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Prompting technologies: A comparison of time-based and context-aware transition-based prompting

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Abstract.
BACKGROUND: While advancements in technology have encouraged the development of novel prompting systems to support cognitive interventions, little research has evaluated the best time to deliver prompts, which may impact the effectiveness of these interventions.
OBJECTIVE: This study examined whether transition-based context prompting (prompting an individual during task transitions) is more effective than traditional fixed time-based prompting.
METHODS: Participants were 42 healthy adults who completed 12 different everyday activities, each lasting 1–7 minutes, in an experimental smart home testbed and received prompts to record the completed activities from an electronic memory notebook. Half of the participants were delivered prompts during activity transitions, while the other half received prompts every 5 minutes. Participants also completed Likert-scale ratings regarding their perceptions of the prompting system.
RESULTS: Results revealed that participants in the transition-based context prompting condition responded to the first prompt more frequently and rated the system as more convenient, natural, and appropriate compared to participants in the time-based condition.
CONCLUSIONS: Our findings suggest that prompting during activity transitions produces higher adherence to the first prompt and more positive perceptions of the prompting system. This is an important finding given the benefits of prompting technology and the possibility of improving cognitive interventions by using context-aware transition prompting.

Keywords: Prompting technology, cognitive intervention, assistive technology, cognitive aids

1. Introduction

Advances in technology have fueled new opportunities for health care assistance, particularly in the field of neurorehabilitation where individuals often need reminders or prompts to assist with activity initiation and completion [1]. Research suggests that prompting technologies, that is, any form of verbal

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or non-verbal intervention delivered to the user [2], can be beneficial for individuals with cognitive impairments [3–5]. Prompting technologies can be as simple as reminders, notifications, and alerts, but also can be more complex, such as machine learning algorithms that monitor an individual's behavior and prompt during specific tasks [3,6,7]. To further development of automated prompting technologies, we evaluated the importance of prompt timing by investigating whether transition-based prompting is more effective than time-based prompting.

A fixed time-based prompting system delivers prompts based solely on a pre-specified and inflexible time, similar to how a kitchen timer or alarm clock works. Time-based prompting has been shown to be effective in promoting task engagement, task completion, and focus [8,9]. For example, individuals with intellectual disabilities became more engaged in tasks after being taught to look at instructional cards when prompted at predetermined times [10]. In addition, several studies have shown an increase in prospective memory performance after subjects with brain injuries used a paging device that delivered time-based prompts for task completion [11,12].

One limitation of time-based prompting is that it may be delivered when the user is engaged in another important task. Also, time-based prompting often requires the user to do extra work (i.e., programming a schedule). For example, Ferguson, Myles, and Hagiwara [13] found that while using a handheld computer helped a child with autism complete IADL's more independently, the device was very hard for the parents and teachers to use and also required a significant amount of user input before it was effective. A user may also become annoyed after hearing a prompt to do a task that has already been completed and problems may arise due to the dynamic nature of some daily activities. An untimely prompt can also increase cognitive load and reduce user attention to the intervention [14]. According to Seelye and colleagues [15], incorporating activity awareness into time-based prompting would address these and other similar problems. Time-based prompting with activity recognition effectively describes activity-aware prompting, a class of context-aware services.

Context-aware prompting systems use the environment and the status of a person (e.g., an individual's location) to recognize effective prompting contexts. In location-based context-aware prompting, prompts are provided based on the location of the user, often utilizing GPS technology (e.g., prompt when near a grocery store [16], prompt based on a to-do list [17]). For example, Frazer and colleagues [18] devised a system to improve GPS navigation in electric vehicles that decreased glancing at the GPS interface while driving by prompting the driver based on relevant location information. Recently, Ramanathan and colleagues [19] began exploratory research on the development of a smartphone-based system, and other studies have used the Wizard-of-Oz techniques or wireless sensor networks to develop a prompting system that improves indoor wayfinding and/or task initiation for individuals with cognitive impairments [20–22]. Similar to time-based prompting, the main limitation of location-based prompting is that the most effective time to prompt may not be dependent on the location of the user, but on the activities the user is or has been engaged in.

Context-aware systems generally use a fixed set of parameters such as time and location to identify a current situation. Not only is the parameter set typically fairly small, but the parameters are considered separately. In contrast, activity-based context-aware prompts take into account a richer state description, expressed as the user's past and current automatically-recognized activity. For example, Lancioni and colleagues [23] found improvements in reading ability when a computer sent a tactile prompt upon registering inactivity while a child with ADHD was told to read information off of a screen. Another study used a gestural recognition system to prompt individuals to complete various vocational activities, which also proved useful in increasing task success rates [24]. Several studies found that activity-based context-aware prompting helped people remember to take their medications and increased treatment adherence compared to time-based prompting [25,26]. These systems improved upon the prompting systems described previously by prompting only when the machine-learning algorithm predicted that the user might not take the medication, and using multiple methods of determining context, which included motion sensors and a wearable location sensor. Despite an improvement over classic time-based prompting methods, context-aware methods of prompting still have limitations. Most studies done using context-based prompting methods still require user intervention to make the prompting work, such as requiring user feedback, or requiring a user to input a schedule [15].

This study aims to provide prompts at times when it would be most opportune for the user to receive them, and therefore respond to them. When delivery of a prompt is based on time or location, the user may or may not be currently engaged in an activity where prompting would be inappropriate or inconvenient. To address this concern, prompting during transition periods, a period of time when the user is not engaged in an activity and may be transitioning between activities, has been suggested as an effective prompting time [14,27,28]. Instances of information overload can occur when prompts are delivered during an activity [27], and individuals typically perform better on tasks if they are only doing one activity at a time [29,30]. Additionally, interruptions during a task can increase the risk of making errors on that task [31–33]. Therefore, if prompting a user to perform an activity occurs while the user is engaged in another activity, time, number of errors and task completion of each activity may be affected.

This study assessed whether activity transition-based prompting improves use and perceptions of prompts to use a digital memory notebook compared to traditional time-based prompting. Participants completed twelve tasks of everyday living (such as cooking, cleaning, and watching television) in a smart home. While completing the tasks, participants received prompts delivered by the experimenter to record information into a digital memory notebook either every five minutes (time-based condition) or during activity transition periods (transition-based condition). At the end of the experiment, participants were asked to critique the timing of the prompts in order to evaluate the effectiveness of the prompt timing. Based on dual-task management theory, which suggests that prompting individuals during a transition period (rather than during a task) will lessen cognitive load [27], we hypothesized that transition-based prompting would result in a greater number of responses to the first prompt and greater user satisfaction compared to time-based prompts.

2. Methods

2.1. Participants

Participants were 42 undergraduate students recruited from a local university. They were randomly assigned to either the transition-based prompting condition or the time-based prompting condition. The majority of students received credit in an introductory psychology course in return for their time.

2.2. Procedure

Participants completed an hour-long testing session in a campus smart apartment. Participants were asked to complete twelve everyday tasks in a predetermined randomized order, including putting together a puzzle, dusting the living room, gathering cooking ingredients, and reading a magazine (see Table 1 for complete list). Each task took between one and seven minutes to complete. To ensure smooth activity transitions, the experimenter read the directions for the next task while the participant was still completing the previous task via an intercom system. While completing the experiment, participants

Table 1
Tasks performed by participants and their respective transition definitions

Activity	Transition start (e.g., ending of task)	Transition end (e.g., beginning of task)	Average time on task (seconds)
Dust the bottom level of the apartment	Puts the duster away	Begins to retrieve the duster	143.68 ± 81.18
Copy a recipe in the kitchen	Puts the last task item back	Begins to retrieve the first task item	248.89 ± 125.96
Pick out an interview outfit and then put it back	Puts the last item of clothing back	Begins to retrieve the first item of clothing	76.97 ± 49.80
Read a particular page in a magazine	Puts the magazine back	Begins to retrieve the magazine	210.80 ± 128.01
Gather ingredients to make spaghetti and then put them back	Puts the last task item back	Begins to retrieve the first task item	145.70 ± 50.39
Watch television in the living room	Turns the television off	Turns the television on	288.97 ± 83.49
Collect items on a list and put them in a picnic basket	Puts the last task item back	Begins to retrieve the first task item	246.00 ± 121.31
Work on a puzzle at the dining room table	Puts the puzzle away	Begins to retrieve the puzzle	325.04 ± 119.50
Sweep the kitchen	Throwing away the dirt	Begins to retrieve the broom	124.35 ± 44.71
Complete some math problems at the dining room table	Puts the pencil down and has all questions completed	Begins to retrieve the pencil and begins problems	220.18 ± 98.02
Make a bowl of oatmeal	Takes oatmeal out of microwave or puts the last task item back (whichever comes last)	Begins to retrieve first task item	206.15 ± 73.32
Play a handheld game at a chair by the door	5 minute time limit is up	Begins to retrieve the game	293.25 ± 61.41

received experimenter initiated audio prompts via an Android tablet. The prompts asked whether they would like to record the completed activities into a daily log on the tablet. If they chose to do so, participants entered the completed activities by either typing on the keyboard or using the voice-to-text system.

Participants were randomly assigned to either the time-based or transition-based prompting condition. For the time-based condition, prompts were delivered every five minutes. For the transition-based condition, prompts were delivered during each of the transition periods between activities and followed strict transition start and stop guidelines (see Table 1). Activities began once participants retrieved the first item required to perform the task at hand, and ended once the last item used to perform the current task was returned to its original position. Transition start times were marked by the participant ending their current task (e.g., the participant is done dusting and is putting away the duster). Transition stop times were defined by the participant beginning a new task (e.g., the participant picks up the magazine to start reading). Of note, there was a small variance in the number of transition-based prompts delivered between participants in the transition-based condition due to lack of clear transition points between certain tasks depending on the randomized order of the tasks. If the participant chose to disregard the original prompt, another prompt was issued one minute later. Participants received the following information about the prompts, "if it's a convenient time for you, record what activities you have completed when the memory notebook prompts you. If the memory notebook prompts you at a bad time, that's okay, it will re-prompt you in a few moments and you can respond then".

While participants were completing the tasks, the experimenter observed from a separate room, watching participant performances through live feed video and communicating through an intercom system. A number of motion sensors installed in the smart apartment were used to track the participant's movements. The experimenter used the Real-time Annotation Tool (RAT) [34] to record what the participant was doing, when activity transitions occurred, and when prompts were delivered. The RAT is a program developed to replace paper-pencil coding by using a computerized annotation system that allowed experimenters to accurately time-stamp participant's actions sequentially. Smart home sensor data and experimenter notes from the RAT were automatically stored in an SQL (Structured Query Language) database for later analysis.

2.3. *Outcome measures*

To investigate the effectiveness of time-based versus transition-based prompting we included multiple outcome measures. First, we recorded the number of times each participant used the memory notebook and how many first prompts were administered to each participant (which excluded re-prompts). Additionally, we coded whether participants responded to the first prompt, the time at which prompts were delivered, and the time at which participants responded to the prompts by writing in the memory notebook (i.e., during an activity, which meant interrupting the activity, or during a transition period). We also recorded how long it took participants to complete all twelve tasks. At the end of the experiment, we had participants complete several questions to evaluate their perceptions of the prompting system. Participants were asked whether the prompts were delivered at convenient times, whether the timing seemed natural, and whether the timing seemed appropriate. Each question was rated on a seven-point scale: strongly agree, agree, slightly agree, neutral, slightly disagree, disagree and strongly disagree, with higher ratings indicating a better system. Six participants (three in each condition) did not receive the questions due to experimenter oversight.

3. Results

3.1. *Analyses*

To test our hypotheses, a series of independent samples t-tests were performed on the outcome measures. For the main outcome measures, we also calculated Cohen's d values to examine effect sizes. General guidelines for interpreting Cohen's d effect sizes are as follows: 0.2 is a small effect size, 0.5 is a medium effect size, and 0.8 is a large effect size [35]. We began by comparing participants in each group to examine whether differences between age, education, or gender existed. To ensure that the experimental manipulation was effective, we then examined whether the transition-based condition received more prompts during transition periods compared to the time-based condition. We then conducted t-tests to determine whether there were differences between conditions in the number of prompts that yielded a response to the first prompt. T-tests also evaluated whether the conditions differed on several other variables including (a) the number of times the participant's response to the prompt interrupted the ongoing task, (b) the number of times the participant used the notebook during a transition period (a pre-determined period of time indicated in Table 1), and (c) the time in took participants to complete all

Table 2
Comparison of prompting variables in the context-aware transition condition and time-based condition

Dependent variable	Transition-based condition ($n = 21$) M (SD)	Time-based condition ($n = 21$) M (SD)	t-test	$p-$value	Cohen's d
Number of memory notebook uses	7.95 (3.38)	8.05 (2.91)	−0.10	$p = 0.92$	0.03
Number of first prompts given	10.00 (1.95)	9.52 (1.40)	0.91	$p = 0.37$	0.28
Response to first prompt	7.05 (3.34)	4.24 (2.28)**	3.19	$p = 0.001$	0.98
Task interruptions	0.67 (0.86)	2.76 (1.79)**	−4.85	$p = 0.001$	1.49
Number of uses during transitions	7.29 (3.43)	5.29 (3.00)	2.00	$p = 0.05$	0.62
Time to complete all tasks	40.13 (7.19)	45.67 (8.11)*	−2.34	$p = 0.02$	0.72

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, M = mean, *SD* = standard deviation, General guidelines for interpreting Cohen's d effect sizes are as follows: 0.2 = small effect size, 0.5 = medium effect size, and 0.8 = large effect size [35].

twelve tasks. In addition, examination of differences between conditions in perception of the prompting system was evaluated using t-tests. Finally, correlation analyses were conducted to examine associations between the prompting variables and participants' perceptions of the prompting system. Given the number of correlations conducted, the significance level was set at $p < 0.01$.

3.2. Comparing participant variables

First, we compared age, education, and gender between participants in each condition. Of note, not all participants completed the questionnaire form; therefore, we do not have data on age, education, and gender for all of our participants. Participants in the transition-based condition had an average of 12.42 years of education and those in the time-based condition had 12.47 years of education, which was not statistically significant, $t(32) = -1.16$, $p = 0.27$. Mean age of participants in the transition-based (19.88 years) and time-based (21.59 years) conditions also did not differ, $t(32) = -0.24$, $p = 0.81$. Furthermore, there were no differences between gender in the two conditions, $X^2(1, N = 32) = 0.00$, $p = 1.00$ (6 males, 11 females, and 4 unknown in each condition).

Due to variance in participant's speed of completing each of the tasks, participants did not receive an equal number of prompts. Also, participants in the transition-based condition were not always administered the same amount of prompts due to lack of clear transition points between certain tasks depending on the randomized order of the tasks. However, there was no significant difference between the number of first prompts administered to participants in the transition-based condition ($M = 10.00$, $SD = 1.95$) and the time-based condition ($M = 9.52$, $SD = 1.40$), $t(40) < 1$; therefore, we were able to use the raw scores in the data analyses. The results remained the same when the data were examined as proportion scores by adjusting for the number of prompts administered.

3.3. Comparisons of prompting responses

Participants in the transition-based condition received significantly more prompts during transition periods ($M = 9.14$, $SD = 2.31$) than participants in the time-based condition ($M = 0.70$, $SD = 0.80$), $t(40) = 15.12$, $p < 0.001$, $d = 4.89$, indicating that the experimental manipulation was effective. Overall, there were no differences between the transition-based condition ($M = 7.95$, $SD = 3.38$) and the time-based condition ($M = 8.05$, $SD = 2.91$) in the number of times that the memory notebook was used, $t(40) < 1$. As seen in Table 2, participants in the transition-based condition responded to the first prompt an average of 7.05 times, while those in the time-based condition responded an average of 4.24 times, which represented a significant difference between conditions, $t(40) = 3.19$, $p < 0.005$, $d = 0.98$. These

Table 3
Comparison of group ratings regarding the prompting system

Questions	Transition-based condition ($n = 17$) M (SD)	Time-based condition ($n = 17$) M (SD)	t-test	$p-$value	Cohen'sd
System usability					
The prompts were delivered at convenient times	6.00 (1.41)	4.06 (1.39)**	4.04	$p = 0.001$	1.39
The prompt timing seemed natural	6.35 (0.86)	4.71 (1.49)**	3.95	$p = 0.001$	1.35
The prompt timing seemed appropriate	6.24 (0.83)	4.65 (0.28)**	4.09	$p = 0.001$	2.57

Note: $^{p} < 0.05$, $^{**}p < 0.01$, M = mean, *SD* = standard deviation, General guidelines for interpreting Cohen's d effect sizes are as follows: 0.2 = small effect size, 0.5 = medium effect size, and 0.8 = large effect size [35].

findings support our main hypothesis that participants in the transition-based condition would be more likely to respond to the first prompt than those in the time-based condition.

Participants in the transition-based condition interrupted an ongoing tasks 0.67 times on average to write in the memory notebook, while participants in the time-based condition interrupted tasks 2.76 times on average, $t(40) = -4.85$, $p < 0.001$, $d = 1.49$ (see Table 2). Participants in the transition-based condition used the memory notebook an average of 7.29 times during transition periods while participants in the time-based condition used the memory notebook during transition periods an average of 5.29 times, which trended towards statistical significance, $t(40) = 2.00$, $p = 0.05$, $d = 0.62$ (Table 2). Of note, the large number of responses at the transition periods by participants in the time-based condition suggests that even though prompts were not administered during transition periods, participants preferred to wait until a transition period occurred to respond to the prompt by writing in the notebook. Finally, participants in the transition-based condition completed all of the tasks an average of 5.54 minutes quicker than participants in the time-based condition, which was statistically significant, $t(40) = -2.34$, $p = 0.02$, $d = 0.72$.

3.4. *Comparison of prompting system ratings*

We also expected that individuals in the transition-based condition would have more positive perceptions of the prompting system. As seen in Table 3, participants in the transition-based condition rated prompt timing as more convenient, $t(32) = 4.04$, $p<0.01$, $d = 1.39$, with a mean rating of 6 ("agree" that the prompt was delivered at convenient times) compared to a mean rating of 4 ("neutral" that the prompt was delivered at convenient times) for the time-based condition. Participants in the transition-based condition also rated prompt timing as more natural $t(32) = 3.95$, $p < 0.01$, $d = 1.35$, with a mean rating of 6 ("agree" that the prompt timing was natural) compared to a mean rating of 5 ("slightly agree" that the prompt timing was natural) for participants in the time-based condition. Finally, participants in the transition-based condition rated the prompt timing as more appropriate, $t(32) = 4.09$, $p < 0.01$, $d = 2.57$, with a mean rating of 6 ("agree" that the prompt timing seemed appropriate) compared to a mean rating of 5 ("slightly agree" that the prompt timing seemed appropriate) for the time-based condition.

We then examined whether individuals' perceptions of the prompting system were associated with any of the prompting variables. As seen in Table 4, individuals rated the system as more convenient when less re-prompts had to be delivered, $r(34) = -0.46$, $p < 0.01$, when they were able to respond to the first prompt more frequently, $r(34) = 0.54$, $p < 0.01$, and when they responded more frequently to prompts during transition periods, $r(34) = 0.43$, $p < 0.01$. Participants also rated the prompt timing as being more natural when less re-prompts had to be delivered, $r(34) = -0.45$, $p < 0.01$.

Table 4
Correlations between prompting variables and perceptions of system usability

Prompting variables	System usability		
	Prompting was convenient	Prompt timing was natural	Prompt timing was appropriate
Number of memory notebook uses	0.25	-0.10	0.05
Number of re-prompts given	-0.46^{**}	-0.45^{**}	-0.40
Response to first prompt	0.54^{**}	0.26	0.30
Task interruptions	-0.41	-0.36	-0.34
Number of uses during transitions	0.43^{**}	0.10	0.23
Time to complete all tasks	0.05	0.02	0.01

Note: $^{*}p < 0.05$, $^{**}p < 0.01$.

4. Discussion

Advancements in technology have encouraged the development of novel assistive technologies, which have enhanced neurorehabilitation techniques and broadened our ability to aid individuals with cognitive deficits [3–5]. However, because technologies evolve so quickly, it is often difficult to understand the various components of a particular technology and what makes it more or less efficacious. For example, although numerous prompting technologies have been employed, factors that impact the effectiveness of prompts (e.g., timing of prompts) are not yet fully understood. Thus, the purpose of this study was to examine whether transition-based prompting (i.e., prompting an individual during activity transition) is more effective than traditional time-based prompting. Participants completed 12 different IADLs in a smart home and received either time-based prompts or transition-based prompts to record information in a digital memory notebook.

Consistent with our hypothesis, participants were more likely to respond to the first prompt when in the transition-based condition, thereby requiring less re-prompting. Participants in the transition-based condition rated the prompting system as being more convenient, natural, and appropriate. This demonstrates that receiving transition-based prompting not only results in higher user responses to initial prompts, it also produces more positive perceptions of the system, which is imperative for any novel device. More positive perceptions of the system were also associated with less re-prompting and ability to respond to prompts the first time and during a transition period. Participants were also able to complete the tasks more quickly when transition-based prompts were delivered, which is likely a result of having less re-prompts and less task interruptions. These findings suggest that prompting systems should try to avoid the need to re-prompt an individual, emphasizing the advantage of transition-based prompting. Furthermore, our analyses revealed that individuals were less likely to interrupt a task to record information in the memory notebook when prompted during transition periods. The dual-task management theory proposes that individuals will be more likely to respond to prompts that do not interrupt activities because the cognitive load is lessened [27]. This may also account for the finding that participants in the time-based condition often waited for a transition period to occur to respond to a prompt, even though the prompt was administered during a task. Thus, our study suggests that a prompting system that utilizes knowledge of activity transitions will be more effective than traditional time-based reminder systems.

This is the first study to evaluate the effectiveness of prompting during activity transitions; however, the literature has investigated other types of context-aware prompting, such as location and activity context-based prompting. Location based prompting systems often utilize GPS systems to alert individual's when they are near a specific location, which can be helpful; however, they do not correct for potential problems of information overload. Activity context-based prompting is similar to transition-based prompting because it attempts to adjust for selected activity contexts such as when a person is out of the home or is sleeping. Similar to our results, many of these activity based prompting studies have concluded that context-based prompting is more effective than traditional methods [25,26]. As Lundell et al. [25] described, "a simple time-of-day rule to trigger an alarm, are not very effective because the reminder is generated whether or not it is an opportune time or place" (p. 1). In fact, we also observed that participants who were interrupted during a task were more likely to respond during transition periods or to interrupt inactive tasks (e.g., reading a magazine) compared to active tasks (e.g., making oatmeal). This highlights the importance of integrated prompting systems that take advantage of "opportune" moments. This is particularly meaningful for real-world applications because many activities will take more time than those assessed in this study, which would likely result in more delayed (and potentially forgotten) opportunities to use the memory notebook. Although our results are similar to other context-based studies, our system defines this "opportune" time as a period of activity transition, rather than inactivity or engagement in a more docile task or location. Therefore, future studies would benefit from comparing and/or integrating these different types of context-aware prompting systems in order to develop the most effective system. Future studies will also be needed to demonstrate that these findings will generalize to cognitively impaired populations.

To experimentally test the effects of time-based and transition-based prompting in the laboratory, we had to set up a design that resulted in the administration of nearly 10 prompts within a one-hour time period. This is different from the frequency of prompting that would be expected in the real world environment and may limit generalization. In addition, some of the activities in this study took only a brief amount of time to complete such that the time between activity completion and the time-based prompt may have been significantly delayed. This too may differ from time-based prompting delivered in a real-world environment.

Although we believe that a transition-based activity-aware prompting system can be useful in many ways, several hurdles must be overcome before such systems are a reality. In the current study, the experimenter issued the prompts, which is not practical outside of an experimental testbed. For this reason, we developed an activity recognition algorithm that has the ability to detect transitions and deliver prompts automatically during activity transitions, thus eliminating the need for human intervention [36]. In a separate study, we evaluated detection of transition periods in scripted and unscripted environments and found that the recognition algorithm was able to detect transition periods greater than 80% of the time, with a false positive rate of less than 15% [37]. However, our completed prompting system would require users to have infrared motion sensors installed in their homes. The home-based sensor system would require very little infrastructure and set-up, but it can seem obtrusive. Of note, most studies suggest that this is a small cost to pay if it allows individuals to remain independent in their homes [15]. Unfortunately, this will limit the system to in-house use only, but other back-up prompting systems can be employed if the user is out of their house when a prompt is needed. It may also be possible to integrate this prompting system into a smartphone, but currently sensors in existing smartphones would not be able to detect transition periods as accurately as a home-based sensor system. It will be important to test this system as a whole, particularly with individuals with cognitive impairment because they are the targeted user for most cognitive interventions. We also hope to expand the use of prompts incorporated into the digital memory notebook. For example, instead of prompting only to use the notebook, prompts to complete particular activities on a to-do-list or prompts to take certain medications listed in the medications section of the notebook can be added. This type of intervention system could be a useful compensatory tool for many individuals with cognitive impairments resulting from neurodegenerative diseases, such as dementia, or acquired neurological conditions, such as a traumatic brain injury. Although the prompting system has not yet been tested by those with cognitive impairment, we would expect the results to be the same, if not amplified. We base this on the theory that transition-based prompting is more effective because it reduces cognitive load, which will especially be important when working with individuals with already compromised cognition.

Overall, an effective prompting system can improve the efficacy of cognitive interventions, minimize the necessity for human assistance, and allow users to feel more independent. Research has shown that prompting technologies can enhance medication adherence, improve the use of external compensatory strategies, reduce caregiver burden, and increase functional independence in those with cognitive impairment [4,5,38]. Our research provides empirical evidence that prompting during activity transitions produces higher user response rates to the initial prompt, which is important so that the prompt is not forgotten, and more positive perceptions of the system, which is crucial for any prompting system. Furthermore, our proposed prompting system requires minimal user-intervention once set-up is complete and is ideal for people experiencing memory problems that may need external cues to successfully complete everyday activities. For people who are experiencing cognitive difficulties due to traumatic brain injuries, stroke, and neurodegenerative processes, it is imperative to develop technologies that will allow them to function more independently in their own homes; thereby reducing cost of health care and burden of caregivers [39]. Therefore, it is essential that prompting systems continue to be investigated and employed in the most effective manner possible.

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Conflict of interest

The authors report no conflicts of interest.

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