered all remaining participants free ongoing use of the technologies, including paying for Internet access for households that require it. McLean Care is also exploring opportunities to re-purpose any returned devices by expanding access to the technologies to other groups of older people and through other funded aged care programs. This is important to prevent the devices used during the trial from becoming obsolete, or ‘e-waste’.

12.4 WITHDRAWING FROM THE TRIAL

Over the course of the project, eight households chose to withdraw from the trial. Two households withdrew early in the project, reporting that they were overwhelmed with the devices and preferred to not proceed. Five households withdrew in the final weeks of the project before the offer of continuing to use the devices at no charge had been made by McLean Care.

The ethnographic research helped explain why some participants withdrew early from the trial, or didn't opt to extend their usage of the devices for a further three months. Participants gave a range of reasons for not wanting to keep the technologies, including financial concerns, ability to operate and maintain the devices independently, health concerns, or the physical space taken up by the devices and black box.

"Now I've had my moments with them, and it's at times I've been, felt really frustrated with them, ... but I've also had a few laughs out of it. ... But at the present moment no, I don't think I want them, thank you very much... It doesn't matter what it is, these things have to be trialled before they can be really accepted by the general public."

Francis

Most participants expressed that the devices would only be considered for future use if their benefits outweighed the existing stresses that could become associated with running them in an affordable, safe and reliable way. They were also concerned about the potential value for other older households.

"But whether we would use it [the technologies]... [if] it would be costly, you have to think of that too if that was all just done as a trial, and we didn't have to pay for anything... because when you're on a pension you don't want to pay for anything extra you don't have to."

Jan

"Probably we, because we, or I for instance, have a bit of knowledge of computers, we were able to cope with it without too much trouble. But I'm thinking of some of our friends who are in our age bracket, and I wonder how they would cope with it."

Bert

Discontinuing, however, was not an indicator of overall dissatisfaction, since participants who withdrew from the trial valued the learning involved. Participants who withdrew told us they had "definitely learned a lot through it" (Jan), and that they now knew what was available for the future.

"Nothing ventured, nothing gained, you know. If you don't try, you don't know, do you?"

Barbara

"I don't feel I needed it [the devices] at this stage. But I know it's there if I need them in the future."

Pat

Older people's lives are often complicated by debilitating health conditions affecting members of a household in different ways. This was the case for a number of participants in the trial, where one partner had a condition that affected their perception of and ability to use the devices. For example, one participant withdrew from the trial because the presence of the devices was too stressful for their partner who had dementia. Another household withdrew mid-way through the trial because they moved into residential aged care due to declining health.

Participants reported feeling a sense of responsibility towards the project team and for using the devices. For instance, a participant from a household who used the devices infrequently felt they were not "doing justice to anyone because we weren't using it enough" (Jan). For them, withdrawing meant the devices could benefit others.

Self perception of being active and independent without the help of the technologies was another reason provided for withdrawing from the trial.

"At this stage, I'm pretty active ... I think for somebody that's not as active as what I am, I do think it is beneficial ...or anybody that reads and that a lot, with the different light settings on it ...just for us at the moment I just don't feel as if we require it."

Barbara



RECOMMENDATIONS



13 RECOMMENDATIONS: OPPORTUNITIES AND ENABLERS FOR OLDER PEOPLE

Provide smart home technologies as optional extras for in-home services for older people ageing in place

The devices trialled in this project could enhance health and wellbeing outcomes for older people ageing in place when provided as optional extras to their in-home services, which remain of high importance for the sense of community connection and social interaction. It is therefore important that devices like those trialled in this project are viewed as supplements – rather than replacements – to other aged care services.

Close the gap to accessing health care and technology services for older people living in rural, regional and remote locations

The location of this project was intentionally selected to explore the opportunities provided by smart home technologies for older people living outside central urban areas – where approximately one third of Australia's ageing population resides. As the participants demonstrated through their engagement and perseverance with the devices, continuing to work with this demographic, and in rural, regional and remote areas, can improve independence and wellbeing outcomes for this often marginalised group of people. This is particularly important because this cohort often don't have the same level of health care or technology services as their urban counterparts. Continuing to innovate with and learn from these unique communities should therefore be an ongoing priority for Australia's aged care providers and policy makers.

Personalise the type and number of smart home devices for each household

A key success of this trial was its focus on a personalised set of devices that were offered to each household, and an installation process which was uniquely tailored to each household's needs, including their housing and living situation. Future

programs and trials need to ensure that smart home devices are fit-for-purpose and suited to older peoples' physical space, abilities and life circumstances, and to recognise that these are likely to change over time. This approach is consistent with the broader philosophy of person-centred practice, which is a key tenet of aged care provision in Australia.

Deliver smart home technologies as part of integrated and sustained service provision with training and ongoing technical support

Beyond simply deploying technology, delivery of smart home projects with older people will benefit from integrated and sustained service provision. Shared assessment and review of suitable devices for each household, personalised training and support, combined with professional technology service and troubleshooting, will better enable older people to integrate smart home devices into their lives.

Provide opportunities for participation and learning to encourage all older people to gain 'digital living skills'

The group with the lowest levels of digital inclusion in Australia are those aged 65+, and the difference with the most digitally included age group (25-34) increased until 2018, before narrowing slightly in 2019.⁴⁷ For older people the benefits of wellbeing, health and independence derive from opportunities to contribute to a valued initiative, learn digital skills, and use smart devices. In this trial, in situ technology demonstrations, and ongoing personal interactions with the project technician and research teams were valued learning opportunities. This provided a scaffolded approach to learning, with additional applications and devices added to some participants' homes as they became more confident with the technology. Providing these learning opportunities – including those relating to

privacy and security – is likely to be critical to the success of future technology projects with older people.

This and past research has shown that in coupled households one partner is more likely to take responsibility for managing digital technologies in the home. All household members should be encouraged to develop digital skills in order to preserve their independence in the event of the loss of health or life of a more technically competent partner. This is particularly important in heterosexual coupled households, because the digital inclusion gap between older women and men is widest for the group aged 75-79 (with men more likely to have digital skills than women).⁴⁷

Provide affordable, reliable and equitable Internet services

Wider access to affordable and reliable Internet services will allow more older people to use smart home technologies to support their ageing in place. As illustrated by this trial, storm activity, unreliable telecommunication infrastructure and other issues contributed to ongoing connectivity issues which compromised the functionality of some devices for short periods. Providing adequate Internet services and associated infrastructure is therefore particularly important for people living in regional and rural locations to ensure equitable access to digital opportunities across Australia's ageing population.

Design smart home technologies to support older people's specific usability requirements

Smart devices supporting independence and ageing in place are likely to require design modifications.^{37, 4, 30} These could include more flexible and suitable language (for requests and responses), increased button and text size, higher levels of colour contrast, lighter weight, and the capacity to be fixed in place to maintain function and reduce the likelihood of device under-use and unnecessary e-waste. There is a significant opportunity for older people to be involved in the co-design of technologies that better suit their unique usability requirements and lifestyles.

Design and install smart home technologies that support older people's independence, mobility and memory

As this trial and existing studies have shown, smart home technologies may contribute to negative outcomes for older people if they contribute to reduced memory capacity or sedentary behaviour due to over-reliance on Internet-enabled devices.^{46, 11} It is therefore important that smart technologies which are integrated into older people's homes and lives support their mobility, independence and memory by maintaining movement throughout the day and encourage recall, mental stimulation and access to programs or apps that assist them with learning new skills.

Test and verify the suitability of all smart devices for older people before deployment

As already outlined, this trial was unique in testing off-the-shelf smart technologies in older households living in regional, rural and remote areas, as well as in adopting an interdisciplinary methodology combining testing and measurement methods with social science research in digital sociology, design anthropology and interventional video ethnography.^{35, 36} More in situ studies with 'real people' (and their companion pets) in their homes are needed, in combination with co-design approaches where older people test and provide feedback on smart devices being developed to ensure they are fit-for-purpose for this vulnerable and marginalised group. Independent testing of all smart devices being developed for older people, including for technical and social reliability under a wide range of conditions, will improve outcomes and reduce waste in the provision of smart home technology services.

Provide smart home technologies for older people as part of flexible and hybrid 'crisis-ready' care systems

The findings from this trial suggest the need for flexible 'crisis-ready' care systems, where face-to-face services can rapidly be supported by smart and other assistive technologies on a temporary basis. The COVID-19 pandemic provides an example of how and where this kind of service may be needed. Conversely, the temporary technological 'crises' experienced during this trial (e.g. power and Internet outages) underpin the importance of maintaining face-to-face services where technologies and their associated infrastructures are temporarily unavailable.

Consider older people's extended families

The research showed that the devices used in the trial often became part of the wider family context in which older people live. Participants' extended family members (children, daughters- or sons-in-law, grandchildren) shared opinions around whether participants should or needed to participate, assisted them in learning to use the devices, and supported them with troubleshooting when required. In turn, devices helped families maintain communications at distance. We recommend that the potential role of family in supporting older people in their use of smart devices should form part of an initial evaluation of future trials or projects and should be monitored over time.

14 CONCLUSION

This project was significant in not only realising an essential and unique combination of ethnographic and technical research, but also in focussing on a very broad range of off-the-shelf, readily available, smart home technologies used by older people in rural and remote communities.

The findings confirm that in certain circumstances, smart devices can and do have a positive impact on wellbeing for older people across a range of domains. Whilst there continue to be challenges and risks – particularly pertaining to the technical, security and privacy-related elements – the project has also highlighted a number of important underpinning conditions to support successful uptake and usage of smart home devices.

These include for instance, tailoring devices to the unique needs of each individual or household, accessible and ongoing technical support, considering the role of the extended family, proactively addressing the common concerns of older people about the potential risks or issues related to use of smart home devices (for instance, becoming overly dependent on them) and viewing smart home devices as supplements – rather than replacements – to other aged care services which support people to remain living independently in their own homes.

This project was also, by chance, conducted in the midst of a global event unprecedented in modern history – the COVID-19 pandemic. Whilst this introduced challenges and required various adaptations to the original project design, it was valuable in offering unique insights as well as the opportunity to approach the ethnographic research and technical support delivery in new and innovative ways.

Looking forward, there is clear scope for greater involvement of older people in these types of research. This unique cohort needs to be more actively involved in the co-design of devices intended for their use. This will necessarily include consideration of aspects not only relating to functionality, but also to broader considerations of how the devices might best be integrated to meet the practical needs of older people who wish to age at home.

At an average age of almost 82 years old, the 33 participants in this trial demonstrated their ability to adapt, modify, integrate, embrace or exclude technologies in their daily lives based on their unique interactions with and experiences of the smart devices. It is imperative that this group must continue to be at the heart of policy and research initiatives aimed at closing the digital divide.



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16 APPENDICES

APPENDIX 1. SAMPLE OF A USER GUIDE



SMART HOMES FOR SENIORS

GOOGLE HOME

Google Home is designed to be your hands-free assistant. You can ask questions, play songs, set reminders and control your smart home with your voice.

Below are some examples of commands that we think you might find useful – but the sky is the limit and if you're not sure, just start by saying "Hey Google", followed by what you want Google to do or tell you"



Google Home comes in a few different shapes and sizes. The small round device is a Google Home Mini and the larger device is a Google Home. They both have the same features.



Google Home is designed to be used with your voice, but they have touch buttons on the top that you can use if you like to turn the volume up and down.


McLean Care®



