

Helping Persons with Cognitive Disabilities using Voice-Activated Personal Assistants

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Abstract— The objective of this study was to determine whether Canadians with cognitive disabilities such as autism could benefit from voice-activated intelligent personal assistants to access digital services and increase their participation in the digital economy. We recruited 24 participants aged 18 to 64 with a cognitive disability to serve as advisors in this study. They were each given an Amazon Echo Dot free of charge to use in their home environments for a month and then interviewed to determine their likes, dislikes, intentions, and whatever new ideas they had for improving the Echo Dot applications. Video recordings of interviews with advisors and/or caregivers were collected for offline analysis. We found that the advisors were overwhelmingly positive about using the Dot for variety of information-retrieval tasks ranging from asking for weather reports to satisfying more serious information needs such as answering health-related questions and planning public transportation routes. Both Advisors and their caregivers found that alarms, reminders and Alexa “routines” were particularly helpful features. Alexa skills available in French are not as numerous or varied as those in English and bilingual advisors often interacted with Alexa in English more than in French.

Keywords—intelligent personal assistants, smart speakers, cognitive disability, digital services, cognitive accessibility

I. INTRODUCTION

Prior research has shown that improving the accessibility of Information and Communication Technologies (ICTs) has the potential to narrow the digital divide that marginalizes people with intellectual disabilities (IDs) [1] but also that the voice-control for intelligent devices increased these devices’ accessibility [2,3]. As voice-activated personal assistants such as Amazon Alexa, Siri and Google Assistant become ubiquitous and the need for improved accessibility of internet services to people with IDs grows, the time seems to be right to investigate the practical uses to which people with cognitive disabilities can put such devices today and which aspects of these devices need to improve to increase the reach of internet services to this community.

In 2017, the Government of Canada established an Accessible Technology Program [4] to foster inclusive participation of Canadians with disabilities in the digital economy. This program aims to allow Canadians with

disabilities to obtain better access to digital services and increase their participation in the digital economy as well as providing Canadians with the necessary skills and tools required to engage socially online, or assist them in their work and educational environments while also enhancing their employability and marketability. One of the important concerns in the Canadian context is the availability of bilingual services.

II. METHODOLOGY

Our study was conducted between May 1 2020 and September 1 2021 in collaboration with the social enterprise Open Collaboration for Cognitive Accessibility (Open) [5] led by Virginie Cobigo from the University of Ottawa’s Faculty of Social Sciences. Professor Cobigo and Dr. Chalhouni, also at Open, provided the project requirements, recruited the advisors, conducted the interviews and collected the data.

We recruited 24 aged between 18 to 64 participants with a cognitive disability who were deemed to be *advisors* in this study. We aimed to have a balanced representation of linguistic preference and genders and from among this group of advisors there were 4 unilingual Francophones, 7 unilingual Anglophones and 13 were bilingual; 10 were female and 14 were male.

Each advisor was given Echo Dots free of charge to use in their environments, as well as installation instructions and guidelines for testing and exploration. Two advisors were given a Dot with a screen (Echo Show 5) because they could not communicate verbally.

After a month of use, each advisor was interviewed up to 4 times or until they were able to articulate their likes, dislikes, intentions, and any new ideas they had for improving the applications and Amazon Skills with which they experimented. These interviews with advisors and their caregivers were conducted on Zoom and were collected for offline analysis.

III. RESULTS

We examined over forty hours of these video recordings to identify the advisors’ and caregivers preferred actions (likes) difficulties (dislikes) and uses (intentions) and attempted to identify commonalities and trends. Table I is a sample of

qualitative data resulting from our video analysis, showing that Advisor 1 is clearly positive and Advisor 2 is ambivalent. Quantitatively, 22 of the 24 advisors were clearly positive and 2 were ambivalent. None were clearly negative.

TABLE I
SAMPLE QUALITATIVE DATA

	Parameters of Interest			
	Likes	Dislikes	Attitude	Ideas
1	Asking questions (what's the forecast, what time is it, tell a winter joke). Playing music.	Improve the interaction. Improve volume control. Doesn't work with SmartTV (improve the way it connects to other devices)	Overall experience was pretty good. Interested in learning more how it works. No frustration at all. Will continue to use it. Would refer it to friends and family. Good for people with disabilities.	Connect to the SmartTV. More options for connecting to other devices.
2	Being reminded to do things (call grandma and grandpa, vacuum the carpet) Helps to sleep knowing Alexa will remind him to wake up. Listening to music.	Can't control the reminders (too much, sometimes ignores the reminders). Doesn't like anything about Alexa. Would rather play games than deal with Alexa. Wording questions can be tricky.	Alexa is good. Will continue to use it. Later: won't recommend it to anyone else.	none

All the advisors had an overall positive experience with their use of Alexa, even if some were limited to very basic uses. They found value in the following information tasks, a.k.a. skills in the Alexa framework:

- a) The performance of simple question answering tasks that Alexa provides as a default capability (i.e. without requiring a custom Amazon Skill) including common questions such as "what time is it?", "what is the weather tomorrow?", "how many days until my birthday?"
- b) The answers to more serious information needs that manifested mostly as health-related questions like "I can't sleep" or "I feel sick" or "I have a fever" but also more complex tasks such as interacting with a public transportation route-planner.

- c) Scheduling tasks such as setting alarms and reminders e.g. to take medicine, attend meetings, wash hands every hour and walking through Alexa "routines" - a list of tasks that occur at a specified time of day. For persons with a speech impairment but with good verbal comprehension, this use of Alexa is as an assistant to the caregiver who can program alarms, schedules, and routines was particularly effective.
- d) Other entertainment-oriented tasks included: playing music, telling jokes and engaging in amusing dialogs with the Alexa bot such as asking, "will you marry me?"
- e) Serving as an educational assistant to answer questions about nature or help in performing arithmetic. In one case, a Francophone advisor who was experimenting with an Echo Dot Show, which also has a display screen the performance of arithmetic operations was accompanied by the corresponding visual equations.

Caregivers also found the Echo Dot useful as a tool to assist in routine support (e.g. providing consistent, periodic reminders of routine tasks). Further, they found the Dot to be a more safe and trustworthy environment than laptops, tablets, and other devices and had no concerns about invasion of privacy or exploitation.

The advisors and caregivers came up with some interesting applications such as providing a mobile, non-tethered Dot in the form of a bracelet or necklace or the attachment of a robot body to Alexa so that it could perform physical tasks.

Finally, we observed that neither the type of cognitive disability nor the age impacted the use of the Dot; rather, the level of communication skills or degree of speech impairment and digital literacy impacted its use. In some instances, a mixed-mode (voice-screen) method of interaction is preferable to a voice-only mode.

IV. LIMITATIONS

The interviews nevertheless revealed some limitations of Alexa on the Echo Dot. Although Alexa can understand and speak both Canadian French and English – as well as recognize which of the two languages is being spoken when it is in bilingual mode - it is nevertheless better at understanding English. Most participants did not take the time to train Alexa to recognize their voices, but for advisors who had strong accents or speech impairment, such training led to better results.

Alexa also has a broader range of Skills available in English than in French and bilingual advisors noted that some capabilities exist only in English.

As with usage in the public at large, our advisors unintentionally woke up Alexa by used the wake word "Alexa" to speak *about* the voice-assistant rather than as a wake up word.

Some of our advisors noticed that the Alexa platform has interfaces to other devices such as light switches, vacuum cleaners and TVs and experienced some difficulties in enabling Alexa-enabled devices to operate with the Echo Dot. The help of an experienced user would be beneficial for setting up these sometimes error-prone couplings.

While the Dot is fairly straightforward to use and learn and the documentation that we provided for setting up the devices and experimenting with them were adequate, we believe that introductory video tutorials that illustrate the range of tasks that the Dot can perform would further enhance the experience.

V. CONCLUSIONS

The results of our investigations are consistent with those of other studies such as [6]. In that study, as with ours, the authors found that

“Opinions regarding IPAs [Intelligent Personal Assistants] were overwhelmingly positive. Most individuals qualitatively reported [an] improved sense of agency and [that] IPAs enabled many individuals to access features associated with wellbeing”

Just as in [3] we found that the Echo Dot was a cost-effective method for “improving the quality of life of vulnerable populations”.

We found, however that some Alexa Skills that require extensive interactive dialogs – such as transportation planning applications – had disadvantages. For example, there are several ways to set up a reminder with Alexa – one that involve a step by step dialog (“User: Alexa create a new reminder” – Alexa: “what’s the reminder for” – User: ”to call my mother” – “Alexa: when should I remind you” – User: ”6pm”) and one that permits a single command (“Alexa, remind me to call my mother at 6pm.”). While dialogs can help lessen the cognitive load of having to remember the command syntax, they introduce the opportunity for hesitation in providing a timely answer and sometimes caused our advisors to be confused.

Studies like this show the value of in situ user participation in the design and evolution of technology. Further, it shows the value of collaboration among several kinds of experts: technology, cognitive disability, business, and care.

A question remains on how to best disseminate and follow up on the results of these investigations. In our case, Open used the following stakeholder organizations to recruit the 24 advisors for the study: Breton Ability Centre (Nova Scotia), Association pour l’intégration sociale d’Ottawa (Ottawa), Société Franco-Ontarienne de l’Autisme (Ottawa), LaRessource (Ontario), Perley Rideau Veteran Centre (Ottawa), and AGE-WELL NCE. We expect these stakeholder organizations to publicize their clients’ use of Alexa through newsletters, blogs, word-of-mouth, and the like. Similarly, the ISSP and Open have publicised the results and

recommendations of our study on their websites. Ideally, we would contact each advisor and caregiver at 6 months and 1 year after project completion September 1 2021 to determine the impact of Alexa on each of them, and also to determine any spread to other individuals in our target population. The feasibility of this follow-up evaluation is undetermined at the time of this writing.

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