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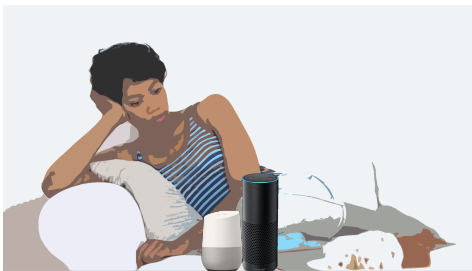
Introduction

Smart speakers are among an array of smart home devices demonstrating potential as assistive technology (AT) for people with disabilities.¹⁻³ Amazon Echo and Google Home are internet connected, voice-activated smart speakers that provide users with hands-free access to voice-controlled digital assistants. These digital assistants provide information, play music, audiobooks and podcasts, set timers and alarms, integrate with to-do lists and calendars, and allow users voice control other smart home devices.

Post-traumatic stress disorder (PTSD) and mild traumatic brain injury (mTBI), both of which can impact independent living and quality of life, are conditions experienced by a significant number of military service members returning from recent conflicts.⁴ Common features of PTSD include anxiety, avoidance, hyper-vigilance or instances of re-experiencing a traumatic event.⁵ People with persistent mTBI symptoms often report experiencing challenges with memory, attention, executive functioning, pain and dizziness. Those who experience both symptoms of PTSD and mTBI commonly report depression and emotional disturbances as well as significant challenges managing each condition.^{6,7} Smart speakers may have potential for use as AT in this population. Systematic assessment of the usability of smart speakers by people with disabilities is needed to help designers and developers ensure equitable access to these technologies as well as inform and guide consumers.

Purpose:

To conduct an in-home diary study of Amazon Echo and Google Home smart speakers with military service members with mTBI and PTSD to gather information about usability, user preferences and potential for development of new apps or skills to increase the role of smart speakers as AT in military service members with mTBI and PTSD.



Methods

Design:

- Take-Home testing within apartments provided while in treatment
- User-centered feature matching of technology
- Cross-over design to minimize bias – participants tested each smart speaker for 2-weeks (total of 4 weeks testing, 2 devices)
 - 6 participants: Amazon Echo for 2 weeks, then Google Home for 2 weeks
 - 6 participants: Google Home for 2 weeks, then Amazon Echo for 2 weeks
- Ten of 12 participants used 2 TP-Link mini-smart plugs to control lamps and/or their television (2 of the 12 participants declined use of the smart plugs, both reporting it felt overwhelming to learn two new technologies at one time).
- Participants were asked to set up the smart devices in their apartments and were provided assistance if they were unsuccessful.

Participants

- 12 veterans with mTBI and PTSD
- 11 male/1 female, ages 30-57 (average 45 years old)
- 1.25 to 37 years post onset of injury (average 17 years)
- Recruited from the SHARE Military Initiative, Shepherd Center
- All reported one or more trauma events resulting in PTSD
- All reported persistent symptoms attributed to mTBI; many reported experiencing multiple mTBIs (blasts, falls and motor vehicle accidents)
- Most common symptom complaints: difficulties with anger, aggression, anxiety, depression, isolation, memory, attention and pain

Do you use any of the following on a regular basis? (n=12)	Percent of participants who responded "Yes"
Smartphone	100%
Laptop or desktop computer	67%
Tablet	42%
Fitness Tracker	42%
Smartwatch	17%
Regular cellphone	8%
Smart plug	8%
Amazon Echo, Dot or Tap	8%
Google Home	0%
Smart home appliance, security or thermostat	0%
Mp3 player (separate from another device)	0%
Google Glass	0%

Measures

Diary Entries

- Completed after initial device setup
- Participants tested each smart speaker for 2 weeks and were asked to complete electronic diary entries about their experience twice weekly, but most participants completed on average only one diary weekly

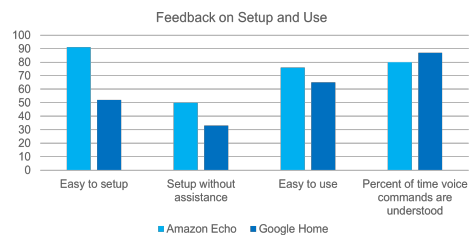
Summative Interview

- Completed at the end of testing both devices
- Included direct comparison questioning

Question Format

- Closed set questions (including use of a 5-point Likert scale ranging from "very hard" to "very easy" for usability questions)
- Open-ended questions (such as "What did you like most?", "What would you change?" or "What did you find most useful?")

Results



Usability barriers and opportunities for development were identified for both devices.

Recommended Changes

Amazon Alexa

- Better voice recognition/ learning
- Ask permission before allowing Drop Ins
- Help for understanding ring colors – "A few times I got the red ring and it had trouble connecting. I didn't know what was going on."
- Improve the lag time between saying "Alexa" and the statement of what it is I am needing.

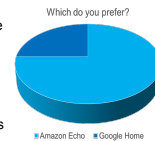
Google Home

- Labels for alarms – "When an alarm goes off I want the details. I don't just want an alarm sound. I want it to be like hey - you gotta do..."
- Its appearance, configuration, and smartphone app
- Make the set up easier
- Change manual control of volume (requires circular finger swipe on top of device)

At study conclusion, all participants reported the smart speakers were useful in their daily life, and 9 of the 12 participants stated they preferred Amazon Echo overall to Google Home.

Qualitative analysis of participant feedback revealed this may have been attributed to a number of factors including:

- More intuitive navigation and clear labeling of functions in the Alexa App
- Ability to label timers
- Less fine motor control required for manual adjustment of volume of Echo than Home
- Greater personal connection with Echo felt by some due to use of a humanizing wake word for Echo ("Alexa", a person's name) versus Home ("OK Google" or "Hey Google"). "It was like having a personal assistant and sometimes a companion." It "provided an unexpected sense of comfort"



Conclusion

- Smart speakers are generally easy to use for this population. Ease of use is critical for populations who may experience challenges with learning to use new technology and with handling stress associated with using technology perceived to be hard to use.
- Smart speakers may be helpful for performing daily tasks and managing mTBI and PTSD related cognitive challenges and stress.
- Rehabilitation professionals may need to provide support for set up and training for effective use as AT.
- Designers and developers should consider exploring opportunities to further develop the assistive capabilities of smart speakers, simplify set up and minimize fine motor control requirements for manual adjustments to device.
- Designers and developers should consider exploring opportunities to further develop the capacity of smart speakers to provide support for memory, stress management and companionship.

References

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