

# How an Older and a Younger Adult Adopted a Cooking Memory Aid

*Quan T. Tran, Gina Calcaterra, Elizabeth D. Mynatt*

College of Computing  
Georgia Institute of Technology  
Atlanta, GA 30332  
{quantt,ginac,mynatt}@cc.gatech.edu

## Abstract

Human memory has been shown to have a limited capacity especially under high workload conditions involving multitasking and managing interruptions. Memory has also been shown to decline with age. We replicate these findings with a longitudinal study involving older and younger adults in four naturalistic cooking scenarios within the home kitchen. We introduce a cooking memory aid, Cook's Collage, and examine how younger and older adults came to use the machine's aid to alleviate their memory demands. In this paper, we report two case studies illustrating how one younger adult and one older adult each adopted the cooking memory aid after repeated use. We also compare their different work strategies and memory needs.

## Keywords

Home, cooking, interruption, task switching, memory aid, environmental support, age-related differences.

## 1 Introduction

Failures to remember self-performed actions can result from routinized tasks occurring automatically without conscious awareness, or from confusion between already performing an action and intending to perform an action (Englekamp, 1998). Memory slips can also be caused by general memory decline of aging (Zacks et al, 2000), or by absentmindedness. Additionally, high workloads of managing interruptions and multitasking can attribute to forgetting recent actions (Gillie and Broadbent, 1989). In efforts to alleviate these memory slips, people have tried various memory strategies and memory aids with varying successes. Younger and older adults have been shown to adopt new technological aids for the home (Melenhorst, Rogers, and Fisk, 2005).

We investigate these general trends by surveying a specific technological memory aid, Cook's Collage (Tran et al, 2005), designed for use in a home kitchen, and examine how one younger and one older adult came to use the machine's aid over time under conditions that impose varying amounts of workload brought on by multitasking and managing interruptions. Of interest is how participants develop and change their strategies for using Cook's Collage to improve their performance on the tasks over time as their knowledge of and experience with the system increases. We report their different work strategies and memory needs.

## 2 Method

As Table 1 shows, participants come to our home kitchen for five 90-minute sessions over approximately two weeks. The sessions are spaced with approximately 2 days between return visits in an effort to minimize practice effects while allowing introspective reflection on performances and work strategies. On the first visit, participants perform the four trial conditions (P, D, D+I, T+D+I defined below) without the Cook's Collage as an introduction to the trials, establishing individual baseline performances. At the beginning of the second visit, participants are given an orientation to the memory aid system and complete the "play around" task mentioned below. In the remaining sessions, the participants have the Cook's Collage available to use in completing the four trials. At the beginning of each subsequent session, participants are given feedback about their performances in the previous session, and are encouraged to improve overall performance relative to their peers. Concluding each trial, participants are interviewed regarding their perceived performance, task strategies, and use of the memory aid when available.

For each session and the remainder of this paper, the trial conditions are defined as

P: Primary task scenario (i.e. punch recipe cooking task)

D: Dual task scenario (i.e. punch recipe cooking task and stove monitoring task)

D+I: Interruptions scenario (i.e. punch recipe cooking task, stove monitoring task, and interruptions task)

T+D+I: Transfer task scenario (i.e. cookies cooking task, stove monitoring task, and interruptions task)

Trials D and D+I are counterbalanced between sessions. Trial P is intended to re-familiarize participants with the cooking task per session, so it is always completed first. Trial T+D+I is intended to determine how participants transfer developed work strategies to a recipe they are not as familiar with, so it is always completed last.

Pre-session: 1 <sup>st</sup> visit (without CC aid)	Session 1: 2 <sup>nd</sup> visit (with CC aid)	Session 2: 3 <sup>rd</sup> visit (with CC aid)	Session 3: 4 <sup>th</sup> visit (with CC aid)	Session 4: 5 <sup>th</sup> visit (with CC aid)
1. Trial P	1. Trial P	1. Trial P	1. Trial P	1. Trial P
2. Trial D	2. Trial D	2. Trial D+I	2. Trial D	2. Trial D+I
3. Trial D+I	3. Trial D+I	3. Trial D	3. Trial D+I	3. Trial D
4. Trial T+D+I	4. Trial T+D+I	4. Trial T+D+I	4. Trial T+D+I	4. Trial T+D+I

**Table 1: Sample sequencing of trials and sessions across the 2-week longitudinal experiment**

## 2.1 Primary Task

Two different recipes (i.e. punch and cookies) are used for the primary task of cooking. Both recipes are posted on the overhead cabinet doors as shown in figure 1b, where participants can easily glance at them as needed. Both recipes require approximately the same number of steps and the same number of ingredients. The punch recipe consists of adding ingredients: 2 tsp strawberry powder, 1 cup sugar, 6½ cups water, 3 scoops orange juice concentrate, 3 scoops pineapple juice concentrate, 1 2/3 cups ginger ale, and 3 scoops sherbet into a large bowl. To complete the task, participants are given a limited set of measuring utensils comprising of a ½ measuring cup for the sugar and water, a 1/3 measuring cup for the soda, a ½ teaspoon for the powder, and an ice cream scooper for the remaining ingredients. The cookie recipe consists of adding ingredients: 1¼ cups flour, ¼ tsp baking soda, and ¼ tsp salt into one bowl, and 1 butter stick, ¼ cup white sugar, ¾ cup brown sugar, 1 egg, and 1 tsp vanilla extract into another bowl. To complete this task, participants are given a ¼ measuring cup and a ¼ teaspoon. The eggs are kept in the refrigerator, and the frozen ingredients (i.e. both juice concentrates and sherbet) are kept in the freezer. All other ingredients are lined around the corner countertop as figure 1b shows. Participants are encouraged to freely arrange items on the countertop as they wish; however, they are told to leave the bowl on a specific, marked spot that is optimally positioned for the system cameras. Participants are told to add the ingredients in whichever sequence they care to, but are asked to adhere to the measurements specified by the recipe. The participants are also advised of no time pressure, so they should cook at a pace that is comfortable for them. At the beginning of each subsequent session, the participants are given feedback about their cooking performance in terms of whether they added all the required ingredients and whether they added the correct counts of each ingredient.

## 2.2 Dual Task

A stove monitoring simulation is used to create a dual task scenario, intentionally overloading working memory and visual attention. Its purpose is to investigate how participants divide and balance their attention between the dual tasks. Participants are told that they will be cooking dinner for friends and family members visiting their home. They are instructed to do so by monitoring a stove simulation on a computer touch screen displaying three dishes (cheese sauce, chilli, and tomato soup) simmering on three different stove burners as shown in figure 1a. A colored vertical bar that increases and decreases in height as the food begins to either heat up or cool down represents the cooking temperature of each dish. The participants' goal is to keep the temperature of each food in the neutral zone where it is neither burning nor cooling. Participants do this by activating the High/Low switch. Pressing the "High" button stops the item from cooling and restarts to heat it, and pressing the "Low" button stops the item from heating and restarts to cool it. The three simulated burners randomly increase and decrease in temperature at different rates (the cheese sauce zips outside the neutral zone in a matter of seconds whereas the tomato soup and chilli take longer to creep outside the neutral zone), and the neutral zones per item are of different lengths and positions. With this dual task scenario, participants simultaneously attend to the stove monitoring simulation in addition to preparing the

recipe. After each dual task trial (D, D+I, T+D+I), participants are given feedback in terms of the percentage of time their food items were either burning or cooling during the given trial condition.

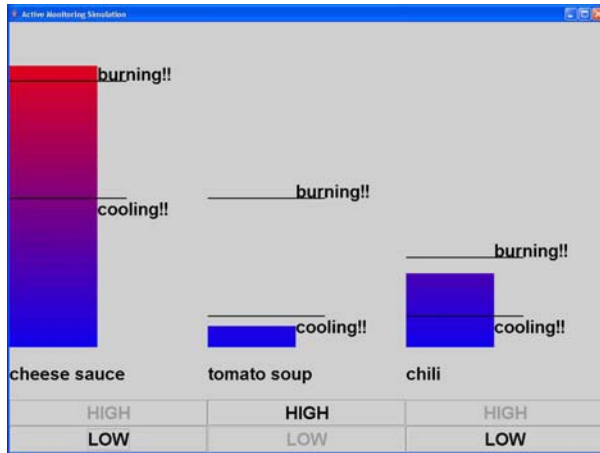


Figure 1a. Stove monitoring simulation screen display, and 1b. Physical kitchen setup of dual task

### 2.3 Interruptions Task

An alarm system simulation is used to create a multi-tasking scenario, intentionally interrupting the primary (and dual) tasks frequently. Its purpose is to investigate how participants recover after an interruption to resume a task. Participants are told that their friend is installing a new security system downstairs, and they can help their friend by disabling the system if the alarm happens to be accidentally activated. The security system is disabled by entering a 5-digit PIN (personal identification number) on a security pad touch screen mounted on a wall in the adjacent living room (shown in purple in figure 2b) within a certain time window (15 seconds for young adults, 25 seconds for older adults to accommodate appropriate walking time). If participants do not respond to the alarm within this time interval, they are required to reset their PIN. Therefore, the participants are encouraged to respond to each alarm within its allotted response time window so they will not have to choose a new number to remember. To start each interruptions trial (D+I, T+D+I), the participants choose a 5-digit PIN they think they will remember if they should need to use it. Alarm interruptions occur randomly, with a minimum of one interruption every 90 seconds. Alarm interruptions can also occur back to back, with only about 10-15 seconds between alarms. At the beginning of each subsequent session, participants are given feedback in terms of whether they failed to disarm alarm interruption(s).



Figure 2a. Cook's Collage display, and 2b. Floor layout showing how participants moved among task areas

## 2.4 Cook's Collage Orientation

At the beginning of the second visit, participants are given an overview of the Cook's Collage (Tran et al, 2005). The orientation gives no hints of developing particular strategies to leverage the system as a useful memory aid. Rather, its purpose is to inform the participants of the system's features and limitations, allowing participants to decide if and how to use the Cook's Collage. The participants are told the system keeps track of (a) the ingredients added to a recipe and (b) the number of times each ingredient is added. The participants watch a brief demo video and listen to detailed descriptions of the memory aid's display features, namely how the collage updates new images and number annotations as new ingredients or repetitions of an ingredient are added to a recipe. The demo video also highlights the system limitations. Participants are advised of variable time latency for each display update, and are pointed to "the tortoise and the hare" timeline, an additional feature at the bottom of the Cook's Collage, as a status indicator for the time latency. The participants are advised to use the timeline in determining how long the time latency is at a given moment by observing how far the tortoise (representing the system) is positioned behind the hare (representing the cook). The participants are told the goal of the Cook's Collage for this study is to reflect their ingredients' sequence and counts accurately at all times; however, they are cautioned that the display may be inaccurate sometimes due to technical and physical constraints. To minimize these inaccuracies, participants are advised (a) to pause momentarily while adding an ingredient over the mixing bowl because the system might miss these quick movements otherwise, and (b) to not add extra scoops adjusting for partial amounts because the system might mistake these additions for full amounts and because precise measurements are not required for this study.

### 2.4.1 Structured "Play Around" Task

After the Cook's Collage orientation, participants are given a 5-minute period to play around with the system. This introduction mimics how people commonly orient themselves to a newly installed product they recently purchased. The structured "play around" task constructively investigates how accurately participants understand the system after an initial use. Given an example display of how someone has made biscuits (as shown in figure 2a), and a "starter kit" with the required ingredients and a  $\frac{1}{4}$  teaspoon, participants are instructed to replicate the sample ingredients' sequence and amounts, thereby producing a similar summary on the Cook's Collage. Concluding the task, participants are asked how they would explain Cook's Collage to a friend. Participants then have the opportunity to ask clarification questions about the system and display before and after each use.

## 2.5 Units of Measurement

Task performances and Cook's Collage were measured quantitatively and qualitatively across the four trial conditions and the five session visits for each participant. Quantitatively, video footage recorded the primary task performance, counting the added amounts of each ingredient; history log from the stove monitoring simulation detailed the secondary task performance, calculating the percentage of time each food item crept outside its neutral range; and another history log from the alarm system simulation documented the interruptions task performance, noting which alarms were unresolved. Qualitatively, semi-structured interviews after each trial debriefed participants with open-ended questions, inquiring about their intentional strategies for the cooking and stove monitoring tasks and with Likert scales, rating their self-perception of how successfully they completed the tasks. History log from Cook's Collage quantitatively detailed the sequence and repetitions of the displayed ingredients, and additional open-ended questions qualitatively probed the participants about their use of the memory aid.

## 3 Preliminary Results

With experimental results from three older and three younger adult participants, we select two as case studies, illustrating what we believe to be emerging behavioral patterns between older and younger adults. We compare the quantitative records of their task performances with their qualitative self-ratings and interviews. We also examine their use of the cooking memory aid over repeated sessions, noting how the system influenced their actual and perceived performances. Our findings point to interesting trends. Younger adults divide their attention more regularly, multitasking on demand; whereas older adults prioritize their attention, selecting tasks sequentially. Younger adults use Cook's Collage as a security blanket, verifying their self-doubting recollection; whereas older adults use the memory aid as a compensation strategy, offloading the memory demands of multitasking.

### 3.1 Older Adult Case Study

We present results for an older adult whom we'll call Susan. Susan is a widowed 78 year-old female who cooks every day and multitasks while cooking (e.g., talking on the telephone, doing laundry) about 20% of the time. Susan rates her cooking skills as not advanced explaining, "If a recipe calls for more than 5 ingredients, I'd hardly ever do it." Her physical movements are slower than the other two older adults in our study; however, she is physically fit from her routine long walks. Susan exhibited absentmindedness during her cooking tasks, particularly with her memory strategy of remembering one particular ingredient at the expense of forgetting another ingredient completely. Susan instantly appreciated the concept of the memory aid, but she did not realize how she could directly benefit from its use until after a few sessions of practice. For these reasons, we select Susan as an interesting case study of how an older adult came to use the Cook's Collage as a memory aid for cooking.

#### 3.1.1 Pre-Session (1<sup>st</sup> visit) without Cook's Collage aid

Table 2 summarizes Susan's performances for the primary cooking task and the secondary stove monitoring task across the four trials. Susan managed the single task of cooking without mistakes for trial P. Increasing her workload with the dual task and interruptions negatively affected Susan's primary task performance. For trial D, she forgot two counts, and her stove monitoring was not optimal. For trial D+I, she forgot one ingredient entirely in addition to committing more counting errors, her stove monitoring declined substantially, and she failed to resolve 1 alarm interruption. For trial T+D+I, Susan's counting mistake yielded inedible cookies, her stove-monitoring performance did not improve, but she did successfully resolved all alarm interruptions.

Trial	Mistakes in primary cooking task	% burning-cooling in stove monitoring task		
		Cheese sauce	Chilli	Tomato soup
P	none			
D	-1 water, -1 soda	42	39	8
D+I	-2 water, -2 pineapple, +1 sherbet, no soda.	61	43	18
T+D+I	+2 flour	62	53	19

**Table 2. Baseline task performances for Susan**

In all 4 trials, Susan's strategy for adding the ingredients was to follow the recipe sequence. Susan confidently reported that she did not forget any ingredients and did not miscount on any ingredients for any of the recipes. For the stove-monitoring task, Susan consistently rated her performance as a 3 on a Likert scale of 1 to 5 (where 1 = never, 3 = sometimes, and 5 = all the time) commenting, "I just tried to keep up with it."

#### 3.1.2 Sessions 1-4 (2<sup>nd</sup> through 5<sup>th</sup> visit) with Cook's Collage aid

After the Cook's Collage orientation, Susan commented that it would be very handy if you were distracted because when you come back into the room, it can tell you how many measurements you put in there. She added, "It would just be a good idea, especially if you have young children and get disturbed a lot. It looks really good!"

Across all trials and all sessions, Susan remained consistent in her self-reports of her task performances. For the stove-monitoring task, Susan consistently rated her performance at 2 or 3 on a scale of 1 to 5 (where 1 = never, 3 = sometimes, and 5 = all the time), commenting, "I tried to pay more attention to it- the one on the left especially." She also reported performing the recipes correctly every time, often adding, "I know I added the correct amount, I checked the monitor." However, how she used the memory aid was critical in how her performance improved.

Trial	Mistakes in primary cooking task	% burning-cooling in stove monitoring task		
		Cheese sauce	Chilli	Tomato soup
P	misread soda measurements from recipe			
D	+1 water, misread soda	60	26	0
D+I	+2 powder, -2 water, misread soda	63	77	27
T+D+I	None	70	38	18

**Table 3. Task performances of first session with cooking memory aid for Susan**

Table 3 summarizes Susan’s primary and secondary performances on the cooking task and stove-monitoring task respectively for session 1. Having heard feedback about her pre-session performances, Susan was surprised that she forgotten the soda entirely for 1 of the 3 recipes. For session 1, She changed her recipe strategy, adding the soda first for all the punch recipes. However, she consistently misread the soda measurements from the recipe, adding 1 1/3 cup instead of the 1 2/3 cups required. Otherwise, Susan again made no mistakes in her singular task for trial P. Similar to her pre-session, Susan committed more mistakes as her workload increased. For trial D, She miscounted by 1 for 1 ingredient; and for trial D+I, she miscounted by 2 for 2 ingredients. Susan did improve her cooking performance by not miscounting any ingredient for trial T+D+I and by not entirely forgetting an ingredient for any trial. She successfully resolved all alarm interruptions except for 3 alarm interruptions in trial D+I, increasing her time away from the kitchen and the dual task.

For session 1, Susan reported using the Cook’s Collage for her water counting in general, once for her sherbet counting in trial D, and once after she was interrupted in trial T+D+I. Her recipe performance does positively correlate to her reported uses of the aid, evidenced in her 100% accurate water count for trials P and D+I, 100% accurate sherbet count for trial D, 100% accuracy in trial T+D+I. She leveraged a strategy of adding random amounts of water and waiting for the aid to count for her before computing the required number of remaining water. For trial P, she added a random amount of water and waited for the aid’s count of 11 before adding the remaining 2 scoops. For trial D, she added a random amount of water before waiting for the aid’s count of 9 and adding the rest. She commented, “I used it about 4-5 times, especially when I had to measure the water, to find the count.” This strategy worked well for trial P and D+I when the Cook’s Collage reflected accurate water counts. Relying on the memory aid for trial D did not work well because the display missed 1 count of water, negatively correlating to Susan’s 1 extra amount of water. The display also produced another minor counting error, showing 2 less amounts of powder for trial D+I, negatively correlating to Susan’s 2 extra amounts of powder. On the other hand, Susan was not negatively influenced by the memory aid’s other minor errors for trial P, counting 1 less powder amount and 1 more soda amount. For session 1, the Cook’s Collage sequenced the ingredients 100% accurately for all trials, and counted 100% accurately for trial T+D+I.

<i>Trial</i>	<i>Mistakes in primary cooking task</i>	<i>% burning-cooling in stove monitoring task</i>		
		<i>Cheese sauce</i>	<i>Chilli</i>	<i>Tomato soup</i>
P	no sherbet.			
D	None	81	29	15
D+I	-1 powder, +1 orange, no sherbet	78	61	18
T+D+I	None	80	61	20

**Table 4. Task performances of second session with cooking memory aid for Susan**

Table 4 summarizes Susan’s performances for the primary cooking task and secondary stove-monitoring task for session 2. Susan was reminded how to read the soda measurements from the punch recipe, remedying her reading error from session 1. Susan miscounted fewer times in this session, but she forgot to add the sherbet ingredient entirely during two trials. Her stove monitoring performance declined slightly from her previous session. Susan successfully resolved all alarm interruptions except for 2 alarm interruptions in trial T+D+I.

For session 2, Susan slightly altered her recipe strategy, bringing out all three frozen ingredients from the refrigerator onto the countertop when she needed to add the first frozen ingredient. However, she failed to add any sherbet from the group of frozen ingredients for trials P and D+I. Except for trial P where Susan reported never using the display, she reported using the Cook’s Collage frequently. She continued her counting strategy developed from Session 1 of allowing the display to catch up and verify the current amount before adding the last 1-4 measurements of water. Susan started applying this counting strategy to her other ingredients. For trial D, she had intended on adding another scoop of sherbet, but she corrected herself by first referring to the Cook’s Collage that showed she had already added the required amount. As she dumped her extra scoop of sherbet in the sink, she commented, “It [display] says 4, so I don’t need to add it [sherbet].” For trial T+D+I, Susan added the final scoop of brown sugar by first resting it on the kitchen countertop, waiting for the display to catch up and verify her current count, before putting it into the mixing bowl. Susan summarized her strategy for using the Cook’s Collage. “I checked to see if they [the tortoise and the hare] were together so I would know if I needed to add any more.” For trial D+I, the Cook’s Collage produced a minor counting error, showing 1 more scoop of powder than what was added; thereby negatively correlating to Susan adding 1 less scoop of powder. Otherwise, the Cook’s Collage had captured Susan’s ingredient sequence and amounts 100% accurately for all trials in session 2.

<i>Trial</i>	<i>Mistakes in primary cooking task</i>	<i>% burning-cooling in stove monitoring task</i>		
		<i>Cheese sauce</i>	<i>Chilli</i>	<i>Tomato soup</i>
P	no soda			
D	-1 sherbet, no soda	76	15	0
D+I	no soda	93	30	32
T+D+I	-3 vanilla	83	47	29

**Table 5. Task performances of third session with cooking memory aid for Susan**

Table 5 summarizes Susan’s performances on the cooking and stove-monitoring tasks for session 3. Having heard feedback for her session 2 performances, Susan was surprised that she had forgotten the sherbet entirely for 2 of the 3 punch recipes. For session 3, she changed her recipe strategy, taking out the sherbet from the refrigerator and placing it by the bowl before starting every punch recipe. However, she consistently forgot the soda ingredient entirely for all 3 recipes. For trial D, the Cook’s Collage miscounted Susan’s sherbet additions, causing her to add 1 less scoop of sherbet. For trial T+D+I, Susan added only 1 scoop of vanilla because she either misread the ingredient amount from the recipe or because she prematurely declared her task completed. Her stove monitoring performance had not substantially improved from her previous sessions, but she had successfully resolved all alarm interruptions for both trials D+I and T+D+I.

For session 3, Susan slightly changed her technique for using the memory aid with her counting. In her new strategy, Susan did not wait for the display to catch up with her random counts of water, but proceeded to add the rest of the ingredients. Only after adding all other ingredients did Susan reference the display to compute the remaining water required. This interleaving strategy allowed Susan to maximize her time by performing other tasks while the system caught up, so she could then return to verify how much she had already added and how much more she has yet to add. For trial D+I, Susan had added 3 scoops of orange juice concentrate, 3 scoops of pineapple juice concentrate, and 4 scoops of sherbet after her 9 scoops of water before returning to finish the recipe with 4 more scoops of water. She exclaimed, “I added two more waters and it came after the sherbet and said I did 13 [total count]!” Similarly, Susan used her interleaving strategy to let the aid count for her while she had to attend to the interruptions. She commented, “I had it count for me, because when I go to the bell I have to come back and check it. I saw that I needed to add some more.” Unfortunately, the aid produced a minor error in trial D, showing 1 more scoop of sherbet than what had been added; thereby negatively affecting Susan’s sherbet count of 1 less scoop than the required amount. Otherwise, the Cook’s Collage reflected Susan’s ingredient sequence and amounts 100% accurately for all trials in Session 3.

<i>Trial</i>	<i>Mistakes in primary cooking task</i>	<i>% burning-cooling in stove monitoring task</i>		
		<i>Cheese sauce</i>	<i>Chilli</i>	<i>Tomato soup</i>
P	None			
D	-1 pineapple	84	29	13
D+I	+1 pineapple, +1 orange, +2 water	91	33	12
T+D+I	-2 brown sugar, -3 vanilla	74	50	20

**Table 6. Task performances of final session with cooking memory aid for Susan**

Table 6 summarizes Susan’s performances on the cooking and stove-monitoring tasks for session 4. Having heard feedback about her session 3 performances, Susan was surprised that she had forgotten the soda entirely for all 3 punch recipes. For session 4, she changed her recipe strategy, adding the soda first for all the punch recipes. Her stove monitoring performances was similar to her previous session, and she again successfully resolved all the alarm interruptions for both trials D+I and T+D+I.

For her final session, Susan added a new strategy for using the Cook’s Collage as a memory aid. For trial P, she reported using the display to check the overall ingredient list after completing the recipe in addition to verifying her water count. For trial D, she reported using the display to verify her counts of pineapple juice, orange juice, and sherbet. She also relied on the display count of water after attending to the secondary task explaining, “When I had to tend to the stove, I stopped doing the water to tend to it. I went back later and added more water.” For trial T+D+I, she reported using the display when returning from alarm interruptions to confirm her counts of some of the ingredients. For trial D+I, she reported using the aid to verify her water and soda counts. However, the display produced a counting error, showing 2 less amounts of water; thereby causing a negative influence on Susan’s adding 2 more amounts of water. The Cook’s Collage committed a few more counting errors in the final session that did not

affect Susan’s cooking performance. For trial D, the aid showed 1 more scoop of orange juice concentrate; For trial D+I, the aid showed 2 less powder amounts; for trial T+D+I, the aid showed 1 more vanilla amount. The Cook’s Collage reflected Susan’s ingredient sequence and amounts 100% accurately for trial P.

### 3.2 Younger Adult Case Study

We present results for a younger adult whom we’ll call Jane. Jane is a married 36 year-old female who cooks every other day and multitasks while cooking (e.g., talking on the telephone, cleaning, doing laundry) about 50% of the time. She quickly became an expert with the recipes, haphazardly altering the ingredient sequences for better efficiency or just for fun. Jane also quickly learned how to leverage Cook’s Collage as a useful memory aid for her cooking tasks so she could better manage her secondary task and interruptions. On a few occasions, the alarm interruptions caused Jane to forget an ingredient count such that she relied on the display to remedy her memory slip. Other times, Jane primarily used the memory aid to confirm the final count of ingredients, diminishing her doubts of being off count by one. For these reasons, we select Jane as an interesting case study of how a younger adult came to use the Cook’s Collage as a memory aid for cooking.

#### 3.2.1 Pre-Session (1<sup>st</sup> visit) without Cook’s Collage aid

Table 7 summarizes Jane’s performances for the primary cooking task and secondary stove monitoring task across the four trials. In trial T+D+I, Jane misread the flour amount from the recipe, adding 1 cup and ¼ teaspoon rather than the 1¼ cup specified. Otherwise, she added the correct ingredients and correct amounts for each recipe. Jane’s performance on the stove-monitoring task improved with practice. She successfully resolved all alarm interruptions.

Trial	Mistakes in primary cooking task	% burning-cooling in stove monitoring task		
		Cheese sauce	Chilli	Tomato soup
P	none			
D	none	12	7	0
D+I	none	8	1	0
T+D+I	misread flour measurement from recipe	5	0	0

**Table 7. Baseline task performances for Jane without the memory aid**

In each trial, Jane’s strategy for adding the ingredients was to follow the recipe sequence. Her strategy for adding the water ingredient was to count aloud in half cups increments, which she explained in her interview. Jane confidently reported that she did not forget any ingredients in all the four trials. She didn’t think she miscounted for the cookie recipe, but she did doubt her counting accuracy for the punch recipe even though she had made no mistakes. On a Likert scale of 1 to 5 (1 = no, 3 = maybe, 5 = yes), Jane self-rated her punch recipe performance explaining, “maybe too few of the water” (rated as 3) for trial P, “may have messed up on the water again” (rated as 2) for trial D, and “I think I added too few of the ginger ale, maybe” (rated as 2) for trial D+I. When asked to rank her performance on the stove-monitoring task on a Likert scale of 1 to 5 (1 = never, 3 = sometimes, and 5 = all the time), Jane rated her performances as 2 for all three trials that involved the dual task.

#### 3.2.2 Session 1-4 (2<sup>nd</sup> through 5<sup>th</sup> visits) with Cook’s Collage aid

After the Cook’s Collage orientation, Jane correctly explained how the system operates, showing her clear understanding of the memory aid. She suggested that it “would be really good for a long, complicated recipe.”

In every trial of every session with the cook’s collage, Jane performed the primary cooking task without any errors, adding the correct ingredients and correct amounts. She also performed well on the stove-monitoring task in every trial of every session as table 8 summarizes. Jane did fail to resolve 1 alarm interruption in trial D+I of session 1 and 1 alarm interruption in trial D+I in session 3. These alarm incidents prolonged her attention away from the dual task, causing a drop in her corresponding stove-monitoring performances.

Like her pre-session interview, Jane confidently reported she did not forget any ingredient across all trials in all sessions with the aid except for trial D in session 2. She reported, “I may have forgotten to add the soda” (rated as 2). Jane did add the soda first in her ingredient sequence, but she did not confirm this with the memory aid until she had completed the entire set of seven ingredients. The Cook’s Collage displays the six most recently added



ingredients only. Referencing the display, Jane could not find the soda, so she could not confirm her recollection of adding the soda. Unlike her pre-session interview, Jane no longer doubted her counting accuracy in any of the remaining trials and sessions with the aid. Jane’s self-reports for her stove-monitoring task varied between ratings of 1-3 on the Likert scale relative to whether she was also adding ingredients and whether she had to leave the room to disarm the alarm. During the pre-session and Session 1, Jane used a strategy of monitoring the stove mostly while stirring the ingredients. Starting with session 2, however, Jane leveraged a more pre-emptive strategy for the stove-monitoring task. She explains, “I tried to keep it in the middle. If it got to be halfway toward burning or cooling I’d set it going the other way.”

Trial	Session 1			Session 2			Session 3			Session 4		
	cheese	Chilli	tomato	cheese	chilli	tomato	cheese	chilli	tomato	cheese	chilli	tomato
D	4	1	0	10	9	4	0	0	0	0	0	0
D+I	10	9	4	2	2	0	6	1	2	3	2	0
T+D+I	3	1	0	2	0	0	0	0	0	4	0	0

**Table 8. Percentage of burning-cooling for Jane’s stove-monitoring task during sessions with the memory aid**

Jane’s excellent performances across all tasks for all the trials and all the sessions did not indicate a ceiling effect because she leveraged compensation strategies to assist her maintain her optimal performance. Immediately following her introduction to Cook’s Collage, she adopted the strategy of going back and adding more of an ingredient at the end of the recipe if the aid did not verify she had the right count. In general, Jane used the Cook’s Collage to verify her recollection of adding an ingredient and its count. She also frequently relied on the display in counting the final scoop of water for the punch recipe. Jane made the general advice of holding the ingredient container when adding an ingredient into the mixing bowl so the displayed picture could identify the ingredient. The Cook’s Collage was 100% accurate for all trials and all sessions except for two minor miscounts detailed below.

In session 1, for trial P, she reported using the display to confirm her water count. For trial D+I, she used the aid for her final scoop of orange juice concentrate. Jane commented, “For the orange juice, I only put in 2. And when it [aid] still said 2, I put in another scoop. I waited awhile first though to make sure it maybe just hadn’t caught up.” For trial T+D+I, she reported using the display to verify if she already added a particular ingredient requiring only one scoop (from the many ingredients requiring similar singular scoops) when she returned from an interruption.

In session 2, for trial P, Jane reported using the display to confirm her water count again, but she did not notice that the aid displayed an erroneous extra scoop of sugar than what she had added. For trial D+I, Jane was completely disrupted by an alarm interruption and relied on the display to resume her task. She explained, “When I came back from the alarm, I needed to check it for something, but I can’t remember what ingredient it was.”

In session 3, for trial P, Jane used the aid to double-check her counts, but she noted a discrepancy between her memory and what she saw on the display. “It told me I only put in 2 orange juices, but I know I put in 3 of them. I looked at it to see if it was going to change.” She was confident that she was right and it was wrong. For trials D, D+I, and T+D+I, Jane reported using the display after completing her cooking tasks to verify the ingredient counts.

In her final session, for trial P, Jane reported using the aid to verify her water count. For trial D, she reported not using the aid at all. For trial D+I, she used the aid for the water count again explaining, “One time when I went to get the alarm, I forgot how many I put in. So I had to check it [display] when I got back.” For trial T+D+I, she referred to the display after an alarm interruption had again disrupted her running count. She commented, “I used it [display] to check my brown sugar. I wasn’t sure how much I put in when I went to the alarm during that one.”

## 4 Discussion

In conducting this experimental method, we learned a few practical lessons regarding technical constraints and user frustration. The touch screen panels used for the stove-monitoring task and the interruptions task proved at times problematic for user input. This was common for the older adults, but both groups experienced some difficulty interacting with the displays especially when their fingers were dirtied from the ingredients. The resulting noise in the distracter task performances and overall frustration are not disadvantageous for the study because they emulate operational frustrations incidentally encountered in everyday cooking. Similarly, the Cook’s Collage produced

counting errors at times. As a technical prototype, we are interested in how people interact with the new device, learn how to best use it to their benefit, and willingly accommodate its limitations. As a technical control in this experimental study, the inaccuracies of the memory aid can cause problems in understanding its impact. However, the case studies illustrate how the interviews can give insight into whether they acknowledged the displayed information and/or were influenced by it.

Based on our preliminary experimental results, we can start comparing differing memory needs and strategies exhibited between the older and younger adult case study as summarized in table 9. Of interest are the similarities and differences in their use of the memory aid, their perceived differences in their memory abilities, and the differences in their work strategies.

	<i>Older adult case study participant: Susan</i>	<i>Younger adult case study participant: Jane</i>
Memory	<ol style="list-style-type: none"> <li>1. fully confident of self recollection</li> <li>2. tendency to forget entire ingredients was greater than tendency to miscount ingredients</li> </ol>	<ol style="list-style-type: none"> <li>1. doubted self recollection</li> <li>2. tendency to miscount ingredients was greater than tendency to forget entire ingredients</li> </ol>
Use of memory aid	<ol style="list-style-type: none"> <li>1. offload memory demands (real need)</li> <li>2. defer final counts of ingredients</li> <li>3. summary check list of ingredients</li> <li>4. used only when needed</li> </ol>	<ol style="list-style-type: none"> <li>1. assuage self doubt (as confirmation only)</li> <li>2. defer final counts of ingredients</li> <li>3. summary check list of ingredients</li> <li>4. used only when needed</li> </ol>
Attention to dual task	<ol style="list-style-type: none"> <li>1. priority driven</li> <li>2. made preparations before switching task</li> <li>3. reacted only when outside neutral zone</li> </ol>	<ol style="list-style-type: none"> <li>1. interrupt driven</li> <li>2. made no preparations before switching tasks</li> <li>3. prevented from going outside neutral zone</li> </ol>
Attention to interruption task	<ol style="list-style-type: none"> <li>1. priority driven</li> <li>2. finished ongoing task before switching</li> </ol>	<ol style="list-style-type: none"> <li>1. interrupt driven</li> <li>2. did not finish ongoing task before switching</li> </ol>
Attention to primary task	<ol style="list-style-type: none"> <li>1. priority driven</li> <li>2. segmented recipe by ingredients</li> <li>3. varied sequence by perceived need</li> </ol>	<ol style="list-style-type: none"> <li>1. interrupt driven</li> <li>2. segmented recipe by each step</li> <li>3. varied sequence by perceived fun</li> </ol>

**Table 9. Summary of differing memory needs and strategies between the older and younger adult case studies**

## 5 Future Work

We continue this longitudinal study to complete a sample size of 20 (i.e. 10 younger adults, and 10 older adults). Of interest is whether the preliminary findings are indeed representative behaviors or would other behaviors emerge.

## References

- Engelkamp, J. (1998). *Memory for actions: Essays in Cognitive Psychology*. Germany: Psychology Press.
- Gillie, T., Broadbent, DE. (1989). What makes Interruptions Disruptive? A study of Length, Similarity, and Complexity. *Psychological Research* 50, pp 243-250.
- Melenhorst, A. S., Rogers, W. A., & Fisk, A. D. (2005). When will technology in the home improve older adults' quality of life? In H. W. Wahl, C. Tesch-Römer, and A. Hoff (Eds.), *Emergence of new person-environment dynamics in old age: A multidisciplinary perspective*. Amityville, NY: Baywood Publishing
- Tran, Q.T., Calcaterra, G., Mynatt, E.D. (2005). *Cook's Collage: Déjà vu Display for a Home Kitchen*. Proceedings of HOIT 2005.
- Zacks, R.T., Hasher, L., & Li, K.Z.H. (2000). Human Memory. In F.I.M. Craik and T.A. Salthouse (Eds.), *The Handbook of aging and cognition* (2<sup>nd</sup> ed., pp. 293-357). Mahwah, NJ: Erlbaum.