# Talk to me: Exploring user interactions with the Amazon Alexa

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# Talk to me: Exploring user interactions with the Amazon Alexa

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## Abstract

Amazon Alexa is a voice-controlled application that is rapidly gaining popularity. We examined user interactions with this technology, and focused on the types of tasks requested of Alexa, the variables that affect user behaviors with Alexa, and Alexa's alternatives. The data about Alexa usage were collected from 19 participants via the online questionnaire and diary methods over the course of several days. The results indicate that across all age groups, Alexa was primarily used for checking weather forecasts, playing music, and controlling other devices. Several participants reported using Apple Siri and Google Now applications in addition to Alexa for similar

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purposes except for controlling other devices. Alexa uses over the weekends were more frequent than on weekdays, but its overall usage tended to decrease over time. The users reported being satisfied with Alexa even when it did not produce sought information, suggesting that the interaction experience is more important to the users than the interaction output. More work is required to understand whether users treat Alexa and similar voice-controlled applications as primarily a traditional information retrieval system, a casual leisure system, a control interface for smart home devices, or, simply, a new toy.

**Keywords**
Conversational agents, digital personal assistants, human information interactions, human information behavior, intelligent personal assistants, voice-controlled agents

## Introduction

The Amazon Alexa is a voice-controlled application developed by the Amazon company for its Echo, Echo Dot and recently introduced Echo Show devices (Amazon, n.d.). Being marketed as an intelligent personal assistant (IPA), Echo/Alexa is reportedly used for playing music, answering general questions, setting alarms and timers, or controlling networked devices (Amazon Developer, n.d.; Levin, 2016; Ong and Suplizio, 2016). Recent industry statistics indicate rapid adoption of this technology manifested in the sales figures that raised from 2.4 million units in 2015 to 5.2 million in 2016 and predicted 24.5 million units by the end of 2017 (Dunn, 2016b; PRNewswire, 2017).

Due to the novelty of the IPA technology, most of the information about Alexa's adoption comes from industry reports, and very few scholarly studies tend to focus on IPA evaluation (Ong and Suplizio, 2016). In an effort to increase our understanding of user interactions with IPAs, we examined Alexa on the Echo device usage by its owners in a natural setting of their homes. We contextualized the study within a larger framework of human information interaction research. Using online questionnaire and diary data, we investigated the types of tasks requested of Alexa, the variables that affect user behaviors with Alexa, and Alexa's alternatives. The findings advance our understanding of user interactions with this emerging technology and illuminate directions for future research.

## Literature review

### *Alexa and other intelligent personal assistance (IPA) technology*

Intelligent personal assistants (IPAs), also frequently referred to as digital personal assistants, virtual personal assistants, voice-controlled or conversational agents, trace their history to the early handheld computers that were designed to store information (e.g. contacts, calendars) and perform simple tasks (calculations, messaging). Early examples of the IPA devices included Psion's the Organizer (Center for Computing History, n.d.), Apple Newton (Center for Computing History, n.d.), IBM Simon (Microsoft, n.d.) and Nokia 9000 the Communicator (Nokia, n.d.).

The current generation of IPAs includes Google Assistant/Now, Apple Siri, Microsoft Cortana, and Amazon Alexa. The IPAs are designed to accept user input from a touch screen virtual keyboard, handwritten or voice-controlled interfaces, answer user queries in a natural language and perform other tasks, such as play music, place online shopping orders, and set calendar reminders (Canbek and Mutlu, 2016). Alexa in particular is a software designed to operate on the Amazon Echo, Amazon Dot, and related hardware, and perform voice-operated functions while communicating through a local WiFi Internet connection with Amazon's AWS cloud servers, or other networked devices, to carry out these functions. In addition to obtaining data from Amazon's servers, the software can be used to control smart home devices, such as lighting and climate (Dunn, 2016a). Alexa is activated when its speech recognition software receives a triggering word or phrase from a user; for example, the word "Alexa" can be used to activate the device, but this trigger word can be customized by a user (Clauser, 2017). The hardware that houses Alexa has multiple microphones that utilize noise cancellation and "far-field voice recognition" so that it can pick up speech patterns from any direction and through other noises (Amazon.com, Inc.). Current Alexa voice-recognition technology cannot distinguish between multiple user voices, so a command or a user interaction can be easily interrupted or misinterpreted. The research is underway to develop voice recognition features capable of identifying individual users as well as to increase Alexa's privacy and security protection features (Reynolds, 2017). When Alexa is voice-activated, the hosting device briefly lights up, making the interactions primarily audial, with feedback available in the Alexa if the user chooses to access the information (Hdz, 2016).

Figure 1 depicts the information architecture of the Alexa task/request process. Users give a request, which is filtered by Alexa through speech recognition, machine learning, and natural language understanding. Alexa accesses web hosted services and provides a response to the user. Included in the response process, Alexa produces a "Card" of information providing a record and results to the user. This information is available to users in the Alexa app.


**Figure 1.** Information architecture of Alexa, modified from Amazon Web Services (2017).

Current IPAs differ in their interface designs, hardware requirements, and the types of tasks they are designed for. A recent comparison of IPAs suggests that Google Assistant/Now performs better than other IPAs on travel, traffic, flight, and translation requests (Dunn, 2016a). Microsoft's Cortana excels in task reminders (e.g. chores, calendar, communications) (Graus et al., 2016). Alexa's strengths include support for the voice-activated purchases from Amazon's website and for "skills", applications designed for specific types of tasks (Crist, 2016) including control of a growing number of smart home devices and even cars (Dunn, 2016b; Thompson, 2017; Villas-Boas, 2017).

Published studies on IPAs tend to focus on evaluation frameworks of this technology and factors related to user satisfaction, expectations and sociability. Through testing the performance of Microsoft's Cortana on a Windows smart phone, Jiang et al. (2015) proposed a model of predicting user satisfaction from the action sequences in a session. For example, slower speaking rates and switching from voice to text input were found to signal dissatisfactory interactions. The authors suggest that while some of the satisfaction measures adopted from the previous web search studies might still apply to the IPAs (e.g. most of the click, request, and response features), acoustic, voice-to-text or other newly designed features might be more appropriate for evaluating IPAs (Jiang et al., 2015).

Kiseleva et al. (2016a) conducted a similar user study in order to develop an automatic method for predicting user satisfaction with IPAs using voice commands, physical touch gestures and other interaction signals. The authors concluded that incorporating touch-based features, such as scrolling or swiping, dramatically improves prediction quality of the user satisfaction model.

Kiseleva et al. (2016b) conducted a user study that measured user satisfaction with Microsoft's Cortana on the tasks related to device control, web search, and structured search dialogue. The findings indicate that the concept of user satisfaction varied across tasks. For example, for making a phone call, task completion was an important predictor of satisfaction, while for planning a night out, it was the amount of effort spent on a task. The authors conclude that for IPA research, the "task-level satisfaction cannot be reduced to query- or impression-level satisfaction" (p. 129), and preserving the interaction context becomes critical for understanding the complexity of user satisfaction with the IPAs (Kiseleva et al., 2016b).

In trying to understand everyday uses of the IPA, Luger and Sellen (2016) interviewed 14 participants about their usage patterns, motivations and expectations of the IPAs. The authors found that users' uncertainty about system features and abilities often lead to frustrating experiences and non-use. The study resulted in several recommendations for the IPA system design including revealing system intelligence levels to the users and improving system feedback.

Several studies examined the IPAs uses in social settings. Porcheron et al. (2017) examined the case of Amazon Echo use in the social setting and found it to contribute to, among other things, the repetition of queries, lapses in conversation resulting from query submissions, body positioning to include the device, and collaborative query refinement. Porcheron et al. (2016) performed a similar ethnomethodology study and concluded that while IPAs are primarily used for information seeking, they also contribute to humor in the social situation, and to interruptions in human conversation. The authors note that the slower speed of interacting with the device, as compared to the pace of social interaction, may be problematic to the device's integration in the social setting.

Additional problems with the use of IPAs in social settings are discussed in Easwara and Vu (2015) who explored the social concerns around the use of the voice-controlled assistants. The authors found that people tented to avoid using voice input in public settings due to privacy concerns. Similar findings were obtained in the study of the smartwatch uses, where the watch owners avoided using voice commands due to concerns for socially acceptable behavior around strangers (Efthymiuo and Halvey, 2016).

We did not identify any reports of user interactions with the Amazon Alexa in the naturalistic setting. Most of the reported studies were conducted in an experimental setting on homogenous user groups. In order to address the limitations of the previous work and extend our understanding of IPAs adoption, we recruited a diverse group of Amazon Echo owners and examined their daily interactions with Amazon Alexa in users' homes.

## Method

In order to understand user interactions with Alexa and extend previous research on IPA adoption, we developed the following research questions:

RQ1. What are the common types of interactions between Alexa and its users?

RQ2. What variables affect user interactions with Alexa?

RQ3. Do participants use other types of IPAs, and if so, what do they use them for?

The data to answer the research questions were collected via an online demographic questionnaire, an online diary, and email.

The online questionnaire was distributed to participants prior to the main study and collected information on participants' demographics and Alexa ownership, including duration of ownership, the device(s) placement in a household, levels of general satisfaction with Alexa, the types of Alexa interactions that participants perceived to be the most common, and other variables (a complete copy of a questionnaire can be found in Appendix A.

The main study instrument consisted of the structured online diary which participants were asked to complete once a day for four days. The diary method is commonly used in information interaction/behavior/seeking studies and enables researchers to examine user behaviors with technology in their daily lives (Beckman et al., 2014; Elbeshausen et al., 2015; Lopatovska et al., 2012; Kuhlthau, 1991). The decision to use a structured diary instrument was made in order to minimize time- and effort-related burdens on participants and collect comparable data across all study participants (Iida et al., 2012). The daily diary rubrics asked participants to identify: (a) the types of interactions they had with Alexa that day, (b) whether these interactions were (un)successful and (un)satisfactory, (c) whether participants' commands to Alexa were understood, and (d) any memorable interactions with Alexa (see Appendix B for a complete copy of the diary instrument). In order to collect information for the RQ1, the diary provided participants with a check list of the most commonly reported Alexa interactions (Levin, 2016; Ong and Suplizio, 2016), including entertainment (e.g. playing music); quick searches (e.g. weather, traffic); controlling other devices and other tasks, and gave them an option to report interactions that were not included in the list.

The data for understanding the variables that might affect user interactions with Alexa (RQ2) were collected via both the demographic questionnaire and the daily diary and included the following variables:

- user's age
- user proficiency level (advanced/non-advanced)
- duration of ownership
- correct understanding of command language
- task completion and satisfaction
- memorable experiences
- day of the week
- device placement at home.

The effects of these variables on information behavior are frequently reported in published research and are discussed in greater detail in the results section below.

The data on Alexa's alternatives (RQ3) were collected by an item in the demographic questionnaire, and an email sent to participants two weeks after they stopped filling out diaries to minimize confusion about their responses related to Alexa and other IPAs. The email asked participants to list other devices/apps similar to Alexa (such as Siri, Google Assistant/Now, Google Home, Cortana) and describe their uses.

The study used a snowball sampling from the pool of researchers' acquaintances and Alexa/Echo users. The sampling method was used in order to (a) ensure diversity of participants' demographic characteristics by age and occupation (e.g. avoid a sample of just graduate students or engineers); (b) use established relationships between researchers and participants to encourage and clarify daily diary responses. The study recruited a sample of 19 Alexa users from nine different households. All members of the household had equal access to Alexa on the Echo device in their home. Participants' demographic characteristics varied by age and occupation. We assumed a relative homogeneity of adult participants' socio-economic characteristics based on their early adoption of Alexa – early adopters are usually characterized by higher socio-economic status (Rogers, 2010). We did not have a good justification for collecting additional demographic information about the participants since it was not previously shown to influence interactions with IPA technology. The participants' ages ranged from 4 to 55 years of age, of which 12 (63%) reported being professionally employed (e.g. two nurses, a lawyer, and a professor), five (26%) students, and two (11%) unemployed or declined to answer the question. Due to the recruitment challenges, certain ages were not represented in our sample, including 10–20-year-olds and older participants (60+). For data analysis purposes, we grouped the participants into the three age groups: children 4–10 years old (6), younger adults 20–39 years old (7) and older adults 40–60 years old (6). Participants received no compensation for their voluntary participation. The study was approved by the Institutional Review Board (IRB**).**

The study was conducted over the course of Friday, Saturday, Sunday, and Monday in order to sample user behaviors during the work days when participants engage in professional activities or attend school, and weekends, time associated with rest, leisurely activities and/or spending more time at home. We decided against collecting data for a longer period in order to avoid major distractions to the routines of our non-compensated participants. At the beginning of the study, participants were asked to complete an online demographic questionnaire, and then to fill out the online diary at the end of every day. If a participant missed a day, a researcher who recruited a participant would remind her to fill out a diary. In a few instances, the diary form for the day was submitted the following morning

**Table 1.** Rating of the most commonly reported types of Alexa interactions in demographic questionnaire and daily diary.

| Ranking | Pre-study questionnaire responses (Frequencies) | Daily diary responses (Frequencies) |
|---|---|---|
| 1 | Quick information searches (17) | Weather (56)<br>Facts (10)<br>News (9) |
| 2 | Entertainment (15) | Play music (38)<br>Tell a joke (7)<br>Play a game (2) |
| 3 | Control external devices (9) | Control another device (23) |

or was not submitted at all. Parents of the participants who were younger than 10 years of age ($N$=4) were asked to read, and if necessary, clarify the demographic survey and the daily diary items to their children and fill out the data collection instruments on their behalf. For example, when a four-year-old Alexa user could not understand the meanings of "satisfaction" or "task completion", a caregiver would explain satisfaction as being happy with the results, and task completion as receiving the requested/expected response from Alexa.

It is worth noting that a few days prior to the study, Alexa services had experienced interruption that might have affected user behavior (Kastrenakes, 2017).

## Results

### *Alexa's ownership, placement, perceived satisfaction, and usage*

The data collected by the demographic questionnaire indicated that the majority of participating households (6, or 67%) reported having one Alexa, two (22%) reported two and one (11%) reported three devices in their homes. Six households (67%) have had their Alexa(s) for at least 3–12 months, two (22%) households had Alexa for less than three months and only one (11%) household had their Alexa for more than a year. Seven (36%) participants reported using Alexa very frequently, eight (42%) said they used it very infrequently, and four (21%) respondents reported medium usage.

In terms of the general satisfaction, 10 (52%) participants indicated being satisfied or very satisfied with Alexa, eight (42%) expressed neutral feelings towards Alexa and one user expressed extreme dissatisfaction with Alexa.

Table 1 illustrates the types of Alexa interactions that our participants perceived to be the most frequent, including quick searches (17), entertainment (15), and control of other devices (9). Use of Alexa to play music, tell jokes, and tell time were mentioned once. We noted several instances where the reported Alexa interactions cluster into the use habits of one or two participants, and therefore may not be representative of their user group as a whole. These include:

- Two participants who reported infrequent uses of Alexa were children from the same household. This may be reflective of conditions in this household, and not the behavior of younger users in general;
- Only one participant reported using their Alexa to set reminders. Attributing use of this function to a particular user group may not be appropriate;
- One participant reported using Alexa to tell a joke during each day of the study, while there were only two other instances of Alexa being used to tell a joke. The use habits of this one participant may inaccurately weight the importance of this function;
- There were only two instances of using Alexa to play a game. Attributing this to the use habits of a particular user group may have less significance because of the limited data in this area.

A majority of the participating households (8, 89%) did not rename their Alexa; the one household that renamed their Alexa did so in order to avoid confusion because the users wanted to differentiate between the two Alexa devices in their household. In addition, these users had a friend named Alexa.

Thirteen (68%) participants reported using Alexa to control external devices, five (26%) said they did not, and the remaining two (10%) were unsure. Half of the participants (9, 47%) added skills to their Alexa, five (26%) reported not adding skills, and five (26%) were unsure.

Participating households reported keeping their Alexa/Echo devices in the living room (6, 43%), kitchen (4, 29%), and bedroom (3, 21%)

#### ***RQ1. What are the common types of interactions between Alexa and its owners?***

During the four days of study, participants reported using Alexa a total of 136 times to complete 10 different types of interactions: check weather, find facts, listen to news, control other devices in the home, set reminder/calendar alerts, play music, set timer, tell a joke, play a game, and check the time (Table 2). Weather-related requests (39)

**Table 2.** Alexa tasks performed by participants during the four days of study.

| Interaction type/Age group | Total frequency | Satisfaction/Dissatisfaction Fr (%) | Complete/Incomplete Fr (%) |
|---|---|---|---|
| Weather | 39 | | |
| Ages 4–10 | 5 | 4/1 (80%/ 20%) | 4/1 (80%/20%) |
| Ages 20–39 | 19 | 19/0 (100%/0) | 19/0 (100%/0) |
| Ages 40–60 | 15 | 14/1 (93%/7%) | 14/1 (93%/7%) |
| Music | 29 | | |
| Ages 4–10 | 12 | 11/1 (92%/8%) | 10/2 (83%/ 17%) |
| Ages 20–39 | 6 | 5/1 (83%/17%) | 3/3 (50%/50%) |
| Ages 40–60 | 11 | 10/1 (91%/9%) | 9/2 (82%/18%) |
| Device | 18 | | |
| Ages 4–10 | 0 | | |
| Ages 20–36 | 8 | 7/1 (87%/13%) | 6/2 (75%/25%) |
| Ages 40–60 | 10 | 9/1 (90%/10%) | 7/3 (70%/30%) |
| Facts | 10 | | |
| Ages 4–10 | 6 | 4/2 (67%/33%) | 3/3 (50%/50%) |
| Ages 20–39 | 0 | 0 | 0 |
| Ages 40–60 | 4 | 1 /3 (25%/75%) | 4/0 (100%/0) |
| News | 9 | | |
| Ages 4–10 | 3 | 3/0 (100%/0) | 3/0(100%/0) |
| Ages 20–39 | 3 | 3/0 (100%/0) | 3/0 (100%/0) |
| Ages 40–60 | 3 | 3/0 (100%/0) | 3/0 (100%/0) |
| Timer | 9 | | |
| Ages 4–10 | 1 | 1/0 (100%/0) | 1/0 (100%/0) |
| Ages 20–39 | 7 | 6/1 (86%/14%) | 6/1 (86%/14%) |
| Ages 40–60 | 1 | 1/0 (100%/0) | 1/0 (100%/0) |
| Joke | 6 | | |
| Ages 4–10 | 1 | 1/0 (100%/0) | 1/0 (100%/0) |
| Ages 20–39 | 0 | 0 | 0 |
| Ages 40–60 | 5 | 5/0 (100%/0) | 4/1 (80%/20%) |
| Game | 2 | | |
| Ages 4–10 | 0 | 0 | 0 |
| Ages 20–39 | 0 | 0 | 0 |
| Ages 40–60 | 2 | 1/1 (50%/50%) | 2/0 (100%/0) |
| Reminder | 2 | | |
| Ages 4–10 | 0 | 0 | 0 |
| Ages 20–39 | 2 | 2/0 (100%/0) | 2/0 (100%/0) |
| Ages 40–60 | 0 | 0 | 0 |
| Telling time | 4 | | |
| Ages 4–10 | 2 | 2/0 (100%/0) | 2/0 (100%/0) |
| Ages 20–39 | 0 | 0 | 0 |
| Ages 40–60 | 2 | 2/0(100%/0) | 2/0 (100%/0) |
| Others | 8 | | |
| Total: | 136 | 114/14 (84%/16%) | 109/19 (80%/20%) |

were the most frequently reported by all age-group participants followed by requests to play music 29 times. Control of other devices via Alexa was performed 18 times by adult participants. Fact checking was performed 10 times across all age groups. Requests for news and timer were reported nine times, requests to tell jokes occurred six times, and the request to play games was reported twice by adult participants.

Additional types of interactions entered by participants in the "Other" text box included three requests from children to tell time, three non-specified questions, one request to tell stories and one request for Alexa to set an alarm.

The diary data indicates that participants had little interest in getting cooking instructions, travel and traffic information from Alexa. Playing games, setting reminders and calendars tasks were also infrequent.

Participants' responses to the diary and the demographic questionnaire were relatively consistent (Table 1). Participants estimated that they most frequently use Alexa

for quick information searches (17), while their diary entries indicated that such searches would include checking the weather (56), facts (10) and news (9). The second most frequently mentioned type of interaction was entertainment (15), which in the diary data translated into playing music (38), telling jokes (7), and playing games (2) tasks. Use of Alexa for controlling other devices was ranked third based on both demographic questionnaire and diary entries (9 and 23 mentions respectively).

The findings pertaining to the types of Alexa interactions reported by our participants are somewhat consistent with prior research on Alexa usage (Ong and Suplizio, 2016; Dunn, 2016a). The most frequent Alexa request was to check weather, a form of factual information consistently favored among all age groups except children, whose top request was to play music. Consistent with prior reports, users in our study frequently reported using Alexa to play music and to control other devices However, requests to set timer/alarm, read news or tell a joke were not reported as frequently as in previous studies (Ong and Suplizio, 2016), a fact that could be explained by the differences in studies' samples and instruments. For example, our study collected daily reports of all daily interactions while Ong and Suplizio (2016) collected reports on the average top eight estimated uses of Alexa. It is also possible that with the longer use of Alexa, owners' habits and common uses change as they discover the strengths and weaknesses in application performance, encounter different information needs and life situations. For example, unlike previous reports, our study found relatively infrequent use of Alexa for news and quick fact checking, and several instances of dissatisfactory interactions related to information search. This might suggest that participants engage Alexa in tasks that they know it handles well (e.g. quick information check for weather report, music), and avoid using it for more complex information searches that are open to interpretation and have a greater rate of error.

***RQ2. What variables affect user interactions with Alexa?***

## Age

Children have been previously shown to search for information differently than adults (Bilal and Kirby, 2002). By extension from traditional information behavior studies we assumed that Alexa interactions will also be influenced by participants' age. In general, age did not seem to affect the types of user interactions with Alexa (Table 2). The only times when age seemed to have affected use or satisfaction occurred for the timer- and jokes-related interactions when only children reported being dissatisfied. It is possible that Alexa is programed to produce adult-oriented jokes that are misunderstood or irrelevant for children. Children did not use the game function at all, but used Alexa to tell time and set timers. Use of Alexa as a clock by children might indicate that they are still mastering their time-telling skills, and find it easier to ask Alexa about time. The fact that none of the children participants used Alexa for games might indicate that children already have a lot of games, do not need to use Alexa for games, are dissatisfied or not aware of Alexa games, or, perhaps, play games on devices that support screen/tactile interactions.

## User proficiency

Traditional information retrieval research often examines the effect of user type, expert/novice or advanced/non-advanced, on information behavior and finds the differences (e.g. levels of effectiveness and efficiency) in the behaviors of the two user types (Marchionini, 1995). In order to examine potential differences in the behaviors of advanced and non-advanced Alexa users, we classified our participants as advanced (10) and non-advanced (9) based on whether they reported using Alexa skills, a specialized type of program within an app. During the time of the study, Alexa skills had to be manually activated through the Alexa app, a feature that required advanced interaction and awareness of the device and its capabilities and could be used to differentiate between advanced and non-advanced Alexa users. The manual activation feature changed soon after the study was over: now Amazon enables Alexa to activate skills through voice commands without awareness of skills usage, such as streaming through a music service (Pullen, 2017).

The findings did not indicate significant variations in behavior of advanced and non-advanced users as both groups most frequently asked Alexa for weather information and to play music. Both groups had comparable rates of successful interactions (54 and 40 respectively), not successful, or incomplete interactions (11 and 9), satisfactory (66 and 44), and dissatisfactory (9 and 5) interactions. The differences between advanced and non-advanced users included frequencies of using Alexa to control other devices: advanced users used Alexa to control other devices 15 times, while non-advanced users only used this feature three times. This finding can be explained in light of our classification of users into advanced and non-advanced categories by their awareness and use of Alexa skills, which include a skill for controlling other devices. Another difference was the effective use of command language. Advanced users reported that Alexa understood all their commands in 25 out of 28 cases (89%), while non-advanced users reported that all their commands were fully understood in only 14 out of 25 cases (56%). This would appear to confirm a higher level of efficiency for advanced users, although the overall effectiveness appears more evenly distributed between these groups, given their comparable success rates on reported interactions. This finding suggests that advanced users' deeper engagement with

**Table 3.** Average Alexa use by long- and short-term users.

| Duration of Alexa ownership: | Less than 3 months | 3–12 months | More than a year |
|---|---|---|---|
| Users | 3 | 12 | 4 |
| Avg. different uses/Day | 2.75 | 2.25 | 1 |

Alexa may give them an advantage in understanding the command language required for the efficient and effective interactions. The non-advanced users might go through several reiterations of their Alexa commands before they are understood and the users are able to complete their tasks.

## *Duration of ownership*

We examined whether the length of time a household has owned an Alexa impacts how frequently it is used to perform different functions. We calculated the number of different kinds of tasks participants used per day, broken down into those who used the device less than three months (*N*=3), 3–12 months (*N*=12), and more than 12 months (*N*=4). While the user group sizes are not equal or large enough for generalization, the data points to the trend of the usage decreasing for the longer-term users (Table 3).

O'Brien and Toms (2008) identify a number of factors that can contribute to user disengagement from technology over time. Among these factors is a lack of novelty experienced by users, lack of new or original feedback to sustain user attention. The authors also identify usability issues as contributing to user disengagement. Luger and Sellen (2016) identified that users' disappointment and lack of understanding of IPAs' abilities often lead to discontinued use. Our observations of decreased Alexa usage over time may relate to these factors. Once a user has explored the Alexa features they intend to use, the lack of new kinds of interactions may drive down interest and use (and also explain the company's efforts to introduce new features to existing devices). Likewise, unsatisfactory interactions, such as Alexa inability to understand commands or poor fact-finding ability, may drive down usage over time (Marchick, 2017).

## *Command understanding, task completion, and satisfaction*

We asked participants to indicate whether their commands to Alexa were understood and tasks completed as, based on the prior research (Kiseleva et al., 2016b), we assumed that those two factors will affect users' overall satisfaction with Alexa performance. The diary collected 53 responses to the question on whether participants' commands to Alexa were understood. Of these 39 (75%) indicated that their Alexa commands were understood. Thirteen (24%) responses indicated that participants' commands were not understood, of which eight responses came from children (ages 4–10), three responses came from the younger adults (ages and 20–39) and two responses came from the older adults (ages 40–60). One participant was not sure/did not remember the experience and was unable to answer this question. The observation that most of the not-understood voice commands came from children can be explained by the still developing clarity and completeness of children's speech (Vygotskiĭ, 2012) as well as inabilities to formulate commands that could be understood by Alexa. It is worth noting that while the attempts are made to market Alexa as "conversational" and "intelligent", the use of the app still requires adjustments to users' natural speech in order to formulate effective commands for Alexa system.

Participants reported the total of 19 incomplete tasks. Among children, the incomplete tasks included music (2) and facts and questions (2); among younger adults, the incomplete tasks included lights control (3), with one music-related task not being complete for an older user. The results are in line with the types of Alexa interactions reported by participants; for example, since no children used Alexa to control other devices, it is not surprising that they did not have any difficulties with this type of task. However, the findings pertaining to the reasons for task incompletion (e.g. command not understood, content is not available through Alexa services) are inconclusive and need further investigation.

Of the total 127 interactions with Alexa, participants reported 104 (82%) instances of completed and satisfactory interactions: 41 (39%) from younger adults, 40 (38%) from older adults, and 23 (22%) from children. Participants reported 10 (8%) incomplete and dissatisfactory interactions, four (40%) of responses from young adults, three (30%) from older adults and three (30%) of responses from children.

We collected nine (7%) reports of incomplete but satisfactory interactions: four (44%) of responses from young adults, three (33%) from older adults and two (22%) of responses from children. Four interactions (3%) were reported as complete but dissatisfactory: all of these reports came from the older adults.

The high frequencies of satisfaction reports on completed Alexa requests are consistent with previous findings (Kiseleva et al., 2016b). However, the reasons behind incomplete but satisfactory, and complete but unsatisfactory tasks need further investigation and are further discussed in the next section. Potential explanations for such inconsistencies might include fundamental differences in

user expectations for IPAs and the emphasis on the interactive and entertaining qualities of the system over its informational value. Such hypothesis would explain why users who did not obtain a desirable response from the system would still be happy with an interaction, perhaps because it kept them entertained or demonstrated their superiority compared to the not so "intelligent" system that was unable to address their request.

### Memorable interactions

Studies on technology adoption suggest that post-usage memories affect user attitudes towards technology and its usage (Bhattacherjee and Premkumar, 2004; Morris and Turner, 2001). In order to gauge users' post-usage memories of Alexa interactions, we asked participants to identify the most memorable interactions each day and determine whether those interactions were generally positive or negative. During the four days of the study, participants reported a total of 33 memorable experiences with Alexa: 25 (80 %) positive and eight negative (25 %). Out of the 25 positive experiences, seven (28%) were related to music requests, seven (28%) were related to weather, three (12%) were related to the control of lights, two (8%) were related to setting alarms/timers, two (8%) were news related, two (8%) experiences were described as funny or silly, and two (8%) were non-specific and described in the general terms of "all good". Within the total of eight negative experiences, three (37%) were related to fact finding, three (37%) were related to lights control, and two (25%) were music related. The memorable interactions mirror the types and frequencies of all the reported interactions (e.g. frequent music and weather requests), and are largely associated with positive experiences. Participants' comments shed light on the factors that may attribute to the memorability of certain interactions, including humor and/or inappropriateness of Alexa responses or participants' own requests:

> Participant 1: Alexa played music, it was nice; but it couldn't respond to my child's questions (What's my brother's name? Am I good at gymnastics?)

> Participant 2: [Alexa] had some silly responses in relation to the questions we asked. We asked her to play 24 k magic by Bruno Mars and she played something totally random.

> Participant 3: [Children] played the same song over and over again on Alexa, to the point that we/parents now think about hooking up Alexa to decent speakers.

The reasons behind the greater memorability of certain Alexa interactions might be related to the task capacity for engagement (e.g. playing music is more engaging than checking traffic) and require further investigation. Future studies related to memorability of IPAs interactions should consider using qualitative methods, such as the critical incident interviews with Alexa users (Urquhart et al., 2003) and observations of the social contexts of use (e.g. instances when Alexa might interrupt conversations, generate humor and interactivity in conversation (Porcheron et al., 2016, 2017).

### Time of the week usage

Due to the known differences between work and leisure information behaviors (Elsweiler et al., 2011) we assumed that users' Alexa interactions will differ between weekdays (when participants work/study) and weekend (when they rest and engage in leisurely pursuits). Analysis of the usage patterns related to the time of the week (weekend vs. weekday) revealed that our participants used Alexa more frequently during the weekend (Saturday and Sunday) than during the weekdays (Friday and Monday), 83 and 53 times respectively. The distribution of various tasks between weekday and weekend days was very similar, as the top three most popular tasks for both weekends and weekdays were weather checks (19/17), music requests (19/12) and controlling other devices (11/7). The heavier use of Alexa during the weekend might have occurred due to the fact that participants spent more time at home, and close to the Alexa-dedicated, device, during the weekend, especially considering that the studied weekend was humid, relatively cold (temperature ranged from 17 to 45 F/-8 to +7 C) and not conducive to outdoor activities. It is also possible that over the weekend, participants had more free time and more need to engage in the leisurely information seeking and use.

### Alexa placement

Information behavior research has traditionally recognized the effect of context, and specifically, location on user's behavior (Leckie et al., 1996; Wilson, 1999). Assuming that users will have different interactions with Alexa depending on the device placement (e.g. set timer in the kitchen and alarm in the bedroom), and considering that Alexa might be used as an "assistant" while users engage in other room-dependent activities (e.g. cooking, dressing up), we examined the relationships between Alexa's placement and usage. We noted that the most frequently performed tasks (weather, play music, control other device) were requested in the three rooms: living room, kitchen, and bedroom, where users reported keeping their Alexa/Echo devices. One user reported moving the device around the home but did not interact with the device throughout the weekend. The majority of tasks were performed in the living room (60, 37%). Asking for a weather update (39, 30%) was most frequently performed in the living room and bedroom. Playing music (29, 23%) was requested more frequently in the kitchen than any other room. Weather, play music, set timer, and set calendar reminders

were the only tasks performed in all rooms. The number of household members and number of devices in the home seemed to influence the number of tasks performed. For example, the average number of reported interactions for the four-member household was 16; three-member household was 17, two-member household was 14.6, and one-member households was nine interactions on average. The most interactions (23, 19%) were reported by a two-person household with one Alexa, and the second highest tasks reported (19, 15%) were from a three-person household with one device. Households with more than one device performed approximately 28% (35) of total study interactions with Alexa.

The findings suggest that Alexa users are more likely to keep their device in their living room or kitchen. Had the activities performed by participants during Alexa interactions been recorded, they might have revealed more information about user behaviors and triggers to engage with Alexa. As a stationary device, the tasks requested of Alexa may relate to common activities within a room. For example, picking the right attire for the day might have correlated with the weather requests in the bedroom. In this study, music was frequently requested in the kitchen; additional user reporting may reveal that playlists or radio stations were requested to accompany long-term activities such as cleaning or cooking. Further studies can evaluate the length of time users utilize Alexa in one session, the home activities surrounding an interaction, and the number of interactions performed in one session. These variables would help to reveal the broader context and the reasons users choose to interact with Alexa.

***RQ3. Do participants use other types of IPAs, and if so, what do they use them for?***

As part of the initial demographic survey we asked participants about the information sources they use when Alexa is not available. All 19 participants provided responses that were summarized using the open coding technique. Participants indicated that some of the alternative sources of information include the Internet (16, 84%), family or friends (5, 26%), Google application (3, 16%), and clock (1, 5%). One user responded that s/he does not use Alexa as an information source.

After the diary portion of the study was complete, we asked participants specifically about the IPAs they are using in addition to Alexa. Nine adult participants emailed their responses and one chose to describe her experiences in a personal conversation. Five participants reported using Apple Siri, one reported using Siri and Google Assistant/Now, one reported using just Google Assistant/Now and three reported using only Amazon Alexa. Users who use Siri reported using it for setting timers or alarms (4), weather (4), entertainment and music (3), facts and information (2), and dictating texts/calling (2). Google Assistant/Now users reported using it for weather (2), music (2), timer (1), facts and information (1), and entertainment (1).

The findings indicate that the preferred alternative to Alexa for information requests is the Internet, while the other IPAs are used for similar purposes as Alexa. One participant reported having unique uses for Alexa compared to the other IPAs:

> We usually use Alexa primarily for music and weather, Siri and OK Google for information/ready-reference, weather, jokes (especially Siri, who's the most "personable" and talks back to children).

While our findings come from a relative small number of participants and do not have great generalizability, they are generally consistent with prior reports (Ong and Suplizio, 2016) and warrant further exploration of the user preferences for various IPAs and their functions.

## Conclusion

Intelligent personal assistant technology (IPA) is becoming ubiquitous, and some users even report developing strong emotional attachments to their IPAs (Shead, 2017). We developed a study to explore user interactions with this emerging technology by examining daily uses of Amazon Alexa's by nineteen heterogeneous Alexa owners.

The study findings suggest that user interactions with Alexa could be classified as casual or leisurely and are not exclusively directed at retrieving information (e.g. instances of Alexa use to control other devices or play games). The reports of the heavier use of Alexa over the weekends (time for rest) than the weekdays (time for work), satisfaction and positive memorable experiences with Alexa even when it did not produce desirable outcomes, suggest that the interaction experiences might be more important to the users than the quality of interaction outputs. Alexa usage for retrieving news and checking facts was not mentioned frequently, an observation that might be attributed to different user expectations of Alexa as a conversational not retrieval agent (Luger and Sellen, 2016) and a relatively poor performance of Alexa on these tasks reported in prior studies (Dunn, 2016a) and by our participants.

In analyzing the demographic and contextual variables that might affect Alexa usage, we noted that children generally interacted with Alexa similarly to older users. Children were less satisfied with Alexa performance on several occasions, including setting a timer and telling a joke. Dissatisfaction with the timer function might be attributed to the lack of skills to properly use this function, while the dissatisfaction with the Alexa joke might be related to inappropriateness of the joke for participant's age (an observation supported by one of the participants' comments). Children uniquely used Alexa for telling time, perhaps because their time-telling skills are still developing,

and, unlike adults, did not use Alexa for games. More work is needed to understand the positioning of Alexa (and other IPAs) in children's information landscape.

Users who were aware and used advanced Alexa features (skills), used Alexa to control other devices five times more frequently than non-advanced users. Advanced users also tended to better verbalize their requests to Alexa and were more frequently understood by the application.

Most of the participants' interactions with Alexa produced desirable outcomes and were satisfactory. Particular reasons behind unexpected users' reports of satisfactory but incomplete, or complete but unsatisfactory interactions need to be further investigated and might be related to humorous/unexpected outcomes, system inability to understand voice commands or distinguish between multiple voices, long response time and other factors.

Another promising avenue for future investigations includes the role of physical space and context in IPAs use. For example, in our study, most of the participants kept their Alexa devices in the living rooms or kitchens and had similar types of Alexa interactions across all locations. However, in the bedrooms, participants most frequently asked for the weather information and never used Alexa to check facts. Proximity to the device might explain the heavier usage of Alexa during the weekend, when participants are at home and close to their devices, than the weekday. Future studies should examine the cases of Alexa's adoption at a workplace, and, more generally, examine how activities performed in parallel to Alexa usage, device location and its immobility compared to smartphone and tablets IPAs affect its usage.

Our participants reported a decline in Alexa usage the longer it was owned. This observation is somewhat consistent with some of the industry reports suggesting that users are not adopting the applications they try (Marchick, 2017) and studies that report disappointing or frustrating experiences with IPAs (Luger and Seller, 2016). While Alexa's ownership is expected to grow (Dunn, 2016b; PRNewswire, 2017), we think it is unclear whether users will find this technology to be vital enough for long-term adoption, whether the main reasons for Alexa's use is its novelty, or it can fill out existing gaps in users' information, entertainment, educational, social or other needs. Understanding Alexa positioning and unique value compared to alternative IPAs (such as Apple Siri and Google Assistant/Now apps used by our participants) requires further examination.

Our study had a number of limitations. The study used convenience sampling, the pool of participants was small, and certain demographic characteristics (e.g. older age and teenagers) were not represented, resulting in a limited generalizability of the findings. The study relied on self-reports and participants' perceptions of Alexa's interactions. Asking participants to record their interactions once a day might have resulted in the loss and incompleteness of data. To mitigate these shortcomings, future studies should consider analyzing Alexa log files containing information about the nature, duration, and frequencies of interactions. Due to the ever-changing nature of the IPA technology and its functionality, investigating this technology brings additional challenges. After our study was complete, several of Alexa's features changed, impacting how users may interact with the device. These changes include allowing the device to automatically activate a skill (Martin, 2017) and introduction of Echo Show, an Alexa hosting device that supports visual interface. The future studies of IPA interactions and adoption should rely on rapid and flexible data collection methods to obtain a reliable snapshot of user interactions.

We initially approached Alexa as an information retrieval system and grounded the study variables and methods primarily in the information seeking and retrieval work. However, during the study we discovered that due to the multi-functional nature of IPAs, and Alexa in particular, traditional models of information behavior and seeking, for example the information behaviour model (Wilson, 1999); casual leisure information-seeking model (Elsweiler et al., 2011), do not fully apply and cannot explain user interactions with this technology. Many user interactions with Alexa aim to use it as a voice-activated remote control for other smart home devices, as a clock or alarm, or to create a certain mood by playing music or telling a joke. Measures related to engagement (O'Brien and Toms, 2008) and users' motivation, for example boredom, escapism (Stebbins 2007, 2009), might be more appropriate for understanding users' focus on the quality of the interaction, not its end result.

Our study produced exploratory findings related to the user interactions with the Amazon Alexa and outlined the need for more research aimed at describing, predicting and improving user interactions with the multi-functional conversational IPAs.

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## Appendix A: Demographic questionnaire

1. How old are you/your participating child?
2. What's your/your child's occupation?
3. How many Alexa devices are in your home?
   a. 1
   b. 2
   c. 3+
4. Do you/your child move Alexa around your home?
   a. Yes
   b. No
5. Where is Alexa primarily located in your home? (If you have multiple devices, give all locations)
6. How long have you/your child had an Alexa?
   a. Less than 3 months
   b. 3 to 12 months
   c. More than a year
7. How often do you/your child use Alexa?Very infrequently 1 2 3 4 5 Very frequently
8. Did you/your child rename your Alexa?
   a. Yes
   b. No
9. If yes, why did you/your child rename your Alexa?
10. Have you/your child added any Alexa Skills (e.g. apps)?
    a. Yes
    b. No
    c. Don't know
11. Is your Alexa connected to any other devices?
    a. Yes
    b. No
    c. Don't know

12. What do you/your child usually use Alexa for? (check all that apply)
    a. Work/school
    b. Entertainment
    c. Quick searches (e.g. weather, traffic)
    d. Controlling other devices
    e. Other
13. How satisfied have you/your child been with your Alexa to date?
    Very unsatisfied 1 2 3 4 5 Very satisfied
14. When Alexa isn't available, you/your child usually find the answer to a question by: [check all that apply]
    a. Asking a family member/friend
    b. Searching the internet
    c. Checking books or other print resources
    d. Other
15. Please enter you/your child's participant ID (animal name) here:

## Appendix B: Daily diary

1. Enter your participant ID (animal name): _____
2. How many times did you use Alexa today?
    a. 0
    b. 1–10
    c. 11+

What did you ask Alexa about/to do today? Check all that apply:

| | Task not completed/ I was dissatisfied | Task completed/ I was dissatisfied | Task not completed/ I was satisfied | Task completed/ I was satisfied |
|---|---|---|---|---|
| Weather | | | | |
| Facts | | | | |
| News | | | | |
| Control another device | | | | |
| Shopping | | | | |
| Cooking instruction | | | | |
| Set reminder/calendar | | | | |
| Play music | | | | |
| Traffic/travel information | | | | |
| Set a timer | | | | |
| Tell a joke | | | | |
| Play a game with Alexa | | | | |

3a. If you used Alexa for something else (for example, basic math, check time), please explain here: ___

4. What was/were your most memorable interaction(s) with Alexa today (positive or negative)? Please describe: ____

5. Did Alexa understand all your commands today?
    a. Yes
    b. No
    c. Not sure/don't remember

6. If you used any non-command language with Alexa today (for example, "please", "thank you", "shut up". "I love you"), what was it? ___