Evaluating a Smartphone-Based Social Participation App for the Elderly

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Abstract. Hyper-aging societies are looking for ways to support their elderly populations and mitigate aging-related societal challenges. One way to do this is by increasing elders' social participation in the workforce and their communities. Towards this end, an opportunity-matching app for Japanese elders called GBER (Gathering Brisk Elderly in the Region) was created and deployed in a large Japanese city. In this paper, we report on the results of a usability and user experience (UX) study that evaluated a new version of the app's user interface (UI), which was redesigned for smartphones based on feedback from current users and by taking an elder-centric design approach. The study, which involved representative elderly users, revealed several insights about the use of flat UI design, conceptual transferability of common app iconography, information reading patterns, and persona and scenario methodology. It also confirmed the diversity of Japanese elders interests and skills, providing further empirical support for the need for an opportunity-matching service like GBER.

Keywords: User interface · Smartphone · Aging · Elderly · Senior workforce Senior community · Social participation

1 Introduction

Societies around the earth are aging rapidly, and Japan is leading the march. As a hyper-aging country [12, 14], Japan has a rapidly increasing population of elderly citizens and one of the lowest birth rates in the world. It is speculated that by 2040 over one third of the population will be over 64 years of age [3]. This is already having important and widespread effects on Japanese society, especially healthcare and social systems, that are sure to be reflected elsewhere as other countries' aging rates catch up. As such, how to manage the realities of a hyper-aging society while supporting elders is becoming a crucial social, technological, and research concern.

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One way to both support elders and society at large is by increasing elders' participation [4, 12]. Participation is defined as a combination of social interaction—the micro scale acts of speaking with and being around people—and community engagement—the macro scale behaviors of being present in community spaces and going to community events. Several factors can affect whether and how elders participate in society. In many industrialized nations, people are expected, if not required, to retire once they reach a certain age; in Japan, this is 60 or 65 years of age. As we get older, we also tend to encounter issues with mobility that assistive tools and devices, such as wheelchairs, may not be able to reverse and may introduce new issues, such as environmental barriers. Finally, relationships can weaken or break down, such as in the event of family moving far away or when elderly friends pass away. In the face of reduced participation and a desire to regain a sense of community presence, many elders in Japan take on part-time jobs or volunteer positions; however, these can be difficult to find and may not match the elder's interests [11].

One avenue for tackling these issues is technology. Elders, in Japan and elsewhere, are becoming an increasingly tech-savvy population. Smartphones, in particular, are becoming a popular choice among seniors in Japan; as of 2014, 39.4% of younger elders (50+59) and 22.5% of older elders (60+) own smartphones [2]. Following this trend, a research team at the University of Tokyo created GBER (short for Gathering Brisk Elderly in the Region), a cross-platform app that matches elders to activities, jobs, and events in their community [1]. The purpose of the app is to improve elders' participation by providing them with curated, personalized opportunities near where they live. The current version of the app was designed using a combination of research-backed guidelines, expert design, and interview with a group of assumed users. At present, 106 elders in Kashiwa city, Tokyo are registered users of GBER.

This paper describes the results of a usability and user experience (UX) study conducted around improving the current GBER app's user interface (UI) design. The current users of the app informally provided feedback about the UI, revealing three main issues. First, it is difficult to imagine what kind of service will be provided under each menu displayed on the top page. Current top page displays a set of abstract icon with brief description by text. Displaying information which does not directly concern each user on top page made user reluctant to interact with further contents in lower hierarchy. Second, finding activities is not tied to the user's availability: users must add their schedule, then go to a different calendar to see booked and recommended events. Third, gathering preference information from users is tedious. Users must fill out a lot of questionnaire forms consecutively, which can be tiresome. With these issues in mind, a new version of the UI was designed and user tested with six elderly Kashiwa residents. The aim of this study was to ensure that the new design addressed these issues in a user-friendly and easy to use fashion, towards the overarching goal of to accelerate elderly participation in GBER service. The main contribution is a series of usability and UX insights on an activity-finding and schedule-based smartphone app design for Japanese elders.

2 Related Work

In the wake of widespread smartphone use, researchers and designers have begun to assess their usability, UX, and accessibility for elderly users. Indeed, there is now some evidence to suggest that elderly users have different kinds of experiences and needs when it comes to the design of smartphone interfaces. Salman *et al.* [13] revealed and categorized some usability issues related to effectiveness (e.g., inability to complete the task), efficiency (e.g., time required to carry out task), and user satisfaction (e.g., not using the feature phone again). This implies there were a gap between developers (who were mostly young) and elderly users' mental models, where developers made design decisions based on their own understanding, which may not al-ways reflect those of elderly users. Other research has shown that elderly users might experience difficulties in navigation, easily getting lost when walking through dialogs that are composed of several phases requiring navigation, selection, input, output, confirmation, and so on [7]. Harada *et al.* [6] investigated the issues and challenges that elderly people may encounter when using smart devices in certain kinds of interfaces, such as map apps and address books. In these interfaces, elderly users were found to make unintentional taps due to parts of their hand accidentally making contact with the touchscreen on the device. Additionally, they sometimes took action without noticing important information or being aware of their mistake, and then received unexpected feedback as a result. During our study, we made sure to watch for these kinds of issues in the redesigned GBER interface.

Some studies have conducted experiments to generate guidelines for how to ad-dress known issues about elderly people using smartphones. Kobayashi *et al.* [10] suggested that an input target should be larger than 30px to make it easier for elders to tap. Since smartphone screen sizes and resolutions have changed much in the seven years since this study was published, we decided to redesign using the official iPhone guidelines. As such, most clickable elements on the redesigned GBER UI are at least 44pt in width or height in the iPhone X. Their study also noted that elderly preferred dragging operations rather than tapping. Further, they suggest that applications should avoid multi-mode interfaces—similar interfaces that show different statuses for one screen or view—as much as possible, since elderly users are less likely to notice changes in the modes and thus can become confused. For example, in their study, there were multiple modes for thumbnails, such as by events and by persons, and the participants had difficulty understanding which mode was active. In the redesigned GBER app, multiple views for the same or similar tasks were removed or merged into one, such as the calendar feature.

The ideal model of technology usage for elderly might involve breaking tasks down into small pieces to avoid elderly users feeling overloaded or getting lost easily. For instance, it is difficult for elderly users to use social networking applications on smart devices because they often require a sequence of actions during form completion. Hiyama *et al.* [9] proposed "Question First," an interaction model based on the interaction modes of phone calls and emails. Elderly users were able to become familiar with the idea of social networking by simply answering questions on the application. The similar concept of micro-tasking can also be found in a study about elderly workforce matching [8]. The authors proposed a "spatial mosaic" framework for management of

time, space, and skills related to elderly workforce matching. The current GBER service was based on this particular framework, and in the redesign, we applied the UI principles to the GBER UI. For example, the event recommendation and question cards were designed with a simple operation for the user: answering one survey question at a time by simply clicking a preset response option. This could make it easier to collect the user's data for the matching system. We will describe this and the other changes we made in more detail in the next section.

3 System Design

The main purpose of GBER as a service app is matching elderly people to jobs or activities that suit their interests and abilities. By collecting user behavior through GBER's in-app questionnaires, the system knows how to recommend opportunities to each individual user. Users need to manage and review their booked activities on the service. The following are the main actions possible using GBER:

1. Jobs and activities exploration based on time and location
2. Questions interface ("Q&A") for user profiling
3. Schedule interface for reviewing and managing booked jobs and events
4. Recommended opportunities information feed
5. Group-based communication and a personal profile page

A mid-fidelity prototype of the redesigned interface was developed using InVision, a web-based prototyping tool that generates realistic, interactive prototypes without the need for coding. The InVision prototype was presented to users on an actual iPhone X device. The following sections detail the parts of the prototype that were redesigned and tested in the user study. See Fig. 1 for a visual reference to the redesigned screens detailed below, and Fig. 2 for the equivalent screens on the current, live version of GBER.

Fig. 1. Key redesigned screens in the new GBER app UI. From left to right: (a) the home page; (b) the Q&A system in action; (c) the calendar page; and (d) the event search page.

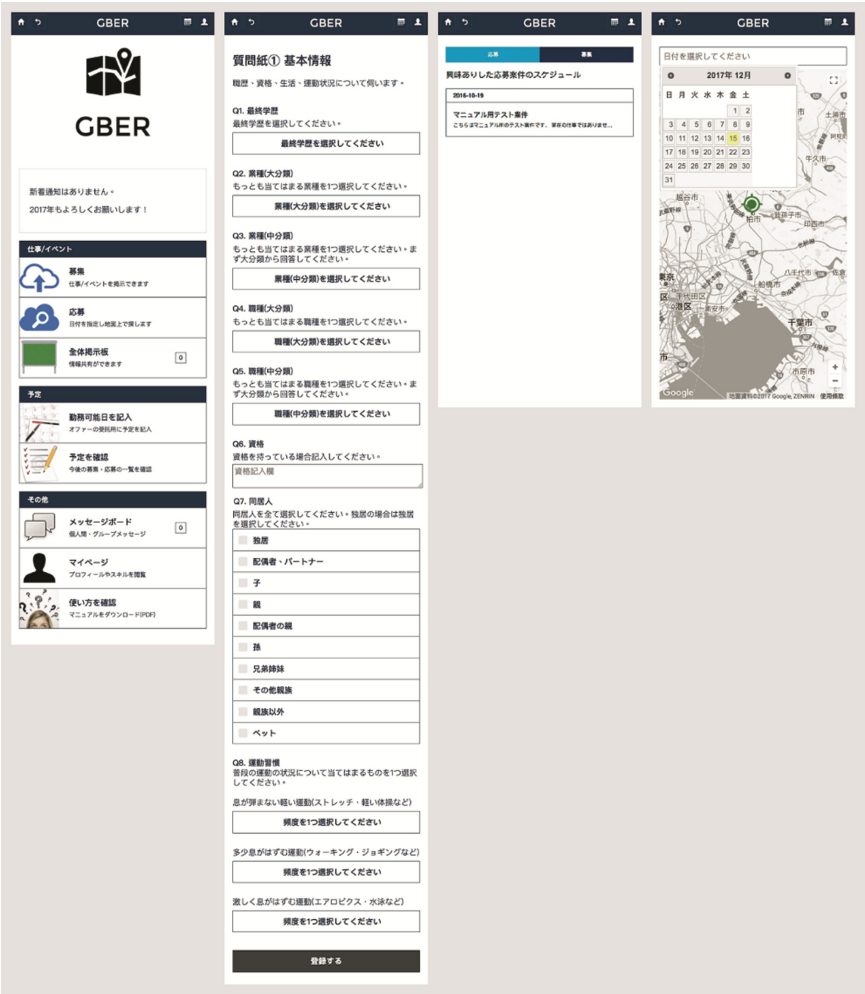

Fig. 2. Original screens in the current version of the GBER app. From left to right: (a) the home page, featuring the long, vertical menu; (b) the long version of the questionnaire; (c) the calendar page with a list display; and (d) the event search page with a calendar filter.

3.1 Tab Bar Navigation

Elderly users have difficulty understanding menu hierarchies [2], so it is recommended that the main navigation be placed identically on all pages [7]. Critical functions, like searching activities and scheduling, should always be accessible, from any screen in the app. Scrolling menu content should be reduced to a minimum as well. The tab bar fits these guidelines, so it was used in the new design (see any screen in Fig. 1).

3.2 Home Page

The aim of the new design (Fig. 1a) is to reduce the effort placed on the user in terms of getting access to the information they need across different situations. The home page design used several design strategies and patterns to reduce the information load yet provide the necessary information. A "feed" approach was used so that the user does not need to look for information by changing pages or by clicking any button: everything is accessible in one page. The card-based design creates a minimized information unit. Showing what is next on the schedule and recommending what can be next can shorten the experience of finding activities and opportunities in schedule calendar or map. By making home page general purpose—not tied to any specific feature—the design and the usage of the service becomes more flexible.

3.3 Q&A

Previous research has shown that extracting information from the elderly about their technology experiences is difficult [1, 9]. The current version of GBER users a series of long questionnaires to get information about users' activities and interests for the opportunity-matching algorithm. However, metrics showed that only about a third of users filled these out [1]. Instead, we redesigned the questionnaires as question cards (Fig. 1a) to divide the original long series of questions into smaller chunks that should be quicker and less overwhelming to complete. These pop up periodically on the home page.

3.4 Calendar

The current version of GBER has two kinds of information that are displayed in the calendar but these have different purposes: one is the user's availability, which they have to input, and the other is any booked events. For the former, this means that the user must go through a longer process of inputting information, with many steps involved. In the new design (Fig. 1c), the user does not need to input their availability: they can just add events at their leisure.

3.5 Map

To achieve the goals of involving users in activities in their region and making sure that the events are accessible, it is important to let users know where the event will be. The map interface needs to allow users to explore where and when events will take place. The difficulty is ensuring that this view provides enough information for the user to browse each possible event. The user will need to explore the available activities and then decide which to apply to given several pieces of information. In the new design (Fig. 1d), an easier solution is explored for elderly users to get access to events information. Specifically, information cards featuring events nearby and soon to happen are displayed at the bottom of the map view. Control filters are provided for fast exploration.

While the redesign was informed by informal feedback from current GBER users, we needed to ensure that the changes made would be beneficial. We also wished to know

more about potential GBER users so as to attract more users and refine the service. Next we describe the user study we conducted towards this end.

4 Method

A user study was conducted to assess the usability and UX of the new GBER UI. The study followed a common approach [15] with a representative user testing an in-progress, mid-fidelity version of the UI through two scenario- and task-based "missions," completed by all participants. A think-aloud protocol [5] was followed to give us access to participants' thoughts as well as what they were looking at in the UI while using it. A split-part (pre- and post-testing) semi-structured interview was conducted to better understand participants' experiences with, knowledge on, and opinions about smartphones, community participation, and the GBER app.

4.1 Participants

Six Japanese elders (3 women and 3 men) aged 62 to 73 (mean age = 67) who were residents of Kashiwa city took part in the study. See Table 1 for demographics and usage information. Participants were not GBER users but all used smart devices, primarily smartphones. They also used map apps, particularly Google Maps, although only half used calendar apps. Participants were recruited through Second Life Factory, the elderly community located in Kashiwa city, which uses current GBER to improve social participation the member. Participants were compensated by Second Life Factory; and they were provided with refreshments and given access to the GBER app. The protocol was covered under the University of Tokyo ethics guidelines.

Table 1. Participant demographics and information on GBER and technology use

ID	Age	Gender	GBER user	Smart device	Map apps	Calendar apps
P1	73	Male	No	Smartphone, PC	Google Maps	Yes
P2	65	Female	No	Smartphone	Google Maps, Yahoo Maps	No
P3	62	Male	No	Smartphone	Google Maps	Yes
P4	65	Female	No	Tablet, Sony	Google Maps	No
P5	66	Female	No	Smartphone, Macbook	Google Maps	No
P6	73	Male	No	iPhone	Google Maps	Yes

4.2 Procedure

Participants were asked to meet the researchers at the University of Tokyo Kashiwa campus. They were greeted, lead to the study room (enclosed meeting rooms with a main table and chairs) and introduced to the study. They were then asked to sit at the table in front of a smartphone containing the new GBER prototype (Fig. 3). The

facilitator then asked about demographics, technology use, and knowledge of GBER. After offering refreshments, the facilitator then introduced the participant to the new prototype and provided two "missions" tailored to assess the three redesigned features: the homepage; finding activities; and the new Q&A setup. An assistant then began to record video of the participants' interactions with the new prototype. The participant was guided through the tasks making up each mission by the facilitator. The facilitator took notes and prompted the participant to think aloud using neutral comments and questions, such as "Tell me more about that," "What are you thinking right now?" and "What are you looking at?" After finishing the missions, the participant was interviewed by the facilitator again about aspects related to the new GBER prototype. They were then debriefed and thanked for their participation.

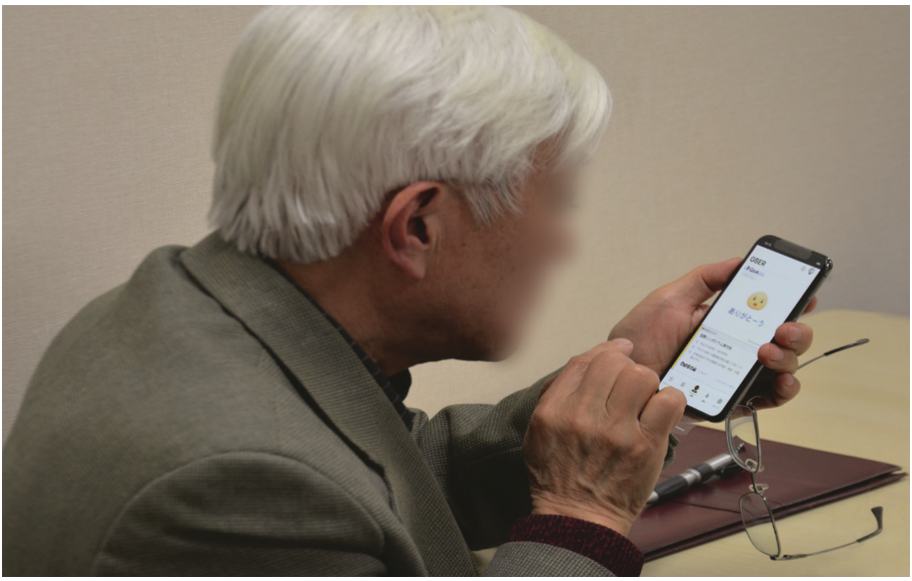

Fig. 3. A participant interacts with the GBER prototype featuring the redesigned UI.

4.3 Missions and Tasks

Two missions addressing the three key issues covered by the redesign were provided to participants verbally by the facilitator. Each was framed as a scenario with a persona [15] and comprised of several tasks, where the participant was asked to imagine themselves as the user and carry out the action they believed would complete each task. The two missions were:

1. *Activity-Finding and Schedule:* Searching out new activities, viewing scheduled activities, and managing the schedule. An example task is: Your friends ask you for dinner next Wednesday, so you need to check if you are available at that time.
2. *Q&A:* Finding, understanding, and responding to the new Q&A system. An example task is: You notice that you are able to join some events tomorrow, so you try to find

an event to join through the searching feature. After you find some events, chose one and apply to it.

4.4 Instruments

Two sets of questions were used for pre- and post-test semi-structured interviews. The questions were split before and after to balance out the flow of the study. The first set of questions asked about demographics (age, gender) as well as GBER use, if the participant was already a user of GBER (e.g., *How do they use GBER, via smartphone, PC, or other? How often?*). The second set of questions asked about perceptions of participation, barriers and challenges to pursuing activities and hobbies, and general smartphone-related issues. Specifically:

- How would you rate your social participation on a scale from 1 to 5, where 1 is very low, 5 is very high?
- What kinds of activities you attend regularly, before and currently?
- Is there anything that makes it difficult for you to pursue your activities, hobbies, or interests? Please give an example.
- What activities do you want to do but cannot, and why? What is the difficulty?
- Do you use a calendar app? Which one? What do you use it for? Are you still using it? (If not, why not?) [The same was asked about map and message/SNS apps.]

4.5 Data Analysis

Written notes and answers to interview questions were transcribed. Video was reviewed to fill in blanks in the notes. Two analysts looked through the data several times for behavioral patterns and points where there were errors, confusion, and breakdowns. These were recorded in a qualitative matrix.

5 Results

5.1 Usability and UX Results

A summary of key results is presented in Table 2. Overall, while all participants were able to complete the missions and tasks, most required guidance, and there were clear areas where usability broke down for a substantial number of elders.

Although they were asked to find the next upcoming event, four of the participants pressed buttons on the recommendation card instead. P4 said that she had no interest in the upcoming event. P2 and P4 said that they were interested in the recommended event and kept pressing the "apply" button on the recommendation card. P6 found the upcoming event the first time and clicked on the information card to read the details, then said he did not see how this information benefited him.

Table 2. Matrix of the key user study results.

ID	Clicked "recommended" and ignored the upcoming card	Clicked the "cross" icon to finish the "add event" task	Used the tab bar to access the calendar	Used tab to find activities	Swiped to find out more information
P1	✓	✓	✓		
P2	✓		✓		✓
P3			✓	✓	
P4	✓	✓			
P5	✓	✓	✓		✓
P6					

Four participants were able to use the calendar icon in the tab bar as intended. P4 and P6 were not able to figure out how to navigate the calendar; they were looking for the entry of the schedule around the upper zone of the screen, not looking down at the tab bar. P2 encountered a bug and P6 was uncertain and give up on the task. The other three participants clicked on the cross icon to close the form. Only P3 used the "save" button on the bottom of the "add event" form page.

In terms of activity-finding, the majority struggled to complete the task, with the exception of P3. Only P3 successfully found and used the middle icon in the tab bar to get to the activities page without direction. P6 clicked another icon on the tab bar and then found themselves on another screen that was not what he wanted. When participants were asked to find an event to join, they kept looking at the event card at the bottom (see Fig. 1d). None used the red pins on the map to see if there was another event to join; instead, they pressed on the "I am interested" button. P2 and P3 used swiping gestures to slide between screens; even when the researchers told them that swiping was not possible and guiding them in terms of how to navigate, they kept trying to swipe between screens.

5.2 Activities and Barriers to Access

The difficulties in terms of pursuing activities that were reported by participants were highly specific and as such there were no patterns. For example, P1 said he was lazy, while P2 and P4's difficulties were about lacking time and money. P3 wanted to start his own business but did not know how. The self-rating of participation in social activities was high (median = 4). Two participants rated themselves as 5, or "very high," one gave a rating of 3, or "medium," and the rest of the participants rated their participation as 4, or "high."

6 Discussion

Overall, participants were intrigued by the new interface and experienced moments of joy. For instance, most participants enjoyed the emoji feedback and the level of detail

presented in the events. However, there were several areas of confusion and usability breakdowns, such that it was challenging for some participants to finish certain tasks.

A common behavior that we observed suggests that our elderly participants were attracted to colors. Most participants kept pressing colorful elements or reading colorful text rather than the black and white elements and text, even though they were the right elements to interact with. This suggests we have to be careful about using flat design because it is hard for elderly to conceptually distinguish between visually similar elements, in our case flat-style tags and buttons. Importantly, this is not a visual perception issue (i.e., contrast, visual acuity), as older adults were able to perceive and read the elements in question. In effect, they were interpreting cues of the visual elements as the same, suggesting they were the same kind of element. Previous research has already indicated that older adults may prefer skeuomorphic rather than flat UI designs [cite]. Our results suggest that there is more than preference at play: flat design may not be as usable as alternatives. However, future work will need to explore this in greater depth. We will assess a skeuomorphic style for the interactive elements, like buttons, so the users might not miss them; also, non-button elements will be presented with colors or borders.

Some typical smartphone icons, like the calendar icon, were clear to participants, but some were not. This became apparent in two tasks requiring use of the tab bar navigation: checking the calendar schedule and exploring activities. Most participants successfully found the calendar (Fig. 1c) through the tab bar, but only one used the tab bar to access the activity-finding page (Fig. 1d), even though both tab bar buttons were placed next to each other in the tab bar. Further, all participants did not understand why and how the red pins on the activity-finding screen worked, even though all were Google Map users. This suggests that there was a mismatch between their mental model of what to expect on an activity-finding screen and what was actually on the screen. With these results alone, we can only speculate about the underlying cause: it could be the label ("recruiting") or presence of the map (elders do not associate maps or locations with activities). We will redesign the event boxes to have clearer clues of how to navigate or get access to other events. These clues will directly point out what users need to do to find out more information. For example, they may provide instruction text to guide first-time users to follow along.

There is a bit of evidence to suggest that certain visual design patterns overwrote the dominant right-to-left, top-to-bottom cultural reading pattern. When participants were asked to change screens using the tab bar or when they were expected to use the interactive elements at the bottom of the screen, they typically spent some time searched around the upper zone of the screen, exploring the bottom zone only after they realized what they needed was not there. However, this behavior changed when they were on the activity-finding page (Fig. 1d). Participants kept looking at the event box at the button and did not explore or interact with the elements in the upper zone (the map, filters, and search control). The most important action elements, like save buttons, may be moved to the upper zone, or perhaps be visually redesigned to more strongly draw the user's attention.

We also discovered an issue in our user study methodology that, in our experience, seems to be particular to our elderly participants. Specifically, it was hard for elders to pretend to be a persona. Even after we spent some time explaining what personas are and why we needed them to pretend (e.g., to save time, because the prototype was

unfinished), they did not seem to understand and/or did not want to pretend In the first task, where participants were asked to find a booked event in the app, some said that they did not want to apply to that event or had not applied to it. One participant pressed on colorful elements, attempting to change the status of the interface. Half of all participants told us their real schedule or plans instead of carrying out the task of checking the schedule and adding an event. The facilitators needed to keep explaining that the tasks were pretend so that the study could go on. While it is unclear why, there are alternatives that we and others can explore in the future. One idea is to start with no preset persona (essentially, ensure a robust prototype design and have the participant carry out all necessary tasks before the main tasks). Another idea is to create customized personas based on the participants themselves (if we can get access to demographics information about them before the study).

The diversity of reasons for not participating or barriers to participation highlight the need for a service like GBER and motivate us to continue developing the platform, especially the matching algorithm.

7 Conclusions

We designed a new version of the GBER social participation app that was inclusive of elders' needs and abilities and then evaluated it with representative users. Through user testing supplemented by semi-structured interviews, we were able to glean new insights into elders' perceptions, behaviors, daily life, and use of smartphones, as well as their impressions on and ability to use GBER. The elders in our cohort—Japanese residents of Kashiwa city—were a tech-savvy group with diverse interests and a strong desire to participate more fully in their communities. The redesigned GBER app shows promise, but further design iterations are needed. Even so, we can propose some general findings and indications from our results. Even when elders are familiar with map and calendar apps, this familiarity may not translate to similar design patterns. Moreover, we must be careful with the use of flat design by ensuring that elements such as tags and buttons are clearly visually distinguishable. Finally, it may be difficult for elders to imagine themselves as personas going through scenarios, so alternative usability procedures may be needed. We will be applying these insights in the next design iteration and then release the new version, after which we will conduct further user testing with GBER users "in the wild." Future research will evaluate not only the usability and UX of the new GBER app but also its ability to improve the social participation of the elderly over a longer period of time and in situ.

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