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Proceedings of a Workshop

IN BRIEF

May 2019

Artificial Intelligence Applications for Older Adults and People with Disabilities: Balancing Safety and Autonomy

Proceedings of a Workshop—in Brief

On October 24, 2018, the National Academies of Sciences, Engineering, and Medicine held a workshop titled Artificial Intelligence Applications for Older Adults and People with Disabilities: Balancing Safety and Autonomy. This workshop, hosted by the Forum on Aging, Disability, and Independence, examined the state of the art and knowledge about artificial intelligence (AI) and explored its potential to foster a balance of safety and autonomy for older adults and people with disabilities who strive to live as independently as possible.

WHAT IS ARTIFICIAL INTELLIGENCE?

Gregory D. Hager of Johns Hopkins University began the workshop with a broad overview of the history, current topics, and themes around AI. Research on AI had its genesis at the 1956 Dartmouth Conference. John McCarthy and Marvin Minsky, who Hager called "the forefathers of artificial intelligence," had different points of view about what AI was—McCarthy viewed it as a question of mathematics (e.g., "How can we formalize the notion of knowledge and how can we build formal reasoning processes that can support the sort of cognitive processes that we see emerge in humans?"), while Minsky saw AI as more "embodied" (e.g., "Can we build systems that seem to act in reasonable and interesting ways, the ways that humans do?"). The field of AI research emerged out of these discussions and has since evolved. AI has been defined in many different ways, including "artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment."[1] Hager prefers this definition because in the end, AI is about "how we can build systems that act intelligently in the environment where intelligence really means understanding, predicting, and acting in a thoughtful way—something that we would ascribe, again, to human intelligence."

Hype Cycles

Hager noted that AI has had several "hype cycles" wherein expectations in AI escalate and then wane when the limits of technology are reached, leading to cuts in research funding and retrenchment in research. For example, in the 1980s and 1990s, McCarthy's followers figured out how to write expert knowledge into formal languages (i.e., expert systems), and the assumption was that this would lead to automated doctors. Hager said that the latest hype cycle is not limited to academia, but includes concurrent levels of interest in the business sector and in the popular press.

Hager attributes this to new advances in deep learning,[2] a specific form of machine learning (when a computer can use continuous learning algorithms to teach itself based on large data sets and other various inputs). Hager emphasized that the systems are powerful, but they depend on having a lot of data available, particularly as the problem they are seeking to solve increases in complexity. Among researchers, deep learning represents a "revolution" that has transformed many different fields such as speech recognition, computer vision, and robotics. The current hype cycle was also generated in part because of attention to stories in the popular press like researchers training a deep learning algorithm to play video games better than humans. Finally, Hager noted, this hype cycle is different because many advances are being driven by the technology industry, which often has access to larger amounts of data and computation than academic researchers.

[1] Nilsson, N. J. 2010. *The Quest for Artificial Intelligence: A History of Ideas and Achievements*. New York: Cambridge University Press, p. 13.
[2] Note that machine learning is a subset of artificial intelligence.

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Weak Versus Strong AI

Weak AI refers to when there is a narrow, well-defined task or problem that can often be solved with better than human performance (e.g., playing a specific video game). Strong AI refers to moving toward a general problem-solving application in the real world, including being able to transfer knowledge from one domain to another. While AI applications can do well on narrow tasks, strong AI does not yet exist and is beyond the capability of current systems, Hager said.

Systems Point of View

Using the example of voice commands to Amazon's virtual assistant Alexa (e.g., turn off the lights, play music), Hager described the "sweet spot of AI right now" as being the narrow concept of AI, wherein the tasks require a narrow set of speech inputs and a finite set of commands. There is a human in the loop and there are no major consequences if the application fails. However, if the system is not responsive enough to fulfill the user's needs, or does not have the ability to learn from user feedback and adapt, it will not continue being used in the long term.

In contrast, using AI systems for activities like driving is hard to do, Hager said. Driving represents a complex, dynamic environment wherein the driver uses accumulated knowledge to assist with decision making. Hager said that it is possible to have fully automated driving in a closed parking lot only for autonomous cars. That is a narrow problem, he added, but the situation becomes more complicated in the real world. Hager challenged the participants to think about which applications will help drivers the most, and which applications drivers will ignore. Furthermore, this is useful to keep in mind when thinking about how AI applications can affect older adults and individuals with disabilities, he stated. Hager posed several questions for the workshop participants to consider: What level of capability will these applications have in specific environments and what are the tradeoffs? How much of the engineering in the system has to be designed toward societal values versus personal values? What are the right levels of autonomy—do we want systems that assist with decision making or are fully autonomous?

Moving Forward

Hager noted that the use of AI for physical manipulation (e.g., lifting a person from a bed) is complicated, and in the short term, approaching the problem will require carving out narrow AI solutions. Additional areas in need of research include AI and verification (How can we build AI systems that meet a certain measure of reliability?), AI and security (How can we ensure that an AI system has not been compromised?), and AI and transparency (How can an AI system explain its rationale?). Finally, Hager said, there are issues around ethics, laws, and values.

Hager concluded his remarks by stating that AI has huge potential impact right now, in part due to the social acceptance of technology. "I don't think it's just an AI problem. I think this is really a systems problem. But I think the time is right for a lot of reasons." He added, "these new tools are really powerful, and I think that as our society ages, we're going to be hitting economic and social barriers that AI can help us address."

THE CONSUMER PERSPECTIVE

During the second session of the workshop, Majd Alwan from LeadingAge interviewed Brian Bard from the Administration for Community Living (ACL) on his experiences with using AI-powered applications (e.g., voice-activated assistive technologies). In his work at ACL, Bard runs the Small Business Innovation Research program, which develops technology for older adults and people with disabilities. Additionally, Bard described himself as a user of assisted technology for 32 years after a spinal cord injury led to his quadriplegia. Bard reflected on the technologies that have been most helpful to him, and where he would like to see AI applications progress in the future.

Bard described his ability to drive as key to his autonomy. He shared pictures of two of his older cars' interiors, noting that there is no computerization, which makes it easy for mechanics to repair. Bard asserted that "the biggest thing that I would like to see is autonomous transportation. I want a vehicle I can roll in and that can drive me to work." However, he then shared pictures of a newer van.

> It was built with a computer. They said the computer's going to be the greatest thing. It'll do everything for you. About 3 months ago, my wife drove it home from dropping me off to pick up one of my other vans, and she left the window down, and it rained 5 days straight. The computer got wet and the whole van is a loss because the computer is ruined. So I have mixed feelings about that kind of intelligence in a vehicle. So they put these things in a van that is already complicated enough. And there's a synergy there that makes it four times more likely to break down. And that's one of the problems with the technology now. It's plug and play, and you would think that's cool, but when it breaks no one can fix it.

The technology Bard uses apart from transportation "has come a long way." The ability to use his current phone from a distance is a "relief." For example, if he is in bed and the home health aide does not show up, he can ask the phone to call someone. However, "what I really want," he said, "is a robot sitting in the corner that can come get me up." Bard played a video of a person with quadriplegia using a robotic arm to bring him a drink of water, calling it the first step toward that robot. Bard was excited about advances like these, but noted other challenges, such as the need for the user to have technical experience to troubleshoot problems.

Alwan asked what the biggest impact these technologies have had on Bard and his family. Bard answered: "Independence is the answer to your question. And safety. When I am home working, my wife can go to the gym. She can go exercise and do other things and not have to worry so much that anything is going to happen to me, or be available for me if something does. So independence is the word, really, the answer. That's what it is all about." Bard further discussed the tradeoffs related to privacy. "I think the benefits outweigh the privacy concerns because it gives more independence, more choices, and in a way it actually gives you more privacy because you're going where you want to go, maybe without everybody in the world having to know."

Looking forward, "AI needs to be more invisible and more integrated so that you can put it in someone's home," Bard said. Furthermore, he raised concerns about the affordability of AI applications. Finally, Alwan and Bard discussed the need to include users and their caregivers in the design and decision-making processes in the development of new AI applications.

CREATING SMART COMMUNITIES

Cathy Bodine from the University of Colorado moderated a discussion about the potential for AI to help create smart communities.

Mobility and Aging in Place

Gwo-Wei Torng from the U.S. Department of Transportation began by noting that AI is already used widely for decision making, such as through applications that provide assistance with driving directions based on current traffic patterns. He added that there needs to be more consideration regarding how AI is used to make choices. For example, current applications direct drivers toward the shortest route, but an individual might prefer a regular route that takes slightly more time. Jon Sanford from Georgia Tech said mobility is key to successful aging in place, but noted that "you can't get to the mobility aspect unless you can successfully age in place in your own home." The ability to integrate lighting and heating and to control these things from a single interface (e.g., Alexa, Google Home) are what help to make a smart home. However, while voice-activated assistants have made certain applications more popular, they do not work well for many people with hearing and visual impairments. Therefore, Sanford said, more thought is needed about developing multimodality interfaces—ones that do not use only voice activation. Sanford added that individuals may have changing abilities (both physical and cognitive), so there is a need to understand how to develop systems that can automatically adjust to an individual's ability at the moment of use.

Laws and Policies

Victor Calise from the New York City Mayor's Office for People with Disabilities said broader thinking is needed for how to continue to evolve smart systems while still adhering to codes standards such as those detailed in the Americans with Disabilities Act (ADA). Calise emphasized that "people with disabilities aren't disabled if our environment is corrected" and argued that those in local government have a role in working to ensure the implementation of new applications and local systems that are accessible. Sanford added that newer AI systems could supplant certain ADA requirements "because it can do things that the ADA doesn't require." For example, the ADA might require a fixed grab bar in a bathroom, but newer AI applications could develop a system that can adjust as an individual's level of disability changes.

Henry Claypool, an independent consultant, raised concerns that overly restrictive policies and legislation could limit the ability of individuals with disabilities to access useful applications. For example, he described the use of smart glasses to help people with vision impairments to navigate while walking around outside. In this case, a camera might be used to capture the individual's environment, including other people, who might have to be informed they are being recorded and give consent to their data being used. Claypool emphasized a need for more education about how to better manage data so that overly restrictive privacy policies do not limit innovation.

Infrastructure

Calise noted the challenge of building AI and other technologies on top of an old physical infrastructure that may not be accessible. Torng posited that AI might help in the repair of the current infrastructure. For example, could AI be used to decide when to schedule construction in a way that would have minimal impact on the overall movement of the transportation system?

Claypool added that the investment in the next generation of wireless communications in several cities will allow for speeds similar to broadband, so large amounts of data will be able to be shared quickly and easily and allow for even more innovation.

Concerns and Unintended Consequences

Claypool cautioned that people with disabilites are at risk of being left out of innovations because "we don't capture enough [data] about disability." Several workshop participants noted similar concerns about the quality of the data available, including the use of commercial data sets that are not fully representative, the dearth of data on individuals aging with disability in general, and the dependence of AI systems on historic data patterns. Several workshop participants raised the issue that the legislative framework is particularly slow at addressing such potential harms.

Calise raised concerns for the levels of technology literacy among users, as well as their ability to afford newer technologies, which may limit their capacity to access innovation. Claypool suggested that good universal design could allow AI applications to help with literacy issues by providing real-time technical assistance.

Sanford warned that another unintended consequence could actually be a loss of mobility or social interaction. For example, improved navigation systems might drop an individual right off at the door of the building and not allow an individual to make the choice to walk for part of the route. He asserted that people need to be able to make decisions on their own about how to use these systems. One workshop participant raised concerns about using AI for "smart choices." He noted that as a geriatrician, he sees his patients' preferences for independence over potential safety. Torng agreed that personalized mobility should include consideration for personal values and needs. Claypool added potential concerns for whether civil rights could be compromised by creating limits to an individual's ability to make choices.

Torng raised concerns about the length of the research cycle, especially for applications that may become obsolete by the completion time of a research demonstration project to prove the usefulness of an individual application.

Moving Forward

Calise said that working with a variety of stakeholders, including people with disabilities, is essential to have all points of view represented so that stakeholders can understand each other and have a unified voice. Sanford stated that "technology is the future of universal design," in that digital technology allows for an infinite number of interfaces for the same application so that the same product can be customized for an individual's needs. Hager cautioned that many of the panel's discussions evolved beyond AI and also suggested that more consideration is needed regarding how the technology being developed today will evolve to meet the needs of future generations who will fully utilize it.

PROMOTING HEALTH AND WELL-BEING AND PROVIDING CARE

Robert Jarrin from QualComm Incorporated moderated a panel discussion on the use of AI to promote health and well-being and to provide care.

Opportunities and Challenges

Jesse Ehrenfeld from the Vanderbilt Medical Center and the American Medical Association's (AMA's) Board of Trustees saw three broad opportunities for AI applications: (1) diagnostic accuracy, (2) chronic care management, and (3) health care delivery systems. As a physician, he sees technology and AI in particular as a tool that will allow him to interact more effectively with patients. However, he noted that many clinicians fear that technology will negatively affect the end user's experience. Amanda Lazar from the University of Maryland saw opportunities particularly for older adults and individuals with dementia, including companionship (e.g., robots and voice-based interactions) and sensors for monitoring and detection. Robyn Stone from LeadingAge noted that provider organizations are bombarded daily with new products and are challenged with decisions about how to best use their resources. Ehrenfeld agreed, noting challenges with direct-to-consumer marketing because of a lack of standards around privacy, security, usability, and clinical validity. Stone questioned what is viable and where investments should be made in the short and long term.

AI Use Today

Ehrenfeld stated that a survey of physicians about integrating technology into their practices revealed four questions: (1) Does it actually work?, (2) Will I get paid for it?, (3) What are the liability issues?, and (4) Will it work in my practice environment? Lazar cautioned that while technologies are often framed as eliminating work (especially in light of a caregiver shortage), they largely only reconfigure the work, noting that studies show that older adults spend a tremendous amount of effort making sure the technologies work. Stone added that she has seen little in the chronic care management space, and she is concerned about the role of human intelligence relative to human capital. "It may make more sense to be putting more money in training human

capital than it is investing in some technology that's obsolete within 2 years or isn't going to take them where they want to go," she said. Ehrenfeld agreed, adding that more thought is needed about how to augment the capabilities of the workforce and leverage the technology to provide the best experience for the end user. Lazar said AI is used in the home for daily care and acute health events, largely through voice-based interactions with commercially available devices. One study found that the greatest health-related use was to find health information, but this raises concerns because the application may provide only a simple answer without the proper context to help the user fully understand what that answer means.

Concerns and Unintended Consequences

Stone said that end users and care providers need to be more involved in product development and testing. In particular, she noted the importance of having even frail, high-risk users as part of the decision-making process, especially early on in product development, to ensure that the right questions are being asked. For example, in a small study, nursing home residents expressed concern that the researchers were focused on their thoughts about privacy rather than asking about their needs. Ehrenfeld and Stone agreed that consideration of personal priorities is essential in order to maintain personal autonomy in health-related decision making. For dementia, Lazar noted that AI may have the ability to gather data on a person's previous decisions in order to guide future decisions that would be in alignment with that person's preferences (as opposed to having a family member make a decision for that person), but cautioned that preferences are not always static. "We want to be really careful in understanding how to weigh preferences of what someone wants now versus what they wanted before."

One workshop participant, who identified as having a rare form of dementia for 12 years, cited her concern for the emphasis on the medicalized model of people with disabilities. While she said she understood the need to mitigate risk (e.g., reduce the chance of falls), she advocates for the human right to have a quality of life that is not just "safe."

Ehrenfeld stated that the AMA has a set of principles for AI in health care that includes concepts related to usability, transparency, and reproducibility. He also spoke to the potential for these systems to introduce bias (in addition to biases inherent in training data sets), particularly for older adults and people with disabilities.

Ehrenfeld said the best examples of AI that are commercially viable relate to image recognition platforms (e.g., screening for diabetic retinopathy), but some hospitals are beginning to use AI systems for prediction (e.g., patients likely to develop sepsis). He questioned whether there is the regulatory framework needed to support new technologies as they evolve. Lazar said much of this relates to efforts to increase earlier diagnosis. Citing the use of AI for the detection of cognitive impairment, she reflected on the potential harmful impacts and stigma of an earlier diagnosis of dementia. Ehrenfeld noted other challenges with the use of AI for diagnosis versus prediction by noting that an AI system may not understand the difference between a person who has shortness of breath and chest pain due to running in the cold versus a person who is having a heart attack. Jarrin added concerns that a number of software functions, including diagnosis, may not be subject to regulatory oversight. Several workshop participants expressed concern with economic motivations alone driving product development. Ehrenfeld said that there are public policy questions around payment coverage and what incentives are created as well as the potential need for post-market surveillance to better understand what happens after the implementation of a new system.

AI, Social Engagement, and Social Isolation

Ehrenfeld warned that AI applications might be helpful at engaging individuals (e.g., virtual communities), but may also run the risk of intensifying isolation by decreasing in-person interactions. Lazar cautioned against a common assumption that older people and people with dementia need a device designed to talk to them. Some studies show that while people may benefit from a robotic pet, what they like the most is when other people approach them to talk about it as it is a new focus point for conversation. She said that the most exciting use "is using technologies to augment and support those social interactions." Stone wondered if AI will remain as a tool to connect people to other human beings or if it "could get to the point of actually having the kind of emotional intelligence and relational characteristics that people need." She added that technologies that connect individuals can enable more efficient use of the existing health care workforce.

The Reality Versus the Promise of AI

A workshop participant pointed out that some speakers spoke to the reality of narrow AI in current use, while others spoke to ubiquitous AI in health care, which does not yet exist. Ehrenfeld cited the ability of AI in the intensive care unit (e.g., sepsis detection and prediction models) "to provide meaningful information at the right time to the right person," but he acknowledged remaining operational challenges. Jarrin opined that until a bridge can be made between structured and unstructured data that gives a meaningful output, today's applications are largely "fancy analytics." Ehrenfeld recognized challenges around the prioritization of where the focus is and where it should be from a development standpoint. Stone raised concerns about prioritization in terms of what resources have the most utility. For example, she noted that low-tech solutions (e.g., good lighting, home modifications) may have a greater impact on independence.

Hager commented that instead of simply thinking of new AI applications as a way to do things differently, these applications should instead be regarded as a learning mechanism. For example, a sensor in a grab bar might be able to generate data on how often the person is holding on to it, which on a large scale could generate information about the progression of frailty and aging. "Before we think about *doing,*" he said, "we may want to think about what are the *learning opportunities* and how do we create those learning opportunities for the decades to come?"

ENSURING PEACE OF MIND

Christina FitzPatrick from AARP moderated a discussion centered around various concerns related to the development and use of AI applications, including unintended consequences, ethics, and personal values.

Bias and Fairness

Ruoyi Zhou from IBM spoke about the need to eliminate bias to achieve fairness, noting how bias may be introduced into AI systems due to personal and societal biases or due to incomplete data sets. Melissa Goldstein from George Washington University called for a common terminology because bias is not necessarily positive or negative, but rather it depends on how you define *fairness.* Fairness, she said, has changed over time and can mean different things to different individuals or communities, depending on what constructs you use (e.g., merit, need, equality, equity).

George Demiris of the University of Pennsylvania noted that personal biases may be introduced based on stereotypes or assumptions about aging. For example, conversational agents may be designed based on assumptions of what older people want to talk about. Demiris also highlighted the risk for biases inherent in the historic data being used to develop AI tools, citing the case of when an AI tool used to screen résumés was favoring male candidates over equally qualified female candidates. In part, this was due to the algorithm being based on success rates and metadata of previous candidates who were predominantly male.

Workshop participant Margaret Campbell of Campbell and Associates Consulting expressed concern that national studies often have unintended biases because the ways in which data are collected may prevent traditionally marginalized groups from participating. She brought attention to the All of Us Research Program funded by the National Institutes of Health that is collecting longitudinal data to accelerate research, particularly related to precision medicine. The researchers reach out to traditionally marginalized populations and provide technical assistance for individuals who might have difficulties participating. She urged that a similar approach should be used for assessing technology needs and preferences.

Ethics and Values

Gloria Ramsey of Johns Hopkins University spoke to an ethical framework for design thinking that includes elements such as (1) having empathy; (2) defining the problem that the application is trying to solve; (3) thinking about how to apply ethical principles (e.g., respect for persons, respect for autonomy, respect for bodily and mental integrity); and (4) testing prototypes in a way that includes likely end users.

Demiris addressed the challenge of conflicting values when caregivers make decisions for their loved ones. For example, if the children of an aging parent with cognitive decline decide to install passive in-home monitoring systems, do they think about what the parent would have wanted in terms of privacy? How are the differing needs and values balanced? Goldstein remarked that while technologies enable caregivers to do things they could not do before (e.g., monitor their parents remotely), the conflicts that may arise among family members regarding an individual's care are not new. Ramsey added that while families may want monitoring systems because of concerns about safety, the individual still has rights to privacy. Stone observed that assistive living facilities and nursing homes are increasingly using these types of technologies, and said that residents may not be given choices.

Demiris raised further concerns about deception. For example, when using conversational agents for individuals with cognitive impairment, he asked "is it okay that the person may believe that this is a real human being or a real pet, because that is how they can mostly engage and benefit from that?" He argued that these types of ethical issues need to be addressed early on in the design process to set parameters for a wide variety of stakeholders and to honor the values and preferences of the individual.

Legal Considerations

As discussed earlier in the workshop, informed consent can be challenging because individuals differ in their opinions about tradeoffs between independence and privacy: what they are willing to give up (e.g., data) in order to get the assistance (via an AI application) they desire. Zhou asserted that informed consent is necessary on a case-by-case basis as individuals will need to consider the benefits and consequences of the use of AI applications for each situation and determine their own levels of

tolerance for risks. Demiris suggested thinking of informed consent as a process rather than a one-time event. People can be educated regularly while using an AI tool or system about how their data will be used, which can contribute to improving their digital literacy.

Goldstein agreed with concerns raised by Claypool that overly restrictive laws related to informed consent might prevent the collection of data that could provide benefit. Referring back to the example of smart glasses and the consent of people in the environment, she suggested that there may be ways to have respect for both parties so as not to prevent such advancements. Goldstein added that there is a difference between the data being collected as a consumer versus as a patient. The same laws that apply to consumer data may not apply to health information data that are covered by the Health Insurance Portability and Accountability Act.

Measuring Outcomes

Zhou suggested that important outcomes related to the use of AI applications may differ depending on the individual. For example, a desired outcome for an older person could be extending the length of time that the person is able to live independently at home, while for that person's children a desirable outcome could be the improved peace of mind they have in being able to check on their parent regularly (e.g., reduction in anxiety). An outcome relevant for providers might be the cost savings achieved through the efficient use of AI applications. Demiris noted that while many potential outcome measures are subjective, they may tie to objective measures (e.g., the correlation between reduced caregiver anxiety and caregiver health).

MOVING TOWARD USER-CENTERED DESIGN

In the final session of the workshop, Steve Ewell from the Consumer Technology Association (CTA) Foundation moderated a discussion about how to ensure that the AI applications of today and tomorrow keep the consumer's voice at the center of the design process.

Reaching Smaller Populations

Jutta Treviranus from the Inclusive Design Research Centre said that her primary interest in AI is not how AI can help people with disabilities, but rather, how people with disabilities can benefit AI. The technologies that can understand diversity and complexity are the ones that will be able to benefit everyone, she said. Rather than developing one solution for everyone, Treviranus argued that systems need to adapt and create solutions for a range of requirements. Decisions based on population data usually revert to what works best for the average, which automatically creates bias against smaller populations (e.g., people with disabilities) that often comprise the outliers of a data set. As a result, Treviranus is experimenting with an alternative learning model that limits the examination of repetitive data elements. That is, the model is forced to look at data across the entire spectrum instead of just looking at the "normal" distribution of the bell curve. While it takes longer for the model to make a useful decision, she observes that it makes the model more adaptable and can result in a better AI system.

Thuc Vu from OhmniLabs added that older adults often experience gradual but progressive declines in their health, behaviors, or capabilities. This requires segmenting populations to allow for better predictive modeling. Ewell agreed that it is important to be able to grow with the consumer in regard to what that person needs today versus what that person will need in a few years.

Treviranus commented that historically, assistive technology is needed to bridge the gap between the person with the disability and the system that person wants to use. However, assistive technologies are becoming more expensive as the standard systems keep changing, requiring more frequent updates in order for the assistive technology to remain interoperable. Instead, she argued, accessibility needs to be integrated directly into newer technologies. Ewell said that general consumer technologies are increasingly building in accessibility features. Gary Schultz of SDI Technologies noted that consumer products that can serve the needs of people with disabilities are becoming more ubiquitous. However, Treviranus asserted that policies are not keeping pace with these changes. She noted that assistive technology must be prescribed by a doctor under the presumption that it is a medical device and not a consumer device.

Partnerships and the Consumer Voice

Vu admitted that there can be a disconnect between the engineer developing the products and the populations these products are serving, but said that "things are getting better." One approach that has been helpful is when the industry works directly with a care provider or living facility, allowing the developer to interact with the residents and better understand how their products are being used, what is needed, and where the shortfalls lie. He also noted that their marketing and outreach efforts to family caregivers often result in requests to assist with pilot testing, which provides valuable feedback. Gina Miller of Senior Portal said what they find the most useful is when they partner directly with the residents of the community. "We found the most

success with our product in communities where we almost co-design with them," she said. They set up resident ambassador committees that can champion a technology to others in that community, and also work with the staff of senior communities. She added that it is important "to try to the extent possible to think about the long-term needs of that user and how technology can grow with them and continue to afford benefits as they transition through the continuum of care." Schultz noted their collaboration with a behavioral science team to gather behavioral data to help tailor the consumer's experience with the AI application. Treviranus described a project in which the Veterans Health Administration engaged individuals with disabilities who needed alternative career training to help develop and design products for unmet consumer needs. This brought valuable insights and resulted in better products.

Technology Literacy Among Consumers

Schultz noted that consumers do not necessarily recognize that they are interacting with AI applications, but rather simply see that there are features of their electronics that they like. Miller noted that the communities they work with expect an underpinning of technology in their lives and increasingly want smart technologies in their homes. However, she agreed that they do not necessarily understand which parts of the technology are actually driven by AI.

Vu said he still sees a lot of fear of using technology in general. His company does not advertise the AI component of its technologies specifically, but instead focuses on the value that a specific technology can bring. Ewell cautioned against stereotypes of older adults and technology, relating a story about a retired engineer who approached him and said, "I know you're going to assume because I'm older I can't use technology. I want to let you know I built all the technology your technology is based off of."

Ewell mentioned studies of both older adults and caregivers designed to better understand what types of technologies they want. Interestingly, he said, these populations expressed trust in getting technology recommendations from medical professionals, yet medical professionals say that they are not up to date on the latest consumer technologies. Alwan mentioned LeadingAge's Center for Aging Services Technologies' technology selection tools that help educate providers on available technologies.

Research: Evaluation and Abandonment

A workshop participant asked about the responsibility of the technology industry to provide evidence that its products are effective. Ewell noted that the CTA Foundation has funded research on different types of technologies (none currently on AI), which includes the evaluation of the impact of the technology on different communities. He added that many companies are also investing in this type of research. Schultz mentioned a device that would require an individual to actively acknowledge taking pills and suggested the data collected could provide evidence of the effectiveness of the technology to improve medication adherence.

Another workshop participant suggested that tracking the abandonment of products is "just as important as going to consumers and getting their feedback and designing it." Schultz said there is some ability to determine, for example, which sensors are no longer being used because they are not providing data to the Cloud. Treviranus argued that abandonment sometimes happens because of increasing issues with interoperability and accessibility. ♦♦♦

DISCLAIMER: This Proceedings of a Workshop—in Brief was prepared by **Caroline M. Cilio** and **Tracy A. Lustig** as a factual summary of what occurred at the workshop. The statements made are those of the rapporteurs or individual workshop participants and do not necessarily represent the views of all workshop participants; the planning committee; or the National Academies of Sciences, Engineering, and Medicine.

REVIEWERS: To ensure that it meets institutional standards for quality and objectivity, this Proceedings of a Workshop—in Brief was reviewed by **Ann Schwartz Drobnis,** Computing Research Association, and **Sylvia J. Trujillo,** American Medical Association. **Lauren Shern,** National Academies of Sciences, Engineering, and Medicine, served as the review coordinator.

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For additional information regarding the workshop, visit http://nationalacademies.org/hmd/Activities/Aging/AgingDisabilityForum/2018-OCT-24.aspx.

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