"Why would anybody do this?": Older Adults' Understanding of and Experiences with Crowd Work

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ABSTRACT
Diversifying participation in crowd work can benefit the worker and requester. Increasing numbers of older adults are online, but little is known about their awareness of or how they engage in mainstream crowd work. Through an online survey with 505 seniors, we found that most have never heard of crowd work but would be motivated to complete tasks by earning money or working on interesting or stimulating tasks. We follow up results from the survey with interviews and observations of 14 older adults completing crowd work tasks. While our survey data suggests that financial incentives are encouraging, in-depth interviews reveal that a combination of personal and social incentives may be stronger drivers of participation, but only if older adults can overcome accessibility issues and understand the purpose of crowd work. This paper contributes insights into how crowdsourcing sites could better engage seniors and other users.

Author Keywords
Crowdsourcing; motivation; older adults; online work.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (HCI): Misc.

INTRODUCTION
Crowd work is an emerging form of digital labor in which many workers complete small *microtasks* online for various requesters. Crowd work arrangements are established through crowd work platforms, such as Amazon's Mechanical Turk (AMT). In this paper we focus on crowd work platforms which enable requestors to post tasks and payments and workers to complete tasks and earn money (e.g., AMT). Crowd work has emerged as an important online labor market; as such, it is necessary to understand which demographics are participating in crowd work and identify how to help grow and motivate this work force [20]. Prior studies indicate that individuals who perform crowd work tend to be in young or middle adulthood [13,20,35]. Indeed, most research on crowd work focuses on this demographic, resulting in a gap in our understanding of why older people may or may not engage in crowd work. On Amazon's Mechanical Turk, a popular crowdsourcing platform for non-experts, the average worker age is 30 years old [35]. Additionally, of a 1000 participant sample in a study which sought to understand the demographics on AMT, only 2.8% were over the age of 60 [20]. While nearly 60% of older adults in the U.S. are now online [39], only 5% of workers are over 60 years old on CrowdFlower, whereas more than 50% of its contributors are under 30 years old [13]. Although prior work examined specialized crowdsourcing platforms for older adults (e.g., [25]), it is important to understand why older adults are participating so minimally on non-specialized (or general-purpose) crowd work platforms that dominate the marketplace (e.g., AMT). Towards this end, the present paper contributes new insights on issues of inclusion, accessibility, and older adults' values around participating in crowd work.

Engaging older adults in crowd work may hold value both from a worker perspective and from a platform/requestor perspective. Recent work by Zyskowski et al. [45] suggests that people with disabilities (a group that tends to include many older adults) find crowd work an appealing form of employment due the scheduling and location flexibility it provides. Understanding how to help under-represented groups gain access to emerging forms of employment is important from a digital inclusion and social justice perspective. Moreover, the changing structure of retirement [8], a trend in which many seniors retire later or continue to work part-time during the retirement years out of a combination of financial need and a desire to stay active in older adulthood, may also add to the appeal of crowd work for this demographic. Completing crowd work tasks may also offer important cognitive benefits (such as learning new skills, engaging socially with others, feeling purposeful, etc.) for a group at risk of cognitive decline.

From task requestors' perspectives, engaging seniors in crowd work can help increase the size of the available worker pool, helping this new form of work continue to grow. Seniors represent a group of workers who are highly experienced, which suggests that they may contribute a high-quality addition to the talent pool. Recruiting a more diverse group of workers may also offer benefits in terms of output quality because of the positive nature of diversity in team

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environments [22,40]. Additionally, designing tasks and platforms in ways that make them more appealing to and accessible to older adults may result in enhancing the user experience for many other user groups as well.

This paper presents results from a survey of older adults' crowd work practices as well as from interviews and observations of sessions in which older adults completed crowd work tasks. We address the following questions:

RQ1: Are online older adults aware of crowd work opportunities, and which older adults participate?

RQ2: Which aspects of crowd work are most motivating to older adults? How does this differ after completing crowd work tasks?

RQ3: What challenges do older adults encounter when completing microtasks on AMT?

This research is the first to understand older adults' participation on mainstream crowd work platforms and their experiences performing a variety of common tasks types, whereas prior work has only examined specialized platforms in which older adults complete a single type of task (e.g., proofreading [25]). We find that although the majority of older adults have not performed crowd work, those who have are younger and have higher levels of education and internet skill, suggesting further inequities in online participation within this demographic. A deeper analysis of their experiences performing crowd work indicates that integrating personal and social incentives may be ideal, yet such incentives are only valuable if older adults can overcome many accessibility issues with crowdsourcing sites and understand the purpose of the work. Based on these findings, we extend prior work [25] to include an additional dimension for motivating seniors to complete crowd work tasks, and contribute detailed design recommendations on how to make both crowd work platforms and individual microtasks more appealing and accessible to older adults.

RELATED WORK

State of Seniors Online

Understanding the under-representation of seniors in crowd work is important given that increasing numbers of older adults are going online. While access may still be a barrier for some seniors, this is not the case for the majority of American older adults, 59% of whom are now online according to a recent Pew report [39]. In addition to access, examining measures of Internet skill (e.g., [17]) may help in understanding the relationship between experience and participation in crowd work among online older adults. Prior surveys examine older adults' online behaviors [39,44], particularly e-mail and social networking site usage, but rarely examine older adults' engagement in online work [25], and no studies have qualitatively examined the experience of older adults doing general-purpose crowd work tasks through observation.

Engaging Older Adults

Beyond older adults' knowledge of crowd work, identifying the cognitive, social, or economic factors that may engage older adults in online work could help bridge this gap. For example, some seniors may be encouraged to be crowd workers because of the flexibility of working from home and because volunteering or working in older adulthood is associated with lower mortality rates [16,32]. Online "brain games" are popular among older adults [15], and older adults may be motivated to perform tasks that focus on particular cognitive skills. If crowd work platforms have a social element, participating in crowd work may be particularly appealing to older adults, as keeping in touch with family members and friends is an important goal in older adulthood [29]. Moreover, seniors may derive a sense of self-worth from helping their social contacts or volunteering for tasks that have social impact [7]. Finally, younger crowd workers tend to be motivated by finances [13], and this may also be a factor for seniors.

Older Adults and Crowd Work

Current knowledge of seniors' interest in participation in crowd work is extremely limited. Kobayashi et al. [26] proposed that older adults' mature linguistic knowledge might be an asset to crowdsourced book-proofreading projects in Japan; they surveyed 170 Japanese older adults to investigate their interest in such activities, and found that respondents might be interested in participating in the project if they were given technical assistance, leading Kobayashi et al. to speculate that crowd work platforms might successfully harness the knowledge of older adults by pairing them with younger, tech-savvy partners via chat. Kobayashi et al. studied how older adults completed one type of social-purpose crowd work task (proofreading) over a six-month period [25,26] and proposed a framework for understanding older adults' motivations to complete a limited type of crowdwork tasks for social incentives. In contrast to this prior work, we examine how older adults complete a variety of common crowd work tasks on the popular platform of AMT. We highlight differences between the motivational framework proposed by Kobayashi et al. [25,26] and our participants' experiences performing crowd work more broadly. In other work, Zyskowski et al. [45] interviewed and surveyed crowd workers with disabilities, whose age skewed older than typical crowd workers (since many disabilities are aging-related). They found that participating in crowd work was important to many disabled workers' sense of self-actualization, but that current crowdsourcing platforms and workflows present barriers to equal participation. We analyze these issues from the perspective of older workers.

SURVEY

Method

We designed an online survey to gather information about older adults' current knowledge of and interest in crowd work. We refined the survey through pilot testing with individuals in the target age group (U.S.-based adults aged 60+), and deployed the survey with a participant recruiting

service, Cint, which conducts "census representative sampling[1]." We asked the service to recruit respondents who were 60 or more years old and who lived in the United States. Respondents were paid $4.00 to complete the survey, which took 10 minutes to complete on average. Knowledge of or experience with crowd work was not a prerequisite for participation. Because prior studies suggest that few older adults participate in crowd work [13,20,35], we used a paid online survey to recruit older adults who were (a) active online and (b) already engaging in a form of online work (paid survey takers), thereby targeting individuals who we suspected would have the computer access and proficiency to perform crowd work.

Profile of Respondents

There were 505 seniors who completed the survey in August 2014 (37.4% male). Respondents' ages ranged from 60 to 80 years old (median = 66), and they resided in 44 different U.S. states. Participants had varied educational backgrounds, with 21.4% having at most a high school education and 38.7% having a bachelor's or graduate degree. The majority of respondents, 65.3%, reported being retired. Socioeconomic status was varied as 11.4% reported an annual household income of more than $100,000 per year, while 48.7% were in households earning less than $50,000 per year. From this diverse sample of older adults, we further inquired about their level of computer skill.

To understand the technical experience of our survey respondents, we used Hargittai et al.'s 27-item scale to approximate participants' level of Internet skill [6]. By computing Internet skill score as a per-user mean across the 27 items (each of which are individually reported on a five-point scale), the mean skills score for respondents was 3.1 (median 3.0). When participants were asked to indicate how they typically access the Internet, being able to choose more than one option, 97.6% indicated they use a computer in their own home and 41.4% indicated using a smartphone or tablet. Respondents were also asked to indicate their level of agreement with several statements about their computer skill level on a 5-point Likert scale. When asked if they considered themselves to be tech-savvy, participants were neutral (median = 3). Participants' self-ratings of their level of tech-savviness were strongly correlated with their score on the 27-item Internet skills index (r = .7). In general, older adults in our sample enjoyed learning new computer skills (median = 4), did not typically require assistance from others when using computers (median = 2), and did not find using the Internet to be stressful (median = 2).

Defining Crowd Work

We defined the concept of crowd work to ensure a consistent understanding across participants before asking survey respondents about crowd work. The following definition appeared as part of the survey:

Crowd work is a form of online work in which workers complete small jobs, called microtasks, in return for small payments. Anyone can sign up to do crowd work. For example, a crowd worker might perform a variety of tasks on the Internet, such as labeling images, transcribing audio, or testing features of a website. Typical tasks take a few minutes to complete, and the crowd worker earns a few cents or dollars for each task, depending on the task's length and complexity. Sites that match crowd workers to available tasks are called crowdsourcing sites.

After reading the definition, we asked survey participants about their familiarity with crowd work, perceived motivation for engaging in crowd work, whether they had completed crowd work before, and for those who had done crowd work, questions about their experience.

Findings

Familiarity with Crowd Work

Even amongst an online and fairly tech-savvy group of older adults, the majority of respondents (84.8%) had never heard of crowd work. For the 77 respondents who indicated they had heard of crowd work, we asked them in a free-response item to tell us how they had learned about it. Common responses were that they knew about it because they participated in crowd work already (AMT, eLance, and Swagbucks were mentioned by several participants), from reading newspaper, magazine, or blog articles about it, from their children or friends, or from doing web searches about how to make money online or reading articles about making money (e.g., the Penny Pincher Blog).

Perceived Motivation

All respondents, regardless of their prior familiarity with crowd work, were asked to use a 5-point Likert-style scale (1 = strongly disagree, 5 = strongly agree) to rate their level of agreement with a series of statements about crowd work (Table 1). Earning money, working on something interesting/fun, or working on something stimulating/challenging (each with median = 4) were the aspects of crowd work that prompted the strongest interest among our respondents. A Friedman test showed significant differences in the median ratings across these prompts, $\chi^2(6, N=505) = 677, p < .001$. Follow-up pairwise Wilcoxon tests indicate that all pairwise differences were significant at the $p \leq .01$ level with the exception of the differences between the following five pairs: helping on a project vs. contributing to society; contributing to society vs. usability of the software; usability of the software vs. being stimulating/challenging; being stimulating/challenging vs. being interesting/fun, and being interesting/fun vs. earning money. Our survey data suggest that *personal* motivators (per Kobayashi's framework [25]) may outweigh *social* motivators for older adults using general purpose crowdsourcing platforms. However, we note the potential for

[1] Cint's recruiting standards - bit.ly/1p4uwWE

Prompt	Med	Mean
Earn money.	4	3.7 (.05)
Do something interesting or fun.	4	3.6 (.05)
Do something that's stimulating or challenging.	4	3.5 (.05)
Easily use the computer interface.	3	3.4 (.05)
Feel like I'm contributing to society.	3	3.3 (.05)
Help other people on their projects.	3	3.2 (.05)
Participate with family and friends.	3	2.8 (.05)

Table 1 - Likert-style statements beginning with "I would be interested in crowd work if I could..." completed by all 505 respondents, 1 = strongly disagree and 5 = strongly agree.

social desirability bias and over-reporting of motivating factors, particularly financial incentives [4], which we examine next through in-depth interviews.

Which Older Adults Perform Crowd Work

We asked all participants how often they perform online crowd work. The vast majority (91.3%) indicated that they had never done crowd work. Others had tried crowd work, but only 2.4% reported doing crowd work at least once per week. To further understand what sub-group of older adults were completing crowdsourcing tasks, we performed further analyses by age, education level, and Internet skill. People who had tried crowd work were younger (mean age 64.6 years) than those who had not tried it (mean age 66.9 years), $t(503) = 3.1, p = .002$. Those who had completed crowd work reported higher average education levels than those who had not. We mapped reported education levels onto an ordinal scale (0 = 12th grade or less, 5 = post-graduate degree) and observed that the mean was 3.3 for those who had tried crowd work and 2.8 for those who had not. A Mann-Whitney U test showed that this education gap was significant ($z = -2.48$, $p = .013$). Additionally, people who had tried crowd work at least once had higher Internet-skills scores (mean = 3.6) than those who had never tried it (mean = 3.0), a significant difference in skill levels according to a two-tailed independent-samples t-test ($t(503) = 3.69, p < .001$). Prior work suggests that many older adults lack the technical skills to perform crowd work [37], and our results suggest a relationship between performing crowd work and having higher levels of internet skills.

We asked the 33 participants who indicated that they had heard of crowd work but never tried it why they had never tried crowd work. Several indicated that they did not have time for crowd work, stating that they, *"Just [haven't] got around to it yet"* or *"just heard about it in the past month – have not followed through."* Many knew of the concept of crowd work, but not of specifically how they could become involved, mentioning they *"haven't seen any places where I could sign up,"* or *"don't know where to access a crowd work site."* A few expressed concern about the level of computer savvy required, responding that *"At the time it seemed beyond my capabilities."* Another concern was that there was *"too big a chance that it's phishing or otherwise fake."* Perceived trust is a factor that affects whether seniors participate in other online communities [28]. Others were concerned about the work's pay structure, stating, *"I am not sure if it is worth my while financially,"* and that it *"seems like a lot of work for very little reward or payout."* We follow up on these concerns through an interview study.

Prompt	Med	Mean
I have found crowd work to be mentally stimulating.	3	3.5 (.02)
Doing crowd work is fun.	3.5	3.4 (.02)
The money I earned doing crowd work is important to me.	3	3.4 (.02)
I feel that I am contributing meaningfully to society when I do crowd work.	3	3.2 (.02)
I have learned new skills doing crowd work.	3	3.0 (.02)
I have difficulty selecting interesting crowd work tasks to work on.	3	3.0 (.02)
Doing crowd work has provided a social outlet for me.	3	2.7 (.02)

Table 2 - Likert-style statements for 44 older adults who had tried crowd work, 1 = strongly disagree and 5 = strongly agree.

We asked the 44 participants who reported having tried crowd work at least once to estimate how much money, cumulatively, they had earned as a crowd worker. The median was $10.00 and the mean was $377.81. There was a weak Spearman's correlation between household income and frequency of performing crowd work, with those with lower incomes likely to perform crowd work more frequently (r = -0.21). We also asked these participants to indicate which of several popular crowdsourcing platforms they had worked through. AMT was the most popular service among our sample of older adults, used by 36.4% of those who had tried crowd work, followed by CrowdFlower, which was used by 22.7% of those who had tried crowd work.

Participants who had tried crowd work were asked to rate their level of agreement on a 5-point scale with a set of statements about their experiences (Table 2). The highest rated statements were that older adults found the work to be mentally stimulating, fun, and that earning money was important. A Friedman test showed significant differences in the median ratings across these prompts, $\chi^2(6, N = 44) = 35.7, p < .001$. Follow-up pairwise Wilcoxon tests indicate that the significant differences in ratings were that crowd work provided less value as a social outlet as compared to being mentally stimulating ($p = .001$), fun ($p = .003$), or an important source of money ($p = .007$). Again per Kobayashi's framework [23], this suggests that older adults who currently perform crowd work on mainstream platforms are motivated by *intrinsic-personal* (e.g., fun) and *extrinsic-personal* (e.g., money) factors rather than *social* factors.

The online survey provides an understanding of older adults' awareness of crowd work, the profile of those individuals who have completed crowd work, and motivating factors. We complement and follow-up results from our survey with in-depth interviews and observations.

OBSERVATIONAL INTERVIEWS

We conducted in-depth interviews and observations of 14 older adults to understand their initial impressions of crowd work and their motivations for doing crowd work in the future. In addition, the interviews explored older adults' values around crowd work in the context of their general computer use, and wanting to learn new skills, and volunteer their time and efforts.

Method

We recruited older adults (age 65+) living in a Midwestern U.S. city through a university database. Seniors were paid $25.00 for participating and chose whether the interviews took place in their homes or in our research lab. On average, interviews lasted 1.5 hours. Using the same definition as in the online survey, we defined the concept of crowd work for interview participants before asking them to discuss the concept of crowd work. We then asked questions of their general computer use, motivation to learn new skills, motivation to volunteer their time and efforts, and anticipated motivation to complete crowd work.

We then presented participants with three to five tasks on the popular crowdsourcing platform, Amazon Mechanical Turk (AMT). These tasks were representative of top categories of AMT tasks/HITs [21] (Table 3). The researcher presented each participant with tasks from the same AMT account to circumvent any usability issues resulting from site components that were not focused on the task (e.g., signing up and verifying accounts), which are beyond the scope of this study (prior work, however, does suggest that account creation in general is likely to be a challenge for older adults [14]). HITs were ordered by expiration dates ending latest and filtered so that only tasks that met the account's qualifications were shown. One task within each category of popular HITs was randomly selected. While participants did not all complete the exact same HIT, this slight variation among the exact details of HITs of the same general task type is more representative of completing HITs "in-the-wild" and a tradeoff we made to enhance external validity (rather than using canned HITs created by an account we control, for instance). For example, to begin a task within the "transcribing" category, the researcher searched the keyword "transcribe" within AMT. A random HIT within the results list was then selected for the older adult to complete. The task types include: transcription, content generation, content summarization, object classification, and website feedback. Participants could choose to abandon tasks.

We anticipated that the set of five microtasks would take approximately 30-35 minutes to complete, but the tasks actually took 45-60 minutes to complete. Therefore each participant was asked to complete three to five HITs depending on the time left in the interview. Participants were instructed to think aloud while completing the tasks and to talk through their thought processes, likes, dislikes, or any questions they had. When they asked for help, the interviewer encouraged them to complete the tasks on their own yet some guidance was given in extreme situations (e.g., accidentally closing the task window or being unable to navigate back to the task window). Of the 61 tasks attempted, 23 were submitted (4 tasks expired). On average, participants attempted 4 tasks and completed only 1 task, a much lower completion rate than reported in previous studies using crowdsourcing interfaces customized for older adults [25]. This suggests that there are significant obstacles to older adults completing crowd work on a mainstream platform like AMT, which we describe below.

Task Type	Understand	Enjoy	Try Again
Transcription	2.5	2.21	1.92
Content Generation	2.38	2.15	2.15
Content Summ.	2.76	2.15	2.46
Object Classification	2.72	2.18	1.90
Site Feedback	1.85	2.14	1.85

Table 3 – Mean ratings of Likert-style statements for task understandability, enjoyment, and willingness to try again (5-point scale; 1=strong disagreement, 5=strong agreement).

After attempting each task, participants were asked to rate their level of task understanding, enjoyment, and likelihood to complete the task on their own in the future using a 5-point Likert scale (1=very hard/very unenjoyable/very unlikely, 5 = very easy/very enjoyable/very likely). After the interviews, all participants completed a brief questionnaire, which included Hargittai's measures of web skill [17] and basic demographic questions. All interviews were video recorded and transcribed. Multiple researchers reviewed and coded transcripts through an initial process of open coding [7]. Categories such as 'unclear instructions' and 'being motivated by cognitive benefit' were further refined through axial coding and grouped as 'challenges' or 'motivations'. We discuss these themes in detail below.

Profile of Participants

Fourteen older adults participated in the interviews (9 females, M = 79 years old, SD = 5.4). Participants had used the Internet for more than 15 years (n=12), 7 years (n=1), and 4 years (n=1). The average Internet skill score was 2.82 (median = 2.92). All participants responded that they were comfortable using computers, and when asked to self-rate their level of familiarity with the Internet, all considered themselves to be intermediate users (on a three-point scale of beginner, intermediate, and advanced). No participants had completed crowd work before. Similar to our survey sample, participants had varied educational levels (post-graduate

degree, n=4; Bachelor's degree, n=6; some college, n=3; some grade school, n=1). Their annual income ranged from under $25,000 to at least $125,000.

Findings

Task Preferences and Challenges of Completing HITS

Prior work surveys older adults' preferences for completing various task types (without having them perform the tasks) and suggests a preference towards transcription, editing, proofreading and captioning tasks, although these tasks were framed around helping people with disabilities [37]. After completing various tasks in our study, older adults rated transcription tasks as most enjoyable and content summarization tasks as easiest to understand, although all tasks received neutral to negative ratings on these dimensions (see Table 3). Of the five types of tasks that participants were given, the website feedback tasks were perceived to be most difficult to understand. Content generation tasks were least enjoyable. Participants said they would be least likely to try website feedback and object classification tasks again on their own.

As with younger populations, designing tasks with clear instructions and explanations of what is expected is important for both the workers' experience and the results provided to requesters [41]. While this is particularly important for workers completing complex data analysis tasks, as reported in [41], our findings reveal that many common tasks on AMT present unclear instructions, unfamiliar terminology, and difficulties in navigating the workflow for older adults. P6 said, "*I can't relate their instructions to anything that's happening.*" P8 commented, "*This is confusing to me 'cause I don't know what all these stupid things mean."* Even after reading the instructions, P7 said *"I don't even know what–how to get started.*" Some participants viewed the complex and unfamiliar language of task instructions as symptomatic of their broader experience using computers. P3 explained, "*That's my complaint to my daughter, I said, 'they use language on computers but…what I think it means is not necessarily what computer people mean.'*" Many participants were confused by unfamiliar terms and phrases. While completing one task, P8 said, "*It just says, 'Extract purchased items from a shopping receipt'. So, if they–I'm not sure what they're trying to do."* Terms such as "URL" and "transcribe" were also challenging, with P2 saying, "*I didn't know what URL meant, if it was link I would've known what link was.*" Similarly, P4 asked, "*It says transcribe this recipe but what does that mean?*" The instructions were either too detailed, leaving seniors frustrated (some of whom then skipped the instructions), or not explained clearly enough. P1 likened his frustration with task instructions to negative interactions with automated support services: "*The feeling I got looking at that task was the feeling I get when I have to deal with customer support.*"

In addition, tasks may ask the worker to take a survey and present an unlinked URL that the worker would have to copy and paste to a new tab or window to open. However, many participants were not familiar or comfortable with opening content in new tabs/windows, resulting in questions such as, "*How do I get back to the instructions?*" (P7) after a new tab was opened. Also, participants often forgot the instructions immediately upon opening the new window, particularly long and detailed instructions. P3 explained:

"*There's too many things to remember all at once. I mean, you don't–you can't read all these instructions and process it! I wouldn't remember them. I'd have to go back. I would never be able to remember all that… One of my complaints about some things on a computer is that, you know, if there's a bunch of instructions or stuff to know–and you have to open up a box and then if you go back to what you're working on the box is gone, and you can't just look up and reference it.*"

The current workflow and instruction format may be particularly problematic for older adults experiencing normal, age-related changes in short-term memory [12]. Beyond this, participants also faced difficulties completing tasks due to the level of computing skills required to use the AMT interface. For example, P3 explained, "*…they keep giving you these screens and you just take this information and put it over there. And I'm also not very good at typing, so I'm slow. So, that makes it even more boring.*" These challenges may be related to normal age-related changes in working memory and psychomotor skills [12,38], further complicating the experience for older adults. Additionally, playing audio required for a transcription task presented challenges for older adults. P2 needed to transcribe audio by playing an audio file and then typing the text. However, the audio management tool provided symbols (e.g., play, pause, stop) and no text to describe what the symbols represented. The unfamiliar and inaccessible nature of these additional controls embedded in tasks presented further difficulties and frustrations for older adults.

These barriers, which may seem trivial from a requester's perspective, *significantly* affected older adults' abilities and time required to complete the tasks. And, because of these barriers, some tasks expired or ran out of time before the older adult was able to complete them. These challenges also affected older adults' self-efficacy, with P7 saying, "*I just think I'm not smart enough to do it", "I just didn't understand anything they were telling me to do… I'm a complete failure*," and "*I don't even understand the instructions. Is everybody else that does this as dumb as I am?*" Although researchers expressed that participants were not being "tested", P5 seemed frustrated, and said, "*I can see I'm flunking this*" and "*I don't like to be defeated.*"

As part of their perceived self-efficacy, older adults tended to view crowd work as designed for other people. P5 said crowd work is designed for "*…somebody else, probably not for me. …I think probably for young people who just spend all their time skulking around on the Internet, you know?*" This perception is attributed to the numerous challenges older adults encountered while completing each task, and several participants viewed crowd work as most appropriate

for younger people or people with more formal and extensive computer training.

As a strategy for overcoming these barriers, participants wanted examples of the tasks being completed. P5 said, "*I would have to see something that I could study and read.*" This quote highlights not only the need for an example or guide but also ample time for processing the task before beginning, both of which are important to older adults. Because there were no examples of how to complete the tasks, participants were not sure if they had successfully submitted a HIT. Often, they would ask the researcher if they had finished a task. This led one participant to question the accuracy and quality of responses, which is a common concern in the field [23]:

"*I think there's somebody who wants to collect a lot of answers, and they've constructed a task, and they don't really, it seems to me, care whether they get good information or not.*" (P1)

Motivations for Completing Crowd Work

After completing the HITs, we discussed with participants what, if anything, would motivate them to complete crowd work tasks. While prior work [20,31,43] and our own survey data suggest that financial incentives are important, our interview participants said they would not be motivated by the current compensation structure of AMT tasks.

"*I certainly don't need the money, that little amount of money. No, I don't think I ever would…*" (P1)

"*Do this for two hours and get paid less than five cents? Why would anybody do this?*" (P4)

We suspect their dismissal of existing financial incentives is related to the high level of frustration they experienced while completing tasks in this session. However, older adults did discuss other factors that may lead them to complete crowd work, such as working on problems with social impact, topics related to their interests, and if there was cognitive benefit to a task.

Twelve of fourteen participants mentioned they would be more likely to complete crowd work if it related to important social issues, echoing prior findings on the importance of making a social contribution [2] as an *intrinsic-social* motivator [25,26]. Specific motivating causes noted by participants include Alzheimer's research, educational policy, and homelessness. Out of the fourteen participants, twelve said they would want the tasks to be more closely related to their hobbies and skills (e.g., word puzzles, watching genetics videos, helping categorize biking trails). Two participants commented that they would like to choose the tasks they complete. For example, P1 said, "*it would be nice if the task fitted my knowledge base and my capabilities."* This further highlights the importance of *intrinsic-personal* (e.g., skill fit) and *extrinsic-personal* (e.g., personal interest) motivators for older crowd workers.

The challenge of completing the tasks intrigued a few participants P7 said, "*It makes you think, and thinking is always good. But I think my thinker is broken today."* Similarly, P8 said, "*Well, I enjoy a challenge and trying to figure things out.*" Many participants said they would be want to be crowd workers if the tasks provided some cognitive benefit, echoing that "human capital advancement" [27] may be an effective motivator. Being mentally stimulated, particularly with respect to improving memory, was of interest to seven participants, including two participants who actively completed cognitive training tasks online through "brain games" on Lumosity.com.

Crowd Work as Volunteerism and Civic Engagement

Prior work [26] suggests that older adults may be particularly motivated by socially-oriented crowd work, and to better understand this, we opened up a discussion about their values around volunteerism and civic engagement. We asked participants to describe their current volunteer efforts and why they decided to get involved. Examples of their current volunteer work include caring for dogs and cats at animal shelters, helping as theater ushers, and being tour guides for visitors to their city. Similar to previous research [18], the main reason for volunteering was a close alignment between the volunteer opportunity and their interests. Other motivations to volunteer included being able to use certain skills or prior knowledge, learn a new skill, and identifying with the organization's mission. Participants said they were motivated to learn new skills related to their interests, skills or activities recommended by friends, and wanting to learn something challenging. Further, choosing opportunities that were meaningful to society was an important factor as was being able to help friends or causes that friends support. Hence, older adults' reasons for volunteering are more complex and span *intrinsic* and *extrinsic* factors that are both *social* (e.g., benefiting friends, supporting a cause) and *personal* (e.g., skill fit, hobbies, learning). This suggests that future volunteer-based crowd work platforms for older adults may be most successful if they adopt a holistic view and create experiences that integrate personal and social factors.

We also learned that older adults desire volunteer positions with flexible time commitments, which is a key benefit of online work. The time commitment required of certain volunteer positions was a deterrent for some older adults. P5 said, "*They want a specific commitment like a six month commitment, specific days every–and it's too constraining for me–after working over sixty years.*" In addition, P9 said she would not volunteer for "*anything that requires me to be at a given place every week, I wouldn't do that. I like the flexibility.*" Five participants reported that they chose not to volunteer due to too large of a time commitment. Others said that an organization's reputation of not appreciating their volunteers would cause them to refrain from helping, citing the importance of receiving feedback from their work as an *extrinsic-social* motivator:

"*Right, well, the [local history museum] has a reputation of sort of ignoring their volunteers, treating them not as good. That's recent. But I would hesitate to volunteer at the [local history museum] because the stories I hear from other volunteers there.*" (P6)

Additional reasons for not volunteering include health limitations, inconvenient locations, and the tasks being uninteresting. Framing crowd work tasks around volunteerism and civic engagement (such as in Brady et al.'s "social microvolunteering" paradigm [5]) may be a useful way to engage older adults, particularly if these tasks leverage older adults' existing skills and interests.

Seeking Meaningful Participation

While participants discussed many factors that may motivate their participation in crowd work, the most significant barrier (based on their experience with AMT) was that the benefits of completing tasks were not well articulated. That is, participants did not understand what their time and effort contributed towards nor the personal or social payoff of their actions. P6 commented, "*Yeah, I couldn't see an object[ive] behind any of these... it seemed like a silly thing to do,*" while P3 stated, "*I would have to be motivated to find value in what the big thing was.*" Understanding the broader impact and meaning of activities is particularly important to seniors:

"*As you get older, it's more difficult to search for meaningful things to do… Your task of social importance and such, that's meaningful stuff… We all look for something like that, and that's worth getting confused about."* (P6)

Similarly, not understanding the significance of crowd work tasks led to disinterest and lack of motivation:

"*…A motivation for doing a task like this has to be some degree of interest. I had absolutely no interest in any of these, um, things that they asked me to do. God, this reminds me of kids who just go bloomp, bloomp, bloomp, bloomp on standardized tests because they find they're completely not relevant."* (P4)

Because of their disinterest, some participants even answered the tasks inaccurately just to complete the HIT. For example, P11 said she "*would try to make something up just to humor somebody.*"

While specialized crowdsourcing platforms have been successful for older adults, much work is needed before we can expect broader participation of older adults in existing online labor markets. Making clear the purpose of crowd work along with framing tasks around personal and social motivators that resonate with older adults is critical. Beyond these issues, the design of existing platforms (e.g., AMT) presents significant accessibility barriers for older adults who may experience normal age-related changes in short-term memory, working memory, and psychomotor skills required to successfully participate in online work.

DISCUSSION

Results from our mixed-methods approach extend prior work in this space [25,26,37,45] while further highlighting the needs, challenges, and motivations of older adults in order to ensure more equitable participation in online labor markets. Our findings indicate that most seniors have never heard of or tried crowd work. After given the opportunity to try crowd work, seniors report not being motivated by current crowd work financial incentives, particularly given significant accessibility challenges of AMT. And, older adults perceive crowd work to be for younger people and people with more formal computer training and knowledge. Indeed, our survey data confirm that even among online older adults, those who have tried crowd work are (relatively) younger and more tech savvy than those who have not. In this section, we revisit our initial research questions and discuss the implications of our findings for designers of crowd work tasks and platforms.

RQ1: Seniors are Unaware of Crowdsourcing

Despite relatively high levels of computer knowledge and Internet access among survey respondents, only 15.2% had heard of crowd work, and only 8.7% had tried it at least once (with 2.4% doing it at least weekly). Increased outreach by crowdsourcing platforms, perhaps by advertising in venues and media catering to older adults (including offline venues), seems like a logical step for including this large, untapped talent pool. Utilizing crowds of older adults would not only benefit the requesters with larger worker pools, but may also help older adults stay engaged in society and contribute to their overall well-being [16,32]. Also, prior work suggests that seniors will adopt a new technology if it provides them with direct benefit [10]. Thus, it is important to make the benefits of participating in online work salient to this group.

RQ2: More Challenge, Cognitive Benefit, and Societal Importance

As has been previously reported with younger workers [20,30], our survey data suggest that older adults are motivated by paid tasks that are fun or interesting. However, after interviewing older adults trying crowd work for the first time during our observation session, we find that not only did seniors think the amount of money being paid was insufficient for the time and effort needed to complete the tasks, but that money is not the primary motivating factor. We expand upon prior work by explaining why money did not motivate older adults. Financial incentives may have seemed more important in prior work and in our survey because of 1) sampling issues since the people who signed up were already volunteering for a paid survey and therefore might place more importance on earning small amounts of money and 2) people's abilities to accurately self-report on potential motivations – most of our survey respondents had not done crowd work and were speculating about what might motivate them based on our description of crowd work. Further, the seniors in our study took far longer than we anticipated would be necessary to complete microtasks, thus effectively making their hourly wage for HITs even lower

than for a typical worker, perhaps further reducing the efficacy of current financial incentives.

Prior work has indicated that a focus on extrinsic incentives (e.g., money) may diminish intrinsic motivation (e.g., positively contributing towards societal problems) [33,36]. Rebalancing intrinsic and extrinsic rewards on commercial sites such as AMT may help diversify the worker pool. We discuss our results using Kobayashi et al.'s motivational framework for crowd work tasks because it is the only study focused on older adults completing crowdwork tasks [25]. While Kobayashi et. al.'s study focuses on a specific type of crowdwork task and a social incentive structure, we use their framework to discuss the particular ways in which these factors resonate with older adults in the context of mainstream crowd work. One key finding in our study is regarding cognitive skill development as a motivator to complete crowd work. While concerns have been raised about the menial nature of some tasks [24], existing older adult crowd workers from the survey said they have found the experience to be mentally stimulating, and the ability to perform stimulating or challenging tasks may encourage other seniors to participate. This was validated in the interviews in which several older adults said they would be more motivated to complete the tasks if provided with some sort of cognitive benefit. Cognitive "brain games" [15] are small tasks of a size and scope similar to crowd work tasks (e.g., matching names and faces) and are designed to be engaging and fun. The similarities between crowd work and cognitive "brain games" make developing microtasks that are structured in a manner that may aid cognitive training an interesting avenue for future exploration involving older adults. However, cognitive training is not accounted for by the motivational framework in Kobayashi et al.'s prior work. It somewhat aligns with the *extrinsic-personal* category of "human capital advancement," but cognitive benefit also has health advantages (i.e., building "cognitive reserve" that may delay the onset of dementia [15]), a consideration not accounted for in the current framework. Therefore, our analysis suggests extending Kobayashi et al.'s motivational framework [25] to include a "Personal Well-Being" category, which would fit in their *extrinsic-personal* quadrant. We define this category as maintaining or improving aspects of mental, and/or emotional well-being.

Further, many older adults use online technology to achieve social goals of staying in touch with family members and friends [19,29,32]. Yet, crowd work communities do not seem to provide a strong social outlet for older adults according to our survey results, and crowd work as currently structured on major platforms may not be a context in which older adults would be highly motivated by social interaction. Given the potential for social desirability bias [4] and older adults' positive attitudes towards volunteering [14], we expected factors such as contributing to society and helping others to be rated more favorably among older adults, yet these social factors were among the lowest-rated items on our survey. After completing crowd work tasks in the interviews, seniors unanimously cited social factors as a reason why they would be interested in being crowd workers. These contradictory findings suggest a more complex picture of what may motivate older adults to perform crowd work. While older adults appear less motivated by traditional crowd work tasks, our data suggest they would be motivated by citizen science microtasks and social microvolunteering [5], particularly if they are related to their interests and fit with their existing skills. Additionally, clearer explanations of how current microtasks may benefit a "big picture" task may also help in making AMT-style microtasks more appealing to this group.

RQ3: Clarify Goals, Instructions, Guidance, Timing

In our study, older adults did not understand the goal of the task they were completing and how it would help someone accomplish a larger problem, and this was partially due to the wording of the instructions. This is not a problem specific to seniors, but has also been described in other crowdsourcing literature [24]. While there are proven benefits to being transparent in the meaningfulness of crowd work tasks [6,24,34], all older adults complained this was still a problem. Therefore, it is worth re-emphasizing that crowd work requesters on platforms such as AMT should make the goals and outcome of the work clearer if they aim to motivate seniors to complete tasks.

Additionally, the instructions should be written without assuming the abilities of the audience. Prior work suggests that older adults want instructions [25] yet similar to reading levels assigned to text, crowd work tasks may need to be vetted for appropriate wording (using jargon dictionaries, reading level analyzers, etc.) before being published for workers to complete them. Technical tools and terminology used in tasks could be matched against Hargittai's Internet skills index [17] to create an estimate of the level of Internet skill required for a task (and workers could complete the index when registering, allowing for automatic filtering of tasks based on their Internet skill level). Instruction creation could even be crowdsourced with diverse audiences, including seniors, testing for vocabulary level, technical jargon, etc. Shorter instructions or ways to display instructions adjacent to task data and input windows may help compensate for the challenges in short term memory that many seniors face. Better guidance could also come in the form of examples. Examples may be difficult to create, yet may be well worth the investment for large batch tasks (the example creation could itself be crowdsourced). Even with more accessible instructions and examples, embedding Q&A within the tasks could provide real-time feedback to people completing the tasks, inspired by [9,26].

Zyskowski et al. [45] found that many workers with disabilities experienced challenges with the short task times built into many HITs to thwart spammers and "lazy" workers. Similarly, we found that the time limits on tasks were problematic for many seniors. Many factors may influence seniors' inability to complete tasks within current

time allocations, including slower cognitive processing speeds, slower physical reaction times, and less experience going online. Enabling more flexibility in task times, and providing more accurate estimates for workers of how long a task is likely to take (perhaps based on their performance on past tasks or on an assessment given during account creation or even on demographic information from an account profile) would be particularly important for enabling older adults' success at crowd work.

Broadening Participation on Crowd Work Platforms

Given the above findings, there may need to be more significant changes made to crowd work platforms for them to be more inclusive to other user groups, such as seniors. Due to the difficulty of completing tasks on a computer, perhaps another medium may be easier to use (e.g., by voice over the phone) or they may find tasks less frustrating if they could complete them in tandem with another crowd worker (e.g., [26]). Older adults frequently turn to their younger family members for assistance with technology [10]. Future work could explore augmenting the crowd work experience through video chat [3,42] or real-time assistance from family or friends, which could benefit other novice users. This could provide new opportunities for social interaction for older adults, which prior work has shown to be important [10,11]. Support systems are already available for crowd work platforms in the form of external forums and message boards [30], but such support may need to be embedded into the sites themselves so that groups of workers can synchronously participate in completing or communicating about tasks. Seniors also expressed an interest in identifying volunteer opportunities based on friends' interests and participation – tighter integration of crowd platforms with social tools may be valuable, so that seniors have visibility into which task types or requestors their friends have also engaged with.

In addition to social incentives, seniors said they would be more motivated to complete microtasks if they provided cognitive benefits. Older adults specifically wanted to improve their memory. Crowd work tasks could be designed to challenge individuals similar to brain games and could be beneficial to other populations seeking cognitive stimulation. Advertising what areas of cognition a task supports might help requestors attract workers as an alternative incentive to financial rewards; manually or automatically-generated metadata about the areas of cognition (or other types of education or skill acquisition) that a task provides could be useful for filtering tasks or automatically matching them to workers. Alternatively, tasks could provide enhanced support for normal age-related memory loss, and prior work shows that modifying tasks to be less reliant on working memory results in better accuracy and performance [1].

Limitations and Future Work

Our survey focuses on older adults who are active online and already seeking out paid work (e.g., through an online survey). We acknowledge that this excludes many seniors who may be interested in online work but do not have the means or ability to go online independently. Our work is also focused on workers in the U.S., and reasons for completing crowdwork tasks in other cultures may differ. Further, the two studies we present focus on the lived experiences and values of older adults and do not compare their motivations to those of younger crowd workers. It is possible that our findings may be applicable to a broader group of people (e.g., younger people [13,20,35]) who do not perform crowd work and face similar challenges that we raise in this paper (e.g. limited computer skill, non-aging-related disabilities [45]). We encourage researchers to conduct future studies to understand how these findings may apply to other user groups. The contribution of this paper lies in describing a unique point of view – older adults' challenges and experiences completing a variety of mainstream crowd work tasks – which has not been considered previously and is critical to challenging our assumptions of the design of crowd work platforms and ensuring equitable representation in online labor markets.

Additionally, our interview participants consist of novice crowd workers, which helps understand initial perceptions and challenges in performing crowd work. We did not intentionally recruit participants who had not completed crowd work. Rather, such a small percentage of the older adult population had completed crowd work or was aware of the term (as evidenced by the survey results), that recruiting experienced older crowd workers for in-person interviews was a significant challenge.

Finally, it may be argued that the interface challenges raised in this paper may not be problems with practice, yet these are issues of accessibility that will only become worse for users as they age. Further, these initial challenges were significant and seniors may not be motivated to return to crowdsourcing sites with such negative initial experiences. Subsequent studies that examine the types of tools and experiences needed for other groups of older adults to successfully engage in online work can help ensure equitable representation of people of all ages and abilities in this growing labor market.

CONCLUSION

Broadening participation in emerging forms of digital labor is important both for harnessing untapped pools of manpower and talent, as well as for ensuring that crowdsourcing platforms evolve in ways that are just, beneficial, and accessible to all parties [24,45]. Prior studies of crowd workers [13,20,35] indicate that older adults are extremely underrepresented. This paper presents the first formal investigation into older adults' attitudes toward mainstream crowd work and calls attention to the lack of awareness even tech-savvy seniors have about crowd work. We provide concrete suggestions to help general purpose crowdsourcing platforms better reach out to older adults by attending to accessibility barriers that may prevent participation as well as incentives (e.g., personal well-being) that may better engage this group in crowd work.

REFERENCES

1. Harini Alagarai Sampath, Rajeev Rajeshuni, and Bipin Indurkhya. 2014. Cognitively inspired task design to improve user performance on crowdsourcing platforms. *Proceedings of the 32nd annual ACM conference on Human factors in computing systems - CHI '14*, ACM Press, 3665–3674. http://doi.org/10.1145/2556288.2557155
2. Sultana Lubna Alam and John Campbell. 2012. Crowdsourcing Motivations in a not-for-profit GLAM context: The Australian Newspapers Digitisation Program. *Location, location, location: 23rd Australasian Conference on Information Systems*, 1–11.
3. Morgan G Ames, Janet Go, Joseph "Jofish" Kaye, and Mirjana Spasojevic. 2010. Making love in the network closet: the benefits and work of family videochat. *Proceedings of the 2010 ACM conference on Computer supported cooperative work*, ACM, 145–154. http://doi.org/10.1145/1718918.1718946
4. Judd Antin and Aaron Shaw. 2012. Social desirability bias and self-reports of motivation: a study of Amazon Mechanical Turk in the US and India. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 2012*. http://doi.org/10.1145/2207676.2208699
5. Erin Brady, Meredith Ringel Morris, and Jeffrey P. Bigham. 2015. Gauging Receptiveness to Social Microvolunteering. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, ACM Press, 1055–1064. http://doi.org/10.1145/2702123.2702329
6. Dana Chandler and Adam Kapelner. 2013. Breaking monotony with meaning: Motivation in crowdsourcing markets. *Journal of Economic Behavior and Organization* 90, 123–133. http://doi.org/10.1016/j.jebo.2013.03.003
7. Kathy Charmaz. 2000. Grounded theory: Objectivist and constructivist methods. In *The Handbook of Qualitative Research*. 509–535. Retrieved from http://books.google.com/books?id=erLspquhd5MC
8. Stephanie Chen. 2010. No retirement for these older folks, just work. *CNN*. Retrieved from http://www.cnn.com/2010/LIVING/09/07/older.workers.100s.90s/index.html
9. Parmit K Chilana, Andrew J Ko, and Jacob O Wobbrock. 2012. LemonAid : Selection-Based Crowdsourced Contextual Help for Web Applications. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 2012*, 1549–1558. http://doi.org/10.1145/2207676.2208620
10. Graeme W Coleman, Lorna Gibson, Vicki L Hanson, Ania Bobrowicz, and Alison McKay. 2010. Engaging the disengaged. *Proceedings of the 8th ACM Conference on Designing Interactive Systems 2010*, ACM Press, 175–178. http://doi.org/10.1145/1858171.1858202
11. Erin York Cornwell and Linda J Waite. 2009. Social Disconnectedness, Perceived Isolation, and Health among Older Adults. *Journal of Health and Social Behavior* 50, 1, 31–48. http://doi.org/10.1177/002214650905000103
12. Fergus I. M. Craik. 1994. Memory Changes in Normal Aging. *Current Directions in Psychological Science 3*, 155–158. http://doi.org/10.1111/1467-8721.ep10770653
13. CrowdFlower. 2014. *Crowd Demographics*. Retrieved from https://success.crowdflower.com/hc/en-us/articles/202703345-Contributors-Crowd-Demographics
14. Anna Dickinson, Alan F. Newell, Michael J. Smith, and Robin L. Hill. 2005. Introducing the Internet to the over-60s: Developing an email system for older novice computer users. *Interacting with Computers* 17, 6, 621–642. http://doi.org/10.1016/j.intcom.2005.09.003
15. Alvaro Fernandez and Goldberk Elkhonon. 2009. *The SharpBrains Guide to Brain Fitness*.
16. Thomas A Glass, Carlos Mendes de Leon, Richard A Marottoli, and Lisa F Berkman. 1999. Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ (Clinical research ed.)* 319, 478–483.
17. Eszter Hargittai. 2009. An Update on Survey Measures of Web-Oriented Digital Literacy. *Social Science Computer Review* 27, 1, 130–137.
18. Dave Harley, Kate Howland, Eric Harris, and Cara Redlich. 2014. Online communities for older users: what can we learn from local community interactions to create social sites that work for older people. *Proceedings of the 28th International BCS Human Computer Interaction Conference on HCI*, 42–51. http://doi.org/10.14236/ewic/hci2014.5
19. Alexis Hope, Ted Schwaba, and Anne Marie Piper. 2014. Understanding digital and material social communications for older adults. *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*, ACM Press, 3903–3912. http://doi.org/10.1145/2556288.2557133
20. Panos Ipeirotis. 2010. Demographics of Mechanical Turk. *Working Paper CeDER-10-01*. http://doi.org/10.2139/ssrn.1585030
21. Panos Ipeirotis. 2010. Analyzing the Amazon Mechanical Turk marketplace. *XRDS: Crossroads, The*

ACM Magazine for Students 17, 2, 16. http://doi.org/10.1145/1869086.1869094

22. Susan E. Jackson and Aparna Joshi. 2004. Diversity in social context: A multi-attribute, multilevel analysis of team diversity and sales performance. *Journal of Organizational Behavior* 25, 675–702. http://doi.org/10.1002/job.265
23. Aniket Kittur, Ed H. Chi, and Bongwon Suh. 2008. Crowdsourcing user studies with Mechanical Turk. *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*, 453. http://doi.org/10.1145/1357054.1357127
24. Aniket Kittur, Jeffrey V. Nickerson, Michael Bernstein, et al. 2013. The future of crowd work. *Proceedings of the 2013 conference on Computer supported cooperative work - CSCW '13*, 1301. http://doi.org/10.1145/2441776.2441923
25. Masatomo Kobayashi, Shoma Arita, Toshinari Itoko, Shin Saito, and Hironobu Takagi. 2015. Motivating Multi-Generational Crowd Workers in Social-Purpose Work. *Proc. of CSCW '15*, 1813–1824. http://doi.org/10.1145/2675133.2675255
26. Masatomo Kobayashi, Tatsuya Ishihara, and Toshinari Itoko. 2013. Age-Based Task Specialization for Crowdsourced Proofreading. *HCII*, 104–112.
27. Karim Lakhani and Robert G Wolf. 2003. Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects. *Social Science Research Network* 49, September, 1–27. http://doi.org/10.2139/ssrn.443040
28. Vilma Lehtinen, J Nasanen, and Risto Sarvas. 2009. "A little silly and empty-headed": older adults' understandings of social networking sites. *BCS-HCI*, British Computer Society, 45–54. Retrieved from http://portal.acm.org/citation.cfm?id=1671011.1671017
29. Siân E Lindley, Richard Harper, and Abigail Sellen. 2009. Desiring to be in touch in a changing communications landscape. *Proceedings of the 27th international conference on Human factors in computing systems - CHI 09*, ACM Press, 1693. http://doi.org/10.1145/1518701.1518962
30. David Martin, Benjamin V Hanrahan, Jacki O'Neill, and Neha Gupta. 2014. Being a turker. *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing - CSCW '14*, 224–235. http://doi.org/10.1145/2531602.2531663
31. Winter Mason and Duncan J. Watts. 2010. Financial incentives and the "performance of crowds." *ACM SIGKDD Explorations Newsletter 11*, 100. http://doi.org/10.1145/1809400.1809422
32. Nancy Morrow-Howell, Jim Hinterlong, Philip A Rozario, and Fengyan Tang. 2003. Effects of volunteering on the well-being of older adults. *The journals of gerontology. Series B, Psychological sciences and social sciences* 58, 3, S137–45. http://doi.org/10.2307/3090173.2001-10009-00110.2307/3090173\r10.1093/geronb/58.3.S137
33. Daniel H. Pink. 2009. *Drive: The surprising truth about what motivates us*. http://doi.org/10.1002/casp
34. Jakob Rogstadius, Vassilis Kostakos, Aniket Kittur, Boris Smus, Jim Laredo, and Maja Vukovic. 2011. An Assessment of Intrinsic and Extrinsic Motivation on Task Performance in Crowdsourcing Markets. *Fifth International AAAI Conference on Weblogs and Social Media*, 321–328.
35. Joel Ross, Lilly Irani, and M Silberman. 2010. Who are the crowdworkers?: shifting demographics in mechanical turk. *CHI'10 Extended …*. Retrieved August 18, 2014 from http://dl.acm.org/citation.cfm?id=1753873
36. Richard M Ryan and Edward L Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American psychologist* 55, 68–78. http://doi.org/10.1037/0003-066X.55.1.68
37. Shin Saito, Toshihiro Watanabe, Masatomo Kobayashi, and Hironobu Takagi. 2014. Skill Development Framework for Micro-Tasking. *HCII*, 400–409.
38. K W Schaie. 1996. *Intellectual Development in Adulthood: The Seattle Longitudinal Study*. Cambridge University Press, Cambridge.
39. Aaron Smith. 2014. *Older Adults and Technology Use*. Retrieved from http://pewrsr.ch/1mMIyvW
40. Warren E. Watson, Kamalesh. Kumar, and Larry K. Michaelsen. 1993. Cultural Diversity's Impact on Interaction Process and Performance: Comparing Homogeneous and Diverse Task Groups. *Academy of Management Journal 36*, 590–602. http://doi.org/10.2307/256593
41. Wesley Willett, Jeffrey Heer, and Maneesh Agrawala. 2012. Strategies for crowdsourcing social data analysis. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 227–236. http://doi.org/10.1145/2207676.2207709
42. Svetlana Yarosh, Kori M Inkpen, and A.J. Bernheim Brush. 2010. Video playdate. *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*, 1251. http://doi.org/10.1145/1753326.1753514
43. Lixiu Yu, Paul André, Aniket Kittur, and Robert Kraut. 2014. A comparison of social, learning, and financial

strategies on crowd engagement and output quality. *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing - CSCW '14*, 967–978. http://doi.org/10.1145/2531602.2531729

44. Katheryn Zickuhr and Mary Madden. 2012. Older Adults and Internet Use. Retrieved from http://pewinternet.org/Reports/2012/Older-adults-and-internet-use.aspx

45. Kathryn Zyskowski, Meredith Ringel Morris, Jeffrey P Bigham, Mary L Gray, and Shaun Kane. 2015. Accessible Crowdwork? Understanding the Value in and Challenge of Microtask Employment for People with Disabilities. *CSCW '15*, ACM – Association for Computing Machinery, 1682–1693. http://doi.org/10.1145/2675133.2675158